Electric Program Investment Charge (EPIC) Evaluation

Final Report

September 8, 2017

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List of Key Terms

Term	Description
Administrators	The four entities that the CPUC authorized to administer EPIC: the California Energy Commission (CEC), Pacific Gas and Electric Company (PG&E), San Diego Gas & Electric (SDG&E), and Southern California Edison (SCE).
Investor-Owned Utilities	The three regulated electric utilities, which are EPIC administrators: PG&E, SDG&E and SCE.
The Legislature	The California State Legislature
Triennial Investment Plans (or Investment Plans)	Required investment planning document to be completed by each administrator on a three year cycle.
Annual Reports	Reports that the CPUC requires the administrators to develop and distribute at the end of each program year, which are due each February 28.
Investment Areas/Program Areas/Funding Categories	The defined categories in which the CPUC authorized the administrators to conduct EPIC projects: Applied Research and Development (Applied R&D), Technology Demonstration and Deployment (TD&D) and Market Facilitation. The IOUs' role is limited to the area of TD&D.
Innovation	A product innovation is defined as the introduction of a good or service that is new or significantly improved with respect to its characteristic or intended uses. Product innovations can utilize new knowledge or technologies or be based on new uses or combinations of existing knowledge or technologies.
Program Theory and Logic Model	A narrative (program theory) and accompanying diagram(s) that describe Program inputs and activities and how they combine to produce expected outputs which, in turn, may produce expected short-term, mid-term and long-term outcomes. Each pathway or linkage in the logic model describes a hypothesized cause and effect relationship.
Theory-Based Evaluation Framework	An evaluation approach and accompanying framework that is often used for complex programs such as EPIC whose benefits are intended to be realized over a long time period. The approach relies on the development of logic models and associated indicators of progress to identify plausible causal mechanisms and test related hypotheses in order to assess the extent to which major components of the Program are successfully implemented and build a case for attribution. For a list of references that provide detail on theory-driven evaluation, please see Section 17: Appendix F.
Applied Research and Development (Applied R&D)	Includes activities supporting pre-commercial technologies and approaches that are designed to solve specific problems in the

Term	Description
	electricity sector.
Technology demonstration and deployment (TD&D)	Installation and operation of pre-commercial technologies or strategies at a scale reflective of anticipated operating environments to enable appraisal of the operational and performance characteristics and financial risks.
Market Facilitation	Refers to a range of activities including program tracking, market research, education and outreach, regulatory assistance and streamlining and workforce development to support clean energy technology and strategy deployment.
Electric System Value Chain Elements	Consisting of: • Grid operations/market design • Generation • Transmission • Distribution • Demand side management
IOU Investment Framework Elements	A framework the IOUs developed to structure their Investment Plans, which includes four investment areas (all within the TD&D area) that the IOUs have identified as critical areas on which to focus in order to modernize the grid: • Renewables and Distributed Energy Resources (DER) Integration – focuses on renewables and distributed energy resources integration, and supports the state's Renewable Portfolio Standard, greenhouse gas emission reduction and energy storage goals. • Advanced Asset Management and Optimization – focuses on grid modernization and optimization, and addresses SB 17 and smart grid planning and implementation. • Customer Products/Service Enablement and Integration – focuses on the integration of demand side management with the smart grid, and supports Zero Net Energy policies. • Cross-Cutting/Foundational Strategies and Technologies – focuses on smart grid architecture, cybersecurity, telecommunications and standards development.
Grant Funding Opportunity and Program Opportunity Notice Solicitations	The CEC has issued these two types of solicitations for EPIC.
Notice of Proposed Award (NOPA)	The CEC issues a NOPA to announce the winning bidder.
Grantee	The bidder who receives a grant from the CEC to conduct EPIC projects under the direction of the CEC's Commission Agreement Manager (CAM).

Term	Description
Vendor	The contractor who receives a contract from the IOUs to conduct a component of an EPIC project under the direction of the IOUs.
Program Manager	For CEC projects, the person designated by the bidder to oversee the project and to serve as the main point of contact from the grantee's organization. For IOU projects, the IOU staff member who serves as the main point of contact for an EPIC project.
Technology/Knowledge Transfer Plan	A plan that the CEC requires grantees to complete and implement that describes how they will disseminate project-related knowledge and results through channels such as published articles, presentations at conferences and workshops, and dissemination of information on grantee websites or via social media platforms.
The Evergreen team	The evaluation team composed of Evergreen Economics, NMR Group, Inc., Ridge & Associates, Jai J. Mitchell Analytics and Advanced Survey Design
Peer RD&D programs	Other Research, Development and Demonstration programs that we reviewed during the course of the best practices assessment, to which we compare EPIC.
Smart Grid	An electricity supply network that uses digital communications technology to detect and react to local changes in usage.
Regional Energy Innovation Cluster	Provides key and coordinated assistance, resources, and infrastructure needed by entrepreneurs and researchers in the region to successfully bring to market energy innovations that can benefit IOU electric ratepayers. Composed of a concentration of interconnected companies, universities, investors, business incubators and business accelerators that stimulate innovative activity by promoting intensive interaction and collaboration, sharing of facilities, competition and promotion of entrepreneurship.
Comprehensive evaluation	An evaluation that includes elements of a process evaluation, a formative evaluation, and an impact evaluation.
Process evaluation	A form of program evaluation designed to determine whether the program is delivered as intended to the target recipients, also known as implementation assessment.
Formative evaluation	Evaluation activities undertaken to furnish information that will guide program improvement.
Impact evaluation	An evaluation study that answers questions about program outcomes and the conditions it is intended to ameliorate. Also known as outcome evaluation.

Acronyms and Abbreviations

ACE Program	The New York State Energy Research and Development Authority's (NYSERDA's) Advanced Clean Energy Exploratory Research Program
ARPA-E	The Department of Energy's Advanced Research Projects Agency-Energy Program
CAISO	California Independent System Operator
CalSEED	California Sustainable Energy Entrepreneur Development Initiative
CAM	Commission Agreement Manager, individual designated by the California Energy Commission to oversee the performance of EPIC contracts resulting from a solicitation and to serve as the main point of contact for the recipient.
CEC	California Energy Commission
CEDMC	The California Efficiency + Demand Management Council
CPUC	California Public Utilities Commission
CVD	Commercialization Valley of Death
DER	Distributed Energy Resources
DG	Distributed Generation
DOE	Department of Energy
DRP	Distributed Resource Plan
DSM	Demand Side Management
DVBE	Disabled Veteran Business Enterprise
EPIC	Electric Program Investment Charge, the source of funding for the projects awarded under this solicitation.
EPRI	Electric Power Research Institute
ERD	Energy Research & Development (ERD) Division – the CEC manages EPIC within its ERD Division
EV	Electric Vehicle
GFO	Grant Funding Opportunity
GHG	Greenhouse Gas
IOU	Investor-Owned Utility, including PG&E, SDG&E and SCE
IP	Intellectual property
IRP	Integrated Resource Plan
NOPA	Notice of Proposed Awards
NYSERDA	New York State Energy Research and Development Authority

OECD	Organization for Economic Co-operation and Development
PAC	Policy Advisory Committee
PG&E	Pacific Gas and Electric Company
PIER	Public Interest Energy Research program (EPIC's predecessor)
PON	Program Opportunity Notice
RD&D	Research Development and Demonstration
RFP	Request for Proposals
RPS	Renewable Portfolio Standard
SBIR	Department of Energy's Small Business Innovation Research Program
SCE	Southern California Edison
SDG&E	San Diego Gas & Electric
STTR	The Department of Energy's Small Business Technology Transfer Program
T&MD	Technology and Market Development – a NYSERDA RD&D program
TAC	Technical Advisory Committee
TRL	Technology Readiness Level
TVD	Technological Valley of Death
ZEV	Zero Emission Vehicle
ZNE	Zero Net Energy

1 Executive Summary

This report documents the results of an evaluation of the Electric Program Investment Charge (EPIC, or the Program), which is a research, development and demonstration (RD&D) program that funds a broad portfolio of innovations[1] that seeks to advance the frontiers of energy science and technology. The California Public Utilities Commission (CPUC) established and oversees EPIC, which is administered by four entities: the California Energy Commission (CEC), Pacific Gas and Electric Company (PG&E), San Diego Gas & Electric (SDG&E) and Southern California Edison (SCE). PG&E, SDG&E and SCE are the three electric California investor-owned utilities (IOUs). CEC projects cover three program areas: 1) Applied Research and Development (Applied R&D), 2) Technology Demonstration and Development (TD&D) and 3) Market Facilitation, while the IOU projects are focused only on TD&D.

By the end of 2016, a total of ***19 EPIC projects were completed and 250 were in progress.***

Table 1 shows the total program budget for the first two Triennial Investment Plans covering program years 2012–2017.

Table 1: EPIC Program Budget (2012–2017)

Administrator	Budget (2012–2017)	Percent of Budget
CEC	$696,804,500	80%
PG&E	$89,000,000	10%
SCE	$72,754,534	8%
SDG&E	$15,540,000	2%
Total	**$874,099,034**	**100%**

Source: Administrators' 2016 Annual Reports

1.1 Evaluation Objectives and Approach

The objective of the study was to conduct a comprehensive evaluation of EPIC to identify opportunities to improve program management and effectiveness. To this end, specific objectives included the following:

[1] A product innovation is defined by the Organization for Economic Co-operation and Development (OECD) as "... the introduction of a good or service that is new or significantly improved with respect to its characteristic or intended uses. Product innovations can utilize new knowledge or technologies or be based on new uses or combinations of existing knowledge or technologies" (Tinguely 2013).

- Determining if the Program is being implemented in a manner consistent with the program objectives, requirements and intent of the CPUC and the California Legislature as set forth in a series of CPUC Decisions;[2]
- Assessing the extent to which the Program supports key energy policies and public research code sections;
- Identifying best practices in research administration;
- Assessing the extent to which the Program is on track, thus far, in meeting its objectives to provide ratepayer benefits, advance energy innovation and support California's energy policy goals; and
- Providing recommendations for improvements to program requirements and practices.

The evaluation results were intended to support and inform the CPUC's consideration of EPIC within the next triennial application proceeding, which was initiated in the spring of 2017 with the administrators' 2018-2020 Investment Plan application filings.

For the purposes of focusing this evaluation on the most fundamental program characteristics, CPUC staff established EPIC's core, overarching goals (or core values).

> ***The evaluation focused on EPIC's core values*** of:
> - providing ratepayer benefits;
> - advancing energy innovation; and
> - supporting California's energy policy goals.

1. ***Electricity IOU Ratepayer Benefits:*** Providing electric ratepayer benefits was established as the mandatory guiding principle of EPIC, which the CPUC defined as promoting greater reliability, lower costs and increased safety.
2. ***Energy Innovation:*** The CPUC established a range of administration and program requirements intended to ensure that EPIC funds Research Development and Demonstration (RD&D) activities that assist the emergence of innovative energy technologies and services, for the benefit of California's electricity IOU ratepayers and the public interest. Overall, advancing true, productive energy innovation is a core purpose of the Program. This goal should be supported not only in EPIC's technical program areas, but also in EPIC's administrative structure. Therefore, all program decisions and activities—from the setting of research priorities to the treatment of intellectual property concerns and the administrative balancing of due process with flexibility and responsiveness—should support, embody and advance true, productive energy innovation.
3. ***California's Energy Policy Goals:*** As the CPUC's EPIC decisions make clear, supporting California's key energy, climate and economic policy goals is one of the

[2] D.11-12-035, D.12-05-037, D.13-11-025, D.15-04-025, and D.15-09-005.

core justifications of the Program that drives much of EPIC's governance and requirements. Each EPIC funding decision and activity must be made and implemented in the context of these policy goals.

Evergreen Economics, along with NMR Group, Inc., Ridge & Associates, Jai J. Mitchell Analytics and Advanced Survey Design, employed a theory-driven evaluation framework within which we assessed the Program's effectiveness, guided by a series of logic models that we developed. We conducted several research activities including review of program documents and data and in-depth telephone interviews with program administrators, project managers, contractors and stakeholders. We also conducted a best practices assessment that included a literature review and in-depth telephone interviews, as well as a network analysis.

1.2 Key Findings and Recommendations

Below, we summarize the highest priority findings and recommendations, in order of priority. A complete set of recommendations is provided in Section 11: Findings and Recommendations, in which we number recommendations sequentially by section (which we have retained in the Executive Summary).

1.2.1 Program Requirements

The Program is guided by a series of CPUC Decisions that establish the purpose and governance for EPIC and provide a policy rationale for continuing public interest funding in the energy area where private capital is unlikely to provide adequate support. To ensure that the Program is administered consistently with its core values, the Decisions establish the requirements and administrative procedures for EPIC.

Based on our review of program administrative procedures (including program document review and interviews with administrators), **we find that the four administrators are in compliance with program requirements**. However, we identified areas where the administrators are technically compliant but could better fulfill the spirit or intent of the requirements (such as stakeholder engagement, coordination and information sharing). Likewise, we identified other cases where the minimum requirements are not sufficient to ensure best-in-class program administration. We discuss these issues below.

> ***Key finding:*** The administrators are in compliance with the *letter* of EPIC program requirements, but could better fulfill the *spirit* of some requirements.

1.2.2 EPIC Project Impacts

The Evergreen team employed a theory-driven evaluation framework within which we assessed the Program's effectiveness, guided by a series of logic models that we developed to support the theory-based research design. For a complex program such as EPIC, our evaluation team developed performance metrics for each activity, output and outcome to assess the extent to which major activities of EPIC have been and are being successfully implemented and whether these activities had led to or are likely to lead eventually to the expected short-, mid- and long-term outcomes. We also assessed the extent to which the projects are aligned with the Program's objectives.

Overall, the EPIC portfolio appears to be on track, thus far, in meeting its objectives to provide ratepayer benefits, advance energy innovation and support California's energy policy goals. Collectively, EPIC is both broad and deep, and administrators take steps to integrate projects into the broader innovation and policy landscape. To that extent, projects appear to be consistent with the Program's objectives and core values. However, as a portfolio, EPIC may not be fully optimized to best support energy policy and innovation, which we describe in the next sub-section.

> *Key finding:* Each project in the EPIC project portfolio is meeting its objectives, but it is unclear if the portfolio as a whole is optimized.

Since 2012, the EPIC administrators have funded hundreds of projects and will continue to do so for the foreseeable future. The combined efforts of the past, present and future projects is expected to move EPIC incrementally closer to achieving California's important public policy goals. Given the on-going nature of EPIC and its long-term objectives, we recommend that:

- ***7a) Using the theory-driven framework developed for this evaluation, monitor and report key performance metrics on an on-going basis and conduct a comprehensive evaluation every three to four years. All of these evaluation activities should be conducted by an independent evaluator in close collaboration with the four administrators to avoid any duplication of efforts and to ensure that the results will be useful to all stakeholders (e.g., the CPUC, state legislators, and the four administrators and other stakeholders).*** While this evaluation report documents what is working and what could be improved, the Program is still very young and should undergo ongoing independent assessment to ensure it remains on track and addresses the issues we have noted. Moreover, most projects have yet to be completed, and independent review is needed in the future to assess project benefits as the Program matures. Conducting independent program evaluations is consistent with the best practice of peer RD&D programs.
- ***7b) The administrators create a single, centralized database containing all relevant information on active and completed EPIC projects along with monitoring and quarterly reporting of key performance metrics,*** in order to support the on-going evaluation of the Program.

1.2.3 Optimizing EPIC's Portfolio

> *Key finding:* There is a need to prioritize among EPIC's many objectives.

Given the many policy areas EPIC is attempting to address, we have identified a need to prioritize the guiding principles, policies and strategic objectives, and operationalize what it means for a portfolio to be optimized. There is no clear set of priorities EPIC is seeking to address, or prioritization of research gaps or needs. For example, we confirmed that every EPIC project may be likely to provide ratepayer benefits, but there is variation in how broad and/or direct those benefits are. We also confirmed that every EPIC project supports at least one energy policy area, but there are many relevant policy areas that lack clear prioritization. Projects are not categorized or tracked by technology or policy area, making it difficult to assess the effectiveness of EPIC on advancing key policy. We also observed that EPIC focuses less on commercialization than peer RD&D programs, though we note that EPIC's objectives are much broader.

As stated above, we can determine that program administrative procedures and EPIC projects meet regulatory requirements, but without clear priorities for the Program, we cannot determine whether the portfolio of projects collectively is truly optimized. To ensure that EPIC is generating the optimal mix of projects that maximize ratepayer benefits, lead to energy innovation and support the state's key policy goals, we recommend that:

- ***2a) The CPUC establish priorities among its current policy goals and funding criteria to better guide the administrators in their investment planning.***
- ***2b) The administrators collaborate in categorizing and summarizing projects*** (such as by technology type and/or policy area) and review projects by topic areas to ensure that the portfolio of projects effectively supports key policy goals.

> In Section 1.2.5, we recommend that the administrators ***convene an independent body*** to support an effort to categorize projects.

1.2.4 Effectively Engaging Stakeholders

Our analysis of knowledge dissemination activities and relational networks suggests that project teams are actively engaged in developing networks of stakeholders and other market actors and are well positioned to disseminate knowledge widely once projects are completed. However, EPIC's four-administrator model has limitations compared to peer RD&D programs that are administered by a single organization. For EPIC, there is no single administrator that can effectively convey information to stakeholders nor is there a program-wide communications mechanism or central repository of project information. As a result, information dissemination and stakeholder engagement is less than optimal.

Further contributing to the inherent limitations associated with the four-administrator model is that each administrator relies primarily on an Annual Report to disseminate information on project status and results. However, this does not optimally engage stakeholders or support effective CPUC oversight. While the administrators are in compliance with program reporting requirements, there is room for improvement by following the best practices of peer RD&D programs.

In order to ensure that the Program is generating a set of projects that most effectively advance energy innovation, and that the administrators more effectively engage stakeholders and facilitate CPUC oversight, we recommend that the administrators share project information more frequently and do so in a more coordinated and topical manner. We recommend that:

- ***4a) The administrators share information while projects are in progress with the CPUC and the public on a more frequent basis***, such as quarterly. The Annual Reports, on their own, are not the most effective way to disseminate information about EPIC projects. These quarterly reports should:
  - ***Be distributed via a single EPIC website and listserv***, so that the CPUC and stakeholders can more easily obtain information about all projects without having to review four separate reports. Included on this website would be a downloadable centralized Excel spreadsheet that contains key information for all EPIC projects. This would ensure that stakeholders have an easy way to obtain all relevant information about EPIC projects that supports their particular areas of interest.
  - ***Categorize projects (as recommended previously) by technology and/or policy, with sort / filter capability***, so the CPUC and stakeholders can more easily obtain information about projects in a particular category without having to search through long lists of individual projects.
  - ***Include current information about project outcomes*** such as recent or upcoming presentations, publications and interim knowledge dissemination. See Appendix D for an example of a quarterly status report that we developed that provides a recommended starting point for such a report.

In Section 1.2.5, we recommend that the administrators ***convene an independent body*** to support such coordination efforts.

- ***4b) The administrators collaborate and jointly convene a quarterly workshop to share results about project status and lessons to-date on a topical basis***, with engagement from stakeholders on topics that are of interest. Such workshops should be publicized in advance along with the topic or topics to be covered. All EPIC projects that fall under the announced topic should be discussed and organized topically. In general, EPIC stakeholder workshops are not organized topically, and IOU projects are typically presented in an ad hoc fashion, which is not an effective way to engage stakeholders.

We also have identified a need for the administrators to coordinate on compiling and jointly reporting on project benefits. There is no central place where project results and benefits are summarized. Reports that document project results are included in the administrators' Annual Reports and posted on websites, and additional dissemination plans are developed on a project-by-project basis. A policymaker, legislator or other stakeholder would have a difficult time determining the aggregate impact of the Program. We recommend that:

- ***4d) The administrators develop a process to jointly report on EPIC's short-, mid- and long-term project benefits*** across the portfolio on a routine basis (e.g., annually) to the CPUC, relevant stakeholders and the general public.

1.2.5 Independent Coordination Body

Our evaluation has identified a critical need for improving administrative coordination and stakeholder engagement that the administrators are not currently addressing due to limitations associated with the administrative model and their reliance on minimum project reporting procedures. **We have identified a need to explicitly supplement the existing administrative structure by convening an independent body that provides coordination and facilitation support to the administrators and compiles and helps disseminate information.** Such efforts would increase transparency and stakeholder engagement and ensure the Program is most effectively directing EPIC funds toward energy innovation that meets the highest priority state policy goals, as identified by the CPUC. These efforts would also address the deficiencies we outlined in the previous two sets of findings. We recommend that:

> *Key finding:* There is a need to supplement the administrative structure by ***convening an independent body to coordinate, facilitate and lend technical expertise***.

- ***6a) The CPUC and/or the administrators fund and convene an independent body to coordinate, facilitate and lend technical expertise.*** The highest priority areas such a body could support include:
    - Convening and engaging stakeholders earlier in the investment planning process;
    - Engaging stakeholders and ensuring any input that would lead to greater ratepayer and state policy benefits is considered by the administrators in their Investment Plans;
    - Supporting administrator and CPUC efforts to track and prioritize policy goals and funding criteria, and periodically revisiting priorities as policy goals change and EPIC matures;

- Supporting administrator and CPUC efforts to ensure that those priorities are effectively addressed in the administrators' Investment Plans;
- Supporting administrator efforts to categorize projects by technology and/or policy areas, to facilitate easier access of EPIC project information for interested stakeholders;
- Reviewing administrator project research plans and quarterly status reports, such as by policy and/or technology areas; tracking related developments in CPUC proceedings and engaging relevant stakeholders in projects of interest; and helping to identify issues or concerns;
- Planning and facilitating a quarterly meeting devoted to a particular topic of interest to stakeholders, including publicizing the meetings to stakeholders and addressing their needs;
- Coordinating an effort to develop a centralized EPIC website, database and listserv; helping to identify interested parties; and ensuring that those parties are linked to relevant information on projects and topic areas of interest; and
- Identifying interested stakeholders and appropriate forums for administrators to more broadly disseminate their results.

1.2.6 IOUs in Compliance, but Not Meeting Intent of All Requirements

The IOUs are technically in compliance with EPIC program requirements, but many of their administrative practices are inconsistent with best practices we identified among peer RD&D programs. We examined the numerous CPUC requirements that fell into the following nine categories.

- Statutory guidance
- Investment Plans
- Limitations on projects
- Contracts
- Stakeholder engagement
- Quantifying benefits/metrics
- Budget
- Annual reports
- Miscellaneous

To verify compliance with these requirements, we relied on a combination of sources, including program filings (e.g., Annual Reports and Investment Plans), the sample of projects for which we had more detailed information (supplemented by interviews with grantees, vendors and IOU/CEC project managers) and the sample of CEC solicitations/bids and IOU request for proposals (RFPs) and vendor bids. We then compared the IOU administrative practices to other peer RD&D program practices and observed a number of areas where performance could be improved. For example, project selection, transparency and stakeholder engagement could be improved. By adopting some or all of the best practices we identify below, EPIC would be more effective at producing energy innovation that is more explicitly supportive of state energy policies.

Table 2 summarizes key differences (and a few similarities) in CEC and IOU administrative processes as compared to other peer RD&D programs. A check mark indicates that the administrative process is consistent with peer programs.

Table 2: Comparison of EPIC Administrative Processes to PEER RD&D Programs

Administrative Process	CEC	IOUs
Program Management and Administration	Awards grants to **external** organizations that conduct their research. ✓	Conduct their research using **internal** staff with use of vendors.
	Administration is managed by a **core team with RD&D program expertise**, with technical support provided by both internal and external experts. ✓	
	Four-administrator model.	
Investment Planning	Identifies a series of strategic objectives with **strong and transparent linkages** to state policy goals. ✓	Develop Investment Plan priorities **internally**, predominantly relying on their own technical experts and management to identify and prioritize research areas, with linkages to policy **less transparent**.
	Relies mostly on input from multiple external stakeholders; develops its Investment Plans **transparently and engages external stakeholders** throughout the process. ✓	Rely mostly on external input from a single utility-focused stakeholder; **insufficient transparency** in developing Investment Plans.
Project Selection	Uses a **transparent and public process** for selecting projects and shares project scopes of work in a timely manner. ✓	Use a **less transparent, internal process** for selecting projects and do not share project scopes of work in a timely manner.
	Due diligence is being done to identify projects that, absent EPIC funding, would not move forward or would move forward more slowly. ✓	
Project Assessment	**Shares information** about projects while they are being implemented but less frequently than optimal.	
	Uses a robust process for collecting the necessary quantitative data needed to comprehensively report on project benefits and disseminate results. ✓	**Lack a robust process** for collecting the necessary data needed to comprehensively report on project benefits and disseminate results.

✓ = consistent with peer RD&D program practices

Note that we also examined each of the four administrators' processes and projects. When we compared across the four administrators, the main finding was the difference in how the CEC approaches program administration as compared to the IOUs. However, we did note some differences in processes across the three IOUs in this report, which we discuss in the report results and findings sections. Note that those comparisons were limited by the size of the project sample for each IOU (which reflects the relatively smaller portion of the EPIC budget that the IOUs receive as compared to the CEC).

While each IOU project is related to at least one area of the state's energy policy, the IOUs' internal needs, rather than energy policy, most often determine which projects are implemented. There is obviously overlap between the IOUs' internal needs and state energy policy, but the mix of projects the IOUs select may not be the most optimal to advance the highest priority state policy areas. Once priorities are set, it will be easier to assess how optimal the set of IOU projects are in advancing a particular energy policy.

The IOUs' TD&D portfolio focuses on a much narrower set of investment areas as compared to the CEC and peer RD&D programs. Moreover, the IOUs have a much narrower stakeholder group from which they solicit project ideas as compared to the CEC and peer RD&D programs. As stated above, the projects the IOUs implement are each related to one or more energy policy areas, but the framework and stakeholder input that shapes their projects leads to a relatively narrow focus. At this time, we are not able to comment on whether internally driven and narrowly focused investment planning and project selection are problematic, but **the intent of the program requirements related to stakeholder engagement and transparency are not being met fully with current IOU investment planning and project selection processes**.

In order to improve the transparency and comprehensiveness of IOU investment planning information sharing and linkages to state policy priorities, we recommend that:

- ***2d & 2e) The IOUs engage more stakeholders earlier in the investment planning process and provide more comprehensive information about their plans prior to and at investment planning workshops to allow time for more meaningful engagement***. Currently, the IOUs present incomplete information to stakeholders, and mostly rely on internal staff expertise along with the Electric Power Research Institute's (EPRI's) input to shape their plans. Above, we recommended that the administrators and/or the CPUC form a new coordination body, which could also support the shaping of the IOUs' Investment Plan priorities to ensure they complement the CEC's Investment Plan and are responsive to the priorities established by the CPUC.

Key finding: The IOUs, while technically in compliance with program requirements, could improve upon information sharing and stakeholder engagement.

There is a lack of transparency in the IOUs' project selection criteria, project selection and research planning processes. In addition, the IOUs are not effectively tracking and reporting on benefits metrics.

Consistent with the issues identified above, while the IOUs are meeting the minimum requirements, they are not operating in a transparent and inclusive manner that would maximize the value that stakeholders could offer. Since the CPUC typically only has access to the same minimal information that stakeholders do, except on an ad hoc basis when staff make inquiries, increasing the completeness and frequency of information sharing would also improve oversight of the Program and increase its support of the highest priority energy policy areas. Our previous recommendation to categorize and report on projects by topic areas of interest would greatly improve the usefulness of project information for both stakeholders and the CPUC.

To improve the transparency of the IOUs' project selection processes, we recommend that:

- ***3a) The IOUs develop more transparent project selection criteria***, which determine the project areas that are described in their Investment Plans as well as the specific projects that are eventually implemented. Once the CPUC establishes priorities, these criteria could be reviewed and revised over time to ensure an appropriate focus on the highest priority areas for advancing state energy policy.
- ***3b) The IOUs share project research plans and budgets with the CPUC and the public***, at least one month prior to launch. The coordination body we recommend establishing could support efforts to classify projects and disseminate such information in a coordinated manner across administrators so the information would be more readily obtained by interested parties, increasing the benefits generated by EPIC projects.

We offer additional recommendations in Section 11 that focus on program administration details.

2 Program and Policy Background

2.1 Program Background

The Electric Program Investment Charge (EPIC, or the Program) is an innovation funding program that seeks to advance the frontiers of energy science and technology. The California Public Utilities Commission (CPUC) established and oversees EPIC. The Program is administered by four entities: the California Energy Commission (CEC), Pacific Gas and Electric Company (PG&E), San Diego Gas & Electric (SDG&E), and Southern California Edison (SCE). PG&E, SDG&E and SCE are the three electric California investor-owned utilities (IOUs). The CEC administers 80 percent of the EPIC budget, and the three electric IOUs administer the remaining 20 percent.[3]

There are four primary CPUC Decisions that together established the requirements and administrative procedures for EPIC:

1. **Decision 12-05-037** (May 24, 2012), which established the purpose and governance for EPIC and funding collections for 2013-2020 as Phase 2 Decision of Rulemaking 11-10-003.
2. **Decision 13-11-025** (November 14, 2013), known as the "EPIC Decision", approved applications for the first program investment period of 2012-2014 (which is referred to as "EPIC 1") from the four EPIC administrators.
3. **Decision 15-04-020** (April 9, 2015), approved applications for the second program investment period of 2015-2017 (which is referred to as "EPIC 2") from the four EPIC administrators.
4. **Decision 15-09-005** (September 17, 2015), addressed new EPIC projects that are introduced by the IOUs between triennial funding cycles, requiring them to submit Tier 3 advice letters.

The first Decision (12-05-037) established the purpose and governance for EPIC and funding collections for 2013-2020, providing a policy rationale for continuing public interest funding in the energy area where private capital is unlikely to provide adequate support. Providing electric ratepayer benefits was established as the mandatory guiding principle of EPIC, which the CPUC defined as promoting greater reliability, lower costs and increased safety. In addition, complementary guiding principles were designed to guide investment decisions, which include:

- Providing societal benefits;

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[3] Of the 20 percent share of the EPIC budget allocated to the IOUs, PG&E administers 50.1 percent of the IOU share, SDG&E administers 8.8 percent, and SCE administers 41.1 percent.

- Reducing greenhouse gas (GHG) emissions in the electricity sector at the lowest possible cost;
- Supporting California's loading order to meet energy needs, first with energy efficiency and demand response, then with renewable energy (distributed generation and utility scale), and third with clean conventional electricity supply;
- Supporting low-emission vehicles and transportation;
- Providing economic development; and
- Using ratepayer funds efficiently.

Program funding is approved in the following defined investment areas: Applied Research and Development (Applied R&D), Technology Demonstration and Deployment (TD&D) and Market Facilitation. The IOUs' role is limited to the area of TD&D.

- **Applied Research and Development (Applied R&D)** – Applied R&D activities support pre-commercial technologies and approaches that are designed to solve specific problems in the electricity sector.
- **Technology Demonstration and Deployment (TD&D)** – TD&D addresses the installation and operation of pre-commercial technologies or strategies at a scale sufficiently large enough and in conditions sufficiently reflective of anticipated actual operating environments to enable appraisal of operational and performance characteristics and financial risks.
- **Market Facilitation** – Market Facilitation refers to a range of activities including program tracking, market research, education and outreach, regulatory assistance and streamlining and workforce development to support clean energy technology and strategy deployment.

In addition to the three investment areas, projects must be mapped to at least one of the different elements of the electricity system value chain, which consists of:

- Grid operations/market design
- Generation
- Transmission
- Distribution
- Demand side management

Section 6 provides more information about EPIC program requirements and how the Program is administered by the CEC and the IOUs.

2.2 California Energy Policy

EPIC is intended to support the state's energy policy priorities. In this subsection, we provide a brief summary of some of the most relevant energy policy areas to provide context for the remainder of this section. The Evergreen team drew from the administrators' Investment Plans and secondary research on energy policy to develop these summaries.

2.2.1 Greenhouse Gas Reduction Legislation and the Renewable Portfolio Standard

On October 7, 2015, California State Senate Bill 350: Clean Energy and Pollution Reduction Act[4] (SB 350) was signed into law, establishing new clean energy, clean air and GHG reduction goals for 2030 and beyond. SB 350 is considered to be the most significant climate and clean energy legislation since the 2006 passage of Assembly Bill 32: California Global Warming Solutions Act[5] (AB 32) that set the statewide goal of reducing GHG emissions to 1990 levels by 2020. In addition, AB 32 directed and authorized various state agencies to engage in actions necessary to achieve this goal. Building off of AB 32, SB 350 established California's 2030 GHG reduction target of 40 percent below 1990 levels. To achieve this goal, SB 350 sets ambitious 2030 targets for energy efficiency and renewable electricity, among other actions aimed at reducing GHG emissions. SB 350 is intended to greatly enhance the state's ability to meet its long-term climate goal of reducing GHG emissions to 80 percent below 1990 levels by 2050.

SB 350 increases California's renewable electricity procurement goal from 33 percent by 2020 to 50 percent by 2030. This will increase the use of Renewable Portfolio Standard[6] (RPS) eligible resources, including solar, wind, biomass and geothermal. In addition, SB 350 requires the state to double statewide energy efficiency savings in electricity and natural gas end uses by 2030. To help ensure these goals are met and the GHG emission reductions are realized, large utilities will be required to develop and submit Integrated Resource Plans (IRPs) to the CPUC. These IRPs will detail how each entity will meet its customers' resource needs, reduce GHG emissions and ramp up the deployment of clean energy resources.

Significant technology advancements and cost savings must be achieved in order to meet SB 350's requirements, and EPIC is well situated to help foster these changes.

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[4] De León, *Chapter 547, Statutes of 2015*. http://leginfo.legislature.ca.gov/faces/billNavClient.xhtml?bill_id=201520160SB350

[5] Nunez, *Chapter 488, Statutes of 2006*. http://www.leginfo.ca.gov/pub/05-06/bill/asm/ab_0001-0050/ab_32_bill_20060927_chaptered.pdf

[6] California's aggressive RPS requires all electricity retailers, including IOUs, to serve 33 percent of their retail sales with renewable energy procurement. The RPS is mandated under Public Resources Code 399.11.22.

2.2.2 Grid Infrastructure

In order to implement the RPS successfully, the CEC identified that it is necessary to upgrade the state's existing transmission and distribution systems. To achieve this, the CEC supported legislation such as Senate Bill 17,[7] which mandates implementing and planning a smart grid to improve the efficiency, reliability, economics and sustainability of electricity services.

The California Independent System Operator (CAISO) developed a smart grid roadmap and associated architecture[8] in 2010, which offers strategies to transition the grid to be responsive to wind and solar energy and smart devices in response to the state's energy and environmental policy goals. Based on the roadmap, "the 'smart grid' is the application of technologies to all aspects of the energy transmission and delivery system that provide better monitoring, control and efficient use of the system."[9] The roadmap identifies research needs that may be used by stakeholders to develop business models and policies.

The CEC, CPUC and CAISO are also collaborating on the development of a Roadmap for the Commercialization of Microgrids in California,[10] which will be completed by the end of 2017. A CEC-commissioned study released in July of 2015[11] provided an assessment of microgrids in California and offered recommendations for future research and development investments.

Additionally, the Distribution Resources Plan Proceeding (R. 14-08-013) requires electrical corporations to file distribution resources plans, which may include demonstration projects, related to grid modernization and distributed energy resources (DER).[12]

In the first EPIC Decision (12-05-037), the CPUC required the IOUs to address the applicability of the relevant public utility codes, which includes Public Utility Code 8360 statutory guidance regarding the smart grid. The code stipulates that: "It is the policy of the state to modernize the state's electrical transmission and distribution system to maintain safe, reliable, efficient, and secure electrical service, with infrastructure that can

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[7] Padilla. *SB-17 Electricity: smart grid systems, Chapter 327*. 2009. http://leginfo.legislature.ca.gov/faces/billNavClient.xhtml?bill_id=200920100SB17

[8] California ISO. *Smart Grid Roadmap and Architecture*. 2010. https://www.caiso.com/Documents/SmartGridRoadmapandArchitecture.pdf

[9] ibid, p. 5.

[10] California Energy Commission. "California Microgrid Roadmap." http://www.energy.ca.gov/research/microgrid/

[11] DVN GL. *Microgrid Assessment and Recommendation(s) to Guide Future Investment*. Prepared for the California Energy Commission. 2015. http://www.energy.ca.gov/2015publications/CEC-500-2015-071/CEC-500-2015-071.pdf

[12] California Public Utilities Commission. *Distribution Resources Plan* (R.14-08-013). http://www.cpuc.ca.gov/General.aspx?id=5071

meet future growth in demand and achieve all of the following, which together characterize a smart grid."[13] See Appendix A for more detail.

2.2.3 Energy Efficiency and the Loading Order

The CEC and CPUC, along with the California Consumer Power and Conservation Financing Authority, established an energy resource loading order to guide their energy decisions in the 2003 Energy Action Plan[14] (and the CEC's Integrated Energy Policy Report, which is described later in this section). The loading order consists of decreasing electricity demand through energy efficiency and demand response, and meeting new generation needs first with renewable and distributed generation resources, and second with clean fossil-fueled generation. The loading order provides a foundation for energy policies and decisions.

On September 18, 2008, the CPUC adopted California's first Long Term Energy Efficiency Strategic Plan,[15] presenting a single roadmap to achieve maximum energy savings across all major groups and sectors in California. The plan provides an integrated framework of goals and strategies for saving energy, covering government, utility and private sector actions, and holds energy efficiency to its role as the highest priority resource in meeting California's energy needs.

While supporting the loading order continues to be an official EPIC supporting principle, and the loading order is still California policy broadly speaking, we note that SB 350 and other current CPUC proceedings are investigating alternative approaches. For example, the IRP process required by SB 350 mandates that energy procurement planning decisions will be optimized for each electricity provider based on a wide range of constraints—with GHG benefits a primary goal. In other words, energy efficiency may not always be placed first, if another resource enables a better outcome (for example, if increased load from electric vehicles in a specific location enables better integration of renewables). Other proceedings, such as the Distribution Resources Planning Proceeding, are investigating the varied situations in which different types of resources hold different value or are pursued in different order.

2.2.4 Distributed Energy Resources

SB 350 required the CPUC to implement an integrated resource plan process to identify optimal portfolios of resources to achieve the state's GHG goals and meet the challenge of

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[13] California Code, Public Utilities Code 8360. http://leginfo.legislature.ca.gov/faces/billNavClient.xhtml?bill_id=200920100SB17

[14] CEC, CPUC and the Consumer Power and Conservation Financing Authority. *State of California Energy Action Plan*. 2003. http://www.energy.ca.gov/energy_action_plan/index.html

[15] CPUC. *Long Term Energy Efficiency Strategic Plan*. 2008, updated in 2011. http://www.cpuc.ca.gov/General.aspx?id=4125

renewables integration. In response, the CPUC issued a Distributed Energy Resources Action Plan[16] in 2016 that is intended to serve as a roadmap for decision-makers, staff and stakeholders and to guide DER policies. The scope of the plan encompasses three groups of related proceedings and initiatives: rates and tariffs; distributed grid infrastructure, planning, interconnection and procurement; and wholesale DER market integration and interconnection. The primary focus is on DER strategies that are sensitive to time and location. The following subsections provide more information on distributed energy resources.

Electric Vehicles

In a 2012 Executive Order (B-16-2012),[17] California Governor Jerry Brown established expectations for agencies to expedite zero emission vehicle (ZEV) commercialization. The order directed California to "encourage the development and success of ZEVs to protect the environment, stimulate economic growth and improve the quality of life in the state," with a long-term target of reaching 1.5 million ZEVs in the state by 2025. Subsequently, the Governor developed a 2013 ZEV Action Plan[18] that identifies specific strategies and actions that state agencies will take to meet milestones of the Executive Order.

In response, the CEC and the CPUC, along with the ISO, are developing a vehicle to grid integration road map[19] to explore how electric vehicles (EVs) can provide grid services while managing charging levels and implementing two way interactions between the vehicles and the grid, and how to leverage smart grid technologies to support reliable grid management. The CPUC has also initiated proceedings in response to California State Senate Bill 626 Electrical Infrastructure: plug-in hybrid and electric vehicles,[20] which requires the CPUC to develop rules to overcome barriers to widespread use of private EVs in the state.

The CPUC also works to support widespread transportation electrification through implementing requirements set forth in SB 350, which directs the IOUs to file Applications

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[16] CPUC. *California's Distributed Energy Resources Action Plan: Aligning Vision and Action*. 2016. http://cpuc.ca.gov/uploadedFiles/CPUC_Public_Website/Content/About_Us/Organization/Commissioners/Michael_J._Picker/2016%20DER%20Action%20Plan%20FINAL.pdf

[17] Office of Governor Edmund G. Brown Jr. *Executive Order B-16-2012*. 2012. https://www.gov.ca.gov/news.php?id=17472

[18] Governor's Interagency Working Group on Zero-emission Vehicles. *2013 ZEV Action Plan*. 2013. https://www.opr.ca.gov/docs/Governor's_Office_ZEV_Action_Plan_(02-13).pdf

[19] California ISO. "Vehicle to grid integration roadmap." http://www.caiso.com/informed/Pages/CleanGrid/Vehicle-GridIntegrationRoadmap.aspx

[20] Kehoe, *Chapter 355, Statutes of 2009*. http://leginfo.legislature.ca.gov/faces/billTextClient.xhtml?bill_id=200920100SB626

for programs that "accelerate widespread transportation electrification." Three of the IOUs have since filed applications for transportation electrification projects.[21]

Energy Storage

In response to AB 2514, the CPUC released a decision in 2013 establishing a target of 1,325 megawatts (MW) of energy storage to be procured by 2020 and installed by the end of 2024.[22] In December of 2014, the CEC and the CPUC, along with the ISO, developed an energy storage roadmap[23] that identifies policy, technology and process changes to address challenges faced by the energy storage sector. The comprehensive roadmap assesses the current market environment and regulatory policies for connecting new energy storage technology to the state's power grid. It is the result of collaboration by the three organizations and input from more than 400 stakeholders including utilities, technology companies, environmental groups and interested parties. The roadmap focuses on activities that address three critical categories of challenges:

- Expanding revenue opportunities for energy storage providers;
- Reducing costs of integrating and connecting to the power grid; and
- Streamlining and defining policies and processes to increase the certainty of expected benefits of energy storage systems.

In 2017, the CPUC released a Proposed Decision, which considered developments from the roadmap and sets forth a process for utilities to propose programs and investments of an additional 500 MW of energy storage, per AB 2868.[24]

2.2.5 Governor Brown's Clean Energy Jobs Plan

Governor Brown set ambitious goals at the start of his most recent term in 2015 to produce 20,000 new MW of renewable energy to accelerate the development of energy storage capacity and strengthen energy efficiency by 2020. Some specifics of the plan include installing 8,000 MW of renewable central station capacity, 12,000 MW of renewable distributed generation by 2020 and adding 6,500 MW of combined heat and power

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[21] CPUC. "Transportation Electrification Activities Pursuant to Senate Bill 350." http://www.cpuc.ca.gov/sb350te/

[22] CPUC. *Decision Adopting Energy Storage Procurement Framework and Design Program*. 2013. http://docs.cpuc.ca.gov/PublishedDocs/Published/G000/M079/K533/79533378.pdf

[23] California ISO. *Advancing and Maximizing the Value of Energy Storage Technology*. 2014. https://www.caiso.com/Documents/Advancing-MaximizingValueofEnergyStorageTechnology_CaliforniaRoadmap.pdf

[24] CPUC. *Decision on Track 2 Energy Storage Issues*. 2017. http://docs.cpuc.ca.gov/PublishedDocs/Published/G000/M185/K070/185070054.PDF

systems over a twenty-year period.[25] Governor Brown has stated that these efforts will produce a half a million jobs over a ten-year period.

2.2.6 Diversity and Disadvantaged Communities

The CEC issued a formal Diversity Policy Resolution in April of 2015 to state its policy to "improve fair and equal opportunities for small businesses; women-, disabled veteran-, minority- and LGBT-owned business enterprises; and economically disadvantaged and underserved communities to participate in and benefit from Commission programs." Subsequently, Assembly Bill 865[26] directs the CEC to establish a diversity task force to consider and make recommendations about diversity in the energy industry. In response, the CEC developed a plan comprised of four main areas:

- Outreach to raise awareness about EPIC and opportunities for participating;
- Geographic targeting of regions for projects (such as economically depressed communities);
- Efforts to address energy-related challenges and opportunities in economically depressed communities; and
- A tracking system to monitor and report on participation among the groups mentioned above.

The CEC has conducted specific outreach activities and has implemented a tracking system to routinely report on participation in EPIC among targeted under-served groups and communities.

The CEC released Part A of a Low-Income Barriers Study mandated by SB 350 in December of 2016.[27] The study presents findings and recommendations related to limited access to clean energy for low income customers including policy and program barriers and structural barriers along with challenges that exist for small businesses located in disadvantaged communities. The study recommended the CEC dedicate 25 percent of its EPIC TD&D funding to investments within or benefiting disadvantaged communities, and made similar recommendations for the IOUs' EPIC funds.

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[25] Governor Edmund G. Brown Jr. *Clean Energy Jobs Plan*. https://www.gov.ca.gov/docs/Clean_Energy_Plan.pdf

[26] Alejo, *Chapter 583, Statutes of 2015*. http://leginfo.legislature.ca.gov/faces/billNavClient.xhtml?bill_id=201520160AB865

[27] CEC. *SB 350 Low-Income Barriers Study, Part A – Commission Final Report*. 2016. http://docketpublic.energy.ca.gov/PublicDocuments/16-OIR-02/TN214830_20161215T184655_SB_350_LowIncome_Barriers_Study_Part_A__Commission_Final_Report.pdf

3 Evaluation Approach

This section describes the objectives and research questions that guided the evaluation design, and then presents details on the methods the Evergreen team used to collect the data and information necessary to conduct the EPIC evaluation.

3.1 Evaluation Objectives and Research Questions

The objective of the study was to conduct a comprehensive evaluation of EPIC to identify opportunities to improve program management and effectiveness. To this end, specific objectives included the following:

- Determining if the program is being implemented in a manner consistent with the program objectives, requirements and intent of the CPUC and the Legislature;[28]
- Assessing the extent to which the program supports key energy policies and public research code sections;
- Identifying best practices in research administration;
- Assessing the extent to which the Program is on track, thus far, in meeting its objectives to provide ratepayer benefits, advance energy innovation and support California's energy policy goals; and
- Providing recommendations for improvements to program requirements and practices.

The evaluation results are intended to support and inform the CPUC's consideration of EPIC within the next triennial application proceedings, which were initiated in the spring of 2017 with the administrators' 2018-2020 Investment Plan application filings.[29]

For the purposes of focusing this evaluation on the most fundamental program characteristics, CPUC staff established EPIC's core, overarching goals (or core values). These core values are (1) to provide electricity IOU ratepayer benefits by (2) advancing energy innovation that (3) supports California's energy policy goals. These core values are defined in more detail below.

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[28] As set forth in D.11-12-035, D.12-05-037, D.13-11-025, D.15-04-025, and D.15-09-005.
[29] The applications are:
PG&E: A.17-04-028
(https://apps.cpuc.ca.gov/apex/f?p=401:56:0::NO:RP,57,RIR:P5_PROCEEDING_SELECT:A1704028),
CEC: A.17-05-003
(https://apps.cpuc.ca.gov/apex/f?p=401:56:0::NO:RP,57,RIR:P5_PROCEEDING_SELECT:A1705003),
SCE: A.17-05-005
(https://apps.cpuc.ca.gov/apex/f?p=401:56:0::NO:RP,57,RIR:P5_PROCEEDING_SELECT:A1705005) and
SDG&E:
A.17-05-009
(https://apps.cpuc.ca.gov/apex/f?p=401:56:0::NO:RP,57,RIR:P5_PROCEEDING_SELECT:A1705009).

Electricity IOU Ratepayer Benefits: As mentioned in Section 2.1, providing electric ratepayer benefits was established as the mandatory guiding principle of EPIC, which the CPUC defined as promoting greater reliability, lower costs and increased safety.

Energy Innovation: The CPUC established a range of administration and program requirements intended to ensure that EPIC funds RD&D activities that assist the emergence of innovative energy technologies and services, for the benefit of California's electricity IOU ratepayers and the public interest. Overall, advancing true, productive energy innovation is a core purpose of the program. This goal should be supported not only in EPIC's technical program areas, but also in EPIC's administrative structure. Therefore, all Program decisions and activities—from the setting of research priorities, to the treatment of intellectual property concerns, to the administrative balancing of due process with flexibility and responsiveness—should support, embody and advance true, productive energy innovation.

California's Energy Policy Goals: As the CPUC's EPIC decisions make clear, supporting California's key energy, climate and economic policy goals is one of the core justifications of the Program, and a purpose that drives much of EPIC's governance and requirements. Each EPIC funding decision and other activity must be made and considered in the context of these policy goals.

To achieve these overarching goals, the evaluation was designed to address a series of specific research questions organized by topic area:

1. **Program Management and Administration** - Are the administrators effectively complying with program requirements? Beyond mere compliance, are administrators functioning as world-class energy innovation program managers?
2. **Investment Planning Process** - Is the triennial investment planning process effectively identifying a broad range of potential energy RD&D objectives, evaluating those objectives according to sensible criteria, and ultimately producing investment plans with a high likelihood of producing benefits for California ratepayers and achieving other EPIC goals?
3. **Project Selection Process** - Is the project selection process resulting in funds going to projects that are consistent with EPIC policy objectives and planning processes, in an open, effective and efficient manner?
4. **Project Assessment Process** - What is the status of EPIC investments? Do the administrators do everything possible to track the progress of funded work? Are ongoing projects showing reasonable indicators of success? Are processes in place to determine project viability over time and disseminate project results to stakeholders?
5. **Policy Alignment and Project Impacts** - Looking beyond project- and administrator-specific considerations, what impacts does the Program overall have

in a wider context? How is EPIC situated in the broader innovation and policy landscape?

To investigate these questions, the CPUC selected a team of consultants (the Evergreen team) to conduct this evaluation. Evergreen Economics was the prime contractor and managed all evaluation activities. Evergreen was assisted by the NMR Group, Inc., Ridge & Associates, Jai J. Mitchell Analytics and Advanced Survey Design.

3.2 Research Approach

The Evergreen team employed a theory-driven evaluation framework within which we assessed the Program's effectiveness. Guided by a series of logic models that we developed to support the theory-based design, we identified plausible causal mechanisms and tested related hypotheses that the successful implementation of key program activities involving multiple actors will lead to the expected outputs and that these in turn will eventually lead to the achievement of the short-, mid- and long-term benefits. Absent a logic model, much that can and should be measured in assessing a program's efficacy would be missed.

The logic models, summarized in Section 4 and with more detail provided in Appendix B, show the program activities and expected outputs and outcomes and serve as a guide for describing the underlying program theory and for developing researchable questions and metrics. This theory-driven approach[30] relies on a mixed methods approach involving the collection and analysis of both quantitative and qualitative data covering program inputs, activities, outputs and outcomes. We conducted several research activities to collect data on the logic model metrics and to support the assessment of the program effectiveness research questions:

1. Review of relevant CPUC Decisions, EPIC Investment Plans and Annual Reports;
2. Telephone interviews with program administrators (several rounds of interviews with key contacts at the CEC, PG&E, SCE and SDG&E involved with administering the Program);
3. Development and review of data on all EPIC projects (for EPIC 1 and EPIC 2, the first two triennial cycles that cover program years 2012–2017);
4. Development of program theory, logic models and metrics;
5. Detailed review of data for a sample of EPIC projects (54 projects);

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[30] Ruegg and Feller, 2003; Chen, 1990; Rogers, 2000, 2008; Rogers et al., 2000; Weiss, 1995, 1997; Coryn, 2011, and consistent with the Emerging Technologies Protocol in the California Energy Efficiency Evaluation Protocols (http://www.cpuc.ca.gov/General.aspx?id=5399). See Section 17: Appendix F for reference information on the theory-driven evaluation approach.

6. In-depth telephone interviews with CEC CAMs, CEC grantees, and IOU project managers and vendors associated with the sampled projects (90 interviews);
7. In-depth telephone interviews with stakeholders (9 interviews with representatives from organizations related to but not necessarily directly involved in CPUC EPIC projects including state agencies, California engineering and technical experts, third party firms that help evaluate EPIC proposals, and incubators/accelerators);
8. Review of a sample of CEC solicitations (5 solicitations, 93 bids submitted) and IOU vendor bids (6 projects, 46 bids submitted);
9. A best practices assessment involving a review of the literature that focused on innovative energy RD&D programs (38 programs) and in-depth interviews with RD&D program administrators (7 interviews); and
10. Network analysis to assess the exchange of project-related information between EPIC project teams and other individuals and organizations sharing similar interests.

The remainder of this section describes how we conducted each data collection activity.

3.3 Program Document Review

One of the first evaluation tasks was to gather and review all relevant documents related to EPIC, including CPUC Decisions and administrators' Investment Plans and Annual Reports. First, the Evergreen team reviewed the CPUC Decisions that together establish the requirements and administrative procedures for EPIC.

Next, we reviewed each administrator's EPIC 1 (2012–2014) and EPIC 2 (2015–2017) Investment Plans, and their Annual Reports for Program Years 2012–2016. To provide an update on EPIC projects, we relied on administrators' 2016 Annual Reports (which were submitted to the CPUC on February 28, 2017), which were the most recent comprehensive status updates of all EPIC projects, covering EPIC 1 and EPIC 2.

We also reviewed each administrator's EPIC website and reviewed relevant California legislation and policies.

3.4 Program Administrator Interviews

Another early evaluation task was to conduct an initial interview with the key contacts from each EPIC administrator to further inform our understanding of how the Program operates. The Evergreen team worked with the CPUC evaluation manager and the administrators to determine the appropriate contacts. We conducted one-hour interviews with each administrator (for a total of four interviews) in October of 2016, and a follow-up round of interviews in April of 2017 to discuss some topics that we had not covered in the first round. We discussed a range of topics, and organized the interview guides by the five research topic areas presented previously in Section 3.1.

3.5 EPIC Project Data Review

The Evergreen team developed a database of all EPIC 1 and EPIC 2 projects, based on data and information provided by the administrators in their Investment Plans and Annual Reports, supplemented by a data request we submitted to them in September of 2016.[31] The database included basic information about each project, including project type, status, technology type and information on the metrics that would be tracked and the types of benefits the project was intended to generate. The CPUC required that the administrators identify metrics against which each project's success may be evaluated, and they provided a list in Decision 13-11-025 (See Appendix A).

We used the database to generate a sample frame from which to draw a project sample (discussed next) to gather more detailed information. We also used the database to characterize EPIC projects (see Section 5).

3.6 Project Sample Data Review

The study team, in consultation with the CPUC project manager for the evaluation contract with Evergreen, decided to develop a project sample to explore in more detail since it would have been cost- and time-prohibitive to review all projects in detail. We wanted to draw a random (or close to random) sample so that when we examined a smaller number of projects, the findings could be generalized to the program level. First, we developed a sample frame of all active and completed projects based on data from the administrators' 2015 Annual Reports supplemented by responses to evaluation data requests. The sample frame (248 total projects[32]) is shown in Table 3, by administrator, EPIC phase and status (i.e., complete or active), at the time we developed the sample.

[31] We also submitted several follow-up requests to obtain additional data as the evaluation progressed.

[32] Note that one of the early evaluation steps was to draw the project sample, and we relied on the administrators' 2015 Annual Reports supplemented with data from the Investment Plans. Later evaluation tasks that were conducted after the 2016 Annual Reports were released on February 28, 2017 made use of the additional data provided in those reports and include a higher number of projects. Additionally, during the evaluation period, additional projects reached completion.

Table 3: Sample Frame by Status, Administrator and EPIC Phase*

Administrator	Complete		Active		Total		
	EPIC 1	EPIC 2	EPIC 1	EPIC 2	EPIC 1	EPIC 2	Total
CEC	3	0	171	18	174	18	192
SCE	3	0	11	0	14	0	14
SDG&E	0	0	5	6	5	6	11
PG&E	5	0	12	14	17	14	31
Total	**11**	**0**	**199**	**38**	**210**	**38**	**248**

* The sample frame table represents the status of projects when the evaluation team drew the sample in November of 2016.

We selected a sample size of 54 projects to study more closely targeted at the 90/10 level of confidence and precision across all projects.[33] Next, we selected all completed projects for the sample (a total of 9 projects).[34] We then randomly selected 43 of the active projects, stratified by TD&D and Market Facilitation. For TD&D projects, we further stratified by administrator. We oversampled the Market Facilitation and IOU projects to make sure that there were enough projects in each category to support our analyses. We then made further adjustments to ensure that the sample represented the number of projects in each phase (EPIC 1 and EPIC 2) and included projects specifically named in Decisions or given special guidance. This sample design was a mix of random and purposive and allowed us to address key research questions more effectively.[35] Table 4 and Table 5 describe the final sample allocation.

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[33] 90/10 is a standard level of confidence and precision used in energy efficiency evaluation. The 90 (percent) represents the level of statistical confidence we have that the true, but unknown, parameter lies within an interval that is +/- 10 percent of the value of the estimated parameter.

[34] The number of projects classified as "complete" changed from 11 to 9 from the time we developed the sample frame to when we pulled the sample. Three of the CEC projects listed as completed in our sample frame (Table 3) had completed the Applied RD&D phase at the time we selected the sample. Each of these projects was transferred to the Market Facilitation phase and awarded EPIC funding and is now classified as active. An additional PG&E project was completed.

[35] Nick Emmel, *Sampling and Choosing Cases in Qualitative Research: A Realist Approach*. Thousand Oaks, CA: SAGE Publications, 2013.

Table 4: Project Sample by Status, Administrator and EPIC Phase*

	Complete		Active		Total		
	EPIC 1	EPIC 2	EPIC 1	EPIC 2	EPIC 1	EPIC 2	Total
CEC	0	0	30	3	30	3	**33**
SCE	0	3	4	0	4	3	**7**
SDG&E	0	0	0	4	0	4	**4**
PG&E	6	0	1	3	7	3	**10**
Total	**6**	**3**	**35**	**10**	**41**	**13**	**54**

*The project sample table represents the status of projects at the time of the evaluation report completion. One sampled PG&E project was completed in the interim. The three CEC projects shown as completed in the sample frame table (Table 3) were transferred to the Market Facilitation stage and were classified as active EPIC 2 projects, between the time we developed the sample frame and obtained the project sample from the administrators. An additional PG&E project was completed.

Table 5: Project Sample by Project Type and Administrator

	Applied R&D	TD&D	Market Facilitation
CEC	9	17	7
SCE	-	7	-
SDG&E	-	4	-
PG&E	-	10	-
Total	**9**	**38**	**7**

From Table 4 and Table 5, we can see that, in general, the sample size within any given cell is quite small, thus reducing the level of confidence and precision in each. This is particularly true for the IOUs. One should, therefore, given this increased uncertainty be cautious in interpreting any observed differences in the project sample across the three IOUs. In addition, the fact that about 58 percent of the IOU projects are still active suggests that any of these observed differences could change over time as projects approach completion.

3.7 Project Interviews

We conducted telephone interviews with managers associated with each of the 54 projects in our sample in order to obtain a deeper understanding of EPIC processes and project outcomes (both those already realized and potential future impacts). First, we contacted the administrator project manager (e.g., the CEC or IOUs) and conducted an interview. Next, for the CEC, we conducted an interview with the grantee, which is the organization that was awarded the project. We also interviewed any vendors that were implementing key parts of IOU projects. Often, we conducted more than one interview per respondent or group of respondents to cover all topics. Counting interviews as a single respondent or group of respondents (not double counting follow-up interviews), we conducted a total of 90 project-level interviews associated with the 54 sampled projects, as shown in Table 6.

Table 6: Project Interviews by Interview Type and Administrator

	Admin	Grantee/Vendor	Total
CEC	32	32	64
IOUs	21	5	26
Total	**53**	**37**	**90**

We developed interview guides for the project interviews based on the logic models and associated metrics, which are discussed in Section 4. Topics included:

- Successes and challenges of the project;
- Feedback on the funding process;
- Information on partners that have collaborated on the project;
- Feedback on the EPIC administrator management processes; and
- Suggestions for program improvement.

The evaluation team conducted the interviews by phone from January through April of 2017.

3.8 Stakeholder Interviews

We conducted a total of nine telephone interviews from February through May of 2017 with representatives from organizations related to but not necessarily directly involved in EPIC projects. These included state agencies, national labs, California engineering and technical experts, and third party firms that help evaluate EPIC proposals. Stakeholder input was critical to inform our understanding of how administrators draw on expert opinion to develop their plans and guide their projects. Likewise, we sought to gauge stakeholder and expert engagement with the Program and identify ways to improve how the administrators tap experts' knowledge and networks.

The team initially sought to conduct interviews with 15 stakeholder organizations, but could not reach this interview target, primarily due to lack of respondent knowledge about EPIC or insufficient cooperation with interview requests. The team made repeated attempts to reach appropriate contacts from a total sample of 19 organizations that were identified as potential stakeholder interview candidates after a review of attendee lists in various EPIC meetings and consultation with CPUC staff. With these requests, the team also inquired about other individuals within their organization who might be knowledgeable about the Program. From the initial sample, three potential interviewees indicated that they did not know enough about EPIC to provide an informed response to our request for an interview. The remaining contacts did not respond to multiple requests for an interview about the Program; their lack of response may indicate that they also were not very knowledgeable—or did not have strong opinions—about EPIC. Table 7 below lists organizations where stakeholders declined or failed to respond to multiple requests for an interview; the status for the former is labeled as "declined" while the latter is termed "incomplete."

Table 7: Incomplete Interviews by Organization Type

Organization Type	Organization	Status
CA state agency/organization	California Air Resources Board	Declined*
	California EPA	Declined
	California Energy Efficiency Industry Council	Incomplete
	California Department of Resources Recycling and Recovery	Incomplete
National Lab	National Renewable Energy Laboratory	Incomplete
Private company	Sunpower	Incomplete
	Solar City	Incomplete
Industry organization	CALSTART	Incomplete
Environmental organization	The Nature Conservancy	Incomplete
	Clean Coalition	Incomplete
Non-profit/Advocacy Organization	Center for Energy Efficiency and Renewable Technology	Declined
	The Utility Reform Network (TURN)	Incomplete

* Stakeholder agreed to an interview, but did not follow through and failed to respond to attempts to re-schedule.

While the number of completed interviews is lower than initially planned, the team feels confident that the interviewees reflect a range of experiences generally representative of program stakeholders. The team completed interviews with at least one individual from five of the seven targeted organization types (Table 8). We were not able to conduct interviews with representatives from private companies or nonprofit organizations.

Table 8: Completed Interviews by Organization Type

Organization Type	Number of Interviewees
CA state agency/organization	3
National Lab	3
Private company	0
Academic organization	1
Industry organization	1
Environmental organization	1
Non-profit/Advocacy Organizations	0
Total	**9**

Note: Individual organizations are not listed because the evaluation team assured interviewees that their identities and individual responses would be kept confidential.

Each interview lasted approximately an hour and was conducted by senior professional staff by phone. We developed interview guides for the project interviews based on the logic models and associated metrics. Topics included:

- Identifying the individuals' role and information about their organization
- Engagement with EPIC
- Networks and relationship building
- Information sources and knowledge exchange
- Program Administration
- Market Facilitation

3.9 CEC Solicitation and IOU Outsourcing Process Review

Each administrator implements a specific project scoping process to move from approved proposals (once its Investment Plan is approved by the CPUC) to reality. The CEC's EPIC 1 and EPIC 2 Investment Plans propose broad objectives and strategic initiatives within them, and the CEC develops solicitations (either Grant Funding Opportunities [GFOs] or Program Opportunity Notices [PONs]) that are aligned with each initiative and issues them throughout the year and awards one or more projects per solicitation. The award status is documented and posted publicly on the CEC's EPIC website via a Notice of Proposed Award.

We developed a sample frame of solicitations and bids (including accepted and rejected) and drew a sample of five solicitations. The sample was drawn to include almost all of our sampled projects and to cover a range of project types and funding levels. The sample included 93 bids. We requested documentation from the CEC for the sample, including the actual bids submitted, solicitation requirements and criteria, and scores. We reviewed the sample of bids to ensure that the bids were reviewed consistently with CPUC requirements and that bid results (e.g., top-scoring winning bidders) matched what was posted to the CEC website and distributed to bidders. We also reviewed the bids to assess how well the awarded bids aligned with the strategic objectives the solicitations were designed to achieve.

The IOU administrators' Investment Plans include the specific projects they plan to implement in the plan period. The IOUs are required to use contractors (which they refer to as vendors) for all projects, for which they either use a direct award or a competitive bid process. To confirm the competitive bid processes were consistent with CPUC requirements and aligned with the project scoring and selection criteria outlined in the relevant CPUC Decisions, we conducted a detailed review of project bids for a sample of six IOU projects. We drew a sample of six projects—four PG&E projects, one SCE project and one SDG&E project—from the project sample described in Section 3.6. The sample included 46 vendor bids across the six projects. We requested documentation from the IOUs for the sample, including the actual bids submitted, project proposal requirements, scoring criteria and scores. We also assessed and documented the cases where the IOUs used a direct award (or sole source) process to award a contract to a vendor.

3.10 Best Practices Assessment

The best practices assessment was used to identify effective practices in other research programs that are comparable to EPIC. Although EPIC is unique in its size, scope and breadth, there are still lessons to be learned by examining the experiences and best practices developed in other research organizations even if they are not directly comparable. The best practices assessment consisted of a literature review combined with telephone interviews with RD&D program administrators and evaluators.

The literature review included reports and documents relevant to the planning, design and implementation of innovative energy RD&D programs. We identified a selection of programs similar to EPIC and reviewed publicly available evaluation reports and other documents about these programs. The team reviewed a total of 38 resources including reports, white papers and webpages. In general, program-related documents draw on publicly available reports, evaluations and other resources related to the peer RD&D programs listed above. We primarily tried to cite practices supported by evaluation results, but some programs either did not have publicly available evaluation reports or the reports did not cover the topics of interest for this review. The team employed a systematic approach to this review, documenting whether elements relevant to the evaluation were present in each document. The research dimensions covered a range of topics including best practices related to investment planning, implementation, program management and tracking; technology transfer mechanisms; market development mechanisms; and key findings from program- or project-level research/evaluation efforts.

The initial literature review identified several programs similar to EPIC. Through the in-depth interviews and further review of program documents, the team determined that four of the seven programs initially identified were very similar to EPIC in terms of their objectives and mission. These primary peer RD&D programs include:

- The U.S. Department of Energy's (DOE) Small Business Innovation Research (SBIR) Program
- The DOE's Small Business Technology Transfer (STTR) Program
- The DOE's Advanced Research Projects Agency-Energy Program (ARPA-E)
- The New York State Energy Research and Development Authority's (NYSERDA's) Technology and Market Development (T&MD) Program

The literature review also identified three other peer RD&D programs that, upon closer investigation, were revealed to be not as similar to EPIC as the programs listed above. Although these three programs support innovative R&D efforts, they do not have an explicit goal related to commercialization, which is a key feature of EPIC. These secondary peer RD&D programs include:

- The New Mexico Small Business Assistance (NMSBA) Program
- The Washington State Clean Energy Fund
- The Connecticut Green Bank

Table 9 provides a description of each of the peer RD&D programs included in the best practices assessment.

Table 9: Peer RD&D Programs Included in the Best Practices Assessment

Program	Description
DOE Small Business Innovation Research (SBIR) Program http://science.energy.gov/sbir/	The SBIR Program awards Federal Research/Research and Development (R/R&D) grants to small businesses through various federal agencies, including the Department of Energy (DOE). Both the SBIR and STTR Programs (described below) have four program goals: 1) stimulate technological innovation; 2) use small business to meet Federal R/R&D needs; 3) foster and encourage participation in innovation and entrepreneurship by socially and economically disadvantaged persons; and 4) increase private sector commercialization of innovations derived from Federal R/R&D. The SBIR and STTR Programs offer participation in three phases. Phase I awards grants to fund up to $225,000 over nine months for feasibility studies. Phase II grants, which are up to $1,500,000 over two years, support more extensive R&D to develop scientific and technical merit. Only Phase I awardees may compete for Phase II funding. Phase III is the period during which Phase II innovation moves into the marketplace with non-SBIR/STTR Program funding, and the small businesses are expected to acquire additional funds to cover these efforts.
DOE Small Business Technology Transfer (STTR) Program http://science.energy.gov/sbir/	Like the SBIR Program, the STTR Program is administered by the DOE's Office of Investments and Innovation. While the SBIR Program is focused on having small businesses engage in federal R/R&D, the STTR Program facilitates R&D cooperation between small businesses and research institutions. As a result, there are two key differences between the two programs: First, with an SBIR Program award, the principal investigator (PI) must be primarily employed by the small business concern (SBC) while the PI of an STTR Program project can be employed by either the SBC or research institution. Second, with the STTR Program, using a research partner with a Phase I and Phase II award is required, and the minimum level-of-effort expended by the SBC must not be less than 40 percent in both Phase I and Phase II. With the SBIR Program, the SBC is not required to partner with a research institution; however, if using a research partner, the minimum level-of-effort expended by the SBC must not be less than 60 percent.
DOE Advanced Research Projects Agency-Energy Program (ARPA-E) https://arpa-e.energy.gov/	ARPA-E focuses on advancing energy technologies designed to reduce the dependence on energy imports, reduce energy related emissions, improve energy efficiency across all sectors of the economy, and ensure that the US remains competitive in developing and deploying transformational technologies. The program provides funding for technologies that are too early for private sector investment but have the potential to lead to new ways to generate, store and use energy. Projects receive direct commercialization support through the Agency's Technology-to-Market program. This support equips projects with a clear understanding of market needs to guide technical development and help projects succeed in the marketplace.

Program	Description
NYSERDA Technology and Market Development (T&MD) Program http://www.nyserda.ny.gov/All-Programs	The mission of the T&MD Program is to "test, develop, and introduce new technologies, strategies, and practices that build the statewide market infrastructure to reliably deliver clean energy to New Yorkers." The specific objectives include moving new and under-used technologies and services into the marketplace to help achieve the goals for the Energy Efficiency Portfolio Standard (EEPS) and Renewable Portfolio Standard (RPS) Programs; validating emerging energy efficiency, renewable and smart grid technologies/strategies and accelerate market readiness; stimulating technology and business innovation to provide more clean energy options and lower cost solutions, while growing the state's clean energy economy; and spurring actions and investments to achieve results distinct from incentive-based programs. The T&MD portfolio is designed to support these objectives by funding nine initiatives in a range of areas, including power supply and delivery, building systems and clean energy infrastructure.
New Mexico Small Business Assistance (NMSBA) Program http://www.nmsbaprogram.org/	The NMSBA Program fosters collaboration between New Mexico small businesses and the Los Alamos and Sandia national laboratories. Small businesses can receive assistance from lab scientists or engineers for projects that require testing, design consultation and access to equipment or facilities that are not available in the private sector. The NMSBA Program offers three types of projects: individual, leveraged and contract. Individual projects involve a single small business tackling a problem with national laboratory expertise. Requests for individual projects are accepted year-round until funding is exhausted. Leveraged projects include multiple small businesses with shared technical challenges. Proposals for leveraged projects are reviewed twice, and awards range from $20,000 to $100,000 per laboratory. Contract projects allow small businesses to contract for services typically not available in the private sector at a considerably reduced cost (such as courses on renewable energy development).
Washington State Clean Energy Fund http://www.commerce.wa.gov/growing-the-economy/energy/clean-energy-fund/	The Washington State Clean Energy Fund invests in clean energy development by supporting the "…development, demonstration, and deployment of clean energy technologies that save energy and reduce energy costs, reduce harmful air emission, or otherwise increase energy independence for the state." The fund provides funding for a range of projects, including grants to electric utilities for smart grid projects, grants to leverage support for research and development, financing opportunities for renewable energy manufacturing, and grants to nonprofit lenders that provide capital to residential and commercial consumers who install renewable energy systems and make other energy-efficient upgrades.

Program	Description
Connecticut Green Bank http://www.ctgreenbank.com/	The Connecticut Green Bank furthers the adoption of clean and renewable energy solutions by making financing available to homeowners, businesses, municipalities and capital providers. The focus of the Green Bank is to attract and deploy capital to fill the investment gap needed to support the successful implementation of the state's clean energy policy goals. The Green Bank is structured to address four consumer sectors: residential (single and multifamily properties), commercial and industrial, institutional (state, municipal, universities, schools and hospitals) and infrastructure (grid-tied projects as well as statutorily required programs such as the Residential Solar Investment Program and the Anaerobic Digester Pilot Program).

We conducted interviews with the seven RD&D program administrators in February through March of 2017. The interviews were designed to gather information about program design, program management and coordination, successes and challenges, and information on other stakeholders to interview and resources to review.

Each interview lasted approximately one hour and was conducted by an experienced interviewer from NMR by telephone. Topics included:

- Background on their RD&D program
- The project selection process
- Program administration
- Support for commercialization
- Program management, tracking and reporting
- Knowledge dissemination and technology transfer
- Indicators of success

3.11 Network Analysis

For programs such as EPIC to be successful, they must collaborate to some extent with other experts and transfer the knowledge gained from their investigations to other stakeholders. The diffusion of such information is critical if others are to adopt these technologies and tools and/or to conduct further research to improve upon them.

The goal of the network analysis is to clarify the knowledge pathways formed when information moves through the relational channels of market actors in the California economy and expert communities, stemming from the outreach, collaboration, marketing and information dissemination activities of the CEC and IOU administrators, CEC project managers, CEC grantees, IOU project managers and IOU contractors. The network analysis was conducted at two levels, the project level and the program level. The project-level analysis, covering the Applied R&D, TD&D and Market Facilitation funding areas, was based on the results of 90 in-depth interviews covering over 250 hours with the CEC project managers, the CEC grantees, IOU project managers and their vendors. Areas covered in these interviews included the sharing of information and resources with other organizations and individuals during the planning and implementation of their projects and, once the projects were completed, the dissemination of the final reports. Questions touched on such topics as the effectiveness of the technical advisory committees, relationships with other organizations, workshop and conference presentations, articles published, fact sheets prepared, and websites and list serves used to disseminate information.

The program-level network analysis was based on in-depth interviews with and data collected from CEC and IOU administrators regarding program-level interactions with other organizations and individuals during the planning and implementation of each EPIC funding cycle. Questions covered such topics including:

- Coordination with other administrators on electric vehicles, storage or micro grids and with other R&D programs and research organizations both inside and outside California (e.g., DOE programs, National Labs);
- Coordination of innovation clusters;
- Creation of an information exchange for facility owners, design professionals, and skilled labor working in facilities construction, operation, and maintenance trades to share integrated DSM, ZNE and other information and experiences based on demonstration deployment results; and
- Coordination of projects across the three program areas.

4 Program Theory and Logic Model

The foundation of a theory-based evaluation is the development of a program logic model. This is critically important when evaluating an RD&D program that consists of a complex network of activities, outputs and outcomes that combine to produce over time a number of mid- and long-term benefits. Absent a logic model, much that can and should be measured in assessing a program's efficacy would be missed. This section discusses how the logic models for EPIC were developed, with additional details provided in Appendix B.

4.1 Overview of Logic Model Approach

At a high level, logic models describe inputs and activities and how they combine to produce expected outputs which, in turn, may produce expected short-term, mid-term and long-term outcomes (see Figure 1 later in this section for an illustration). Each pathway or linkage in the logic model describes a hypothesized cause and effect relationship.

The key elements of any logic model are the inputs, activities, outputs and outcomes. *Inputs* can include human, financial, organizational, community or systems resources in any combination. These inputs serve as the catalyst for program *activities*, which reflect the processes, events, technologies and other devices that are intentional in the program. The direct results of program activities are the *outputs,* which can include the production or availability of different types of program assistance. *Outcomes* are about change and indicate what ideally will occur as a result of the program activities and outputs. Common outcomes include specific changes in awareness, knowledge, skill and behavior. Outcomes are often categorized by time to indicate which are expected in the short, intermediate, and long term. The evaluation team also used these logic models as guides to identify and operationalize specific metrics to be measured along the various paths from inputs to activities and then outputs and outcomes.

We have prepared five logic models that when taken together provide a comprehensive view of the Program. The first logic model, referred to as the overarching EPIC logic model, describes EPIC at a high level including its four key program areas: Administration, Applied R&D, Technology Demonstration and Deployment (TD&D), and Market Facilitation. While this overarching logic model is useful in discussing the entire Program, we developed a sub-logic model for each of these four key program areas in order to reflect the unique logic and contributions of each. It was these other four more detailed logic models that provided the framework for identifying performance metrics and data collection activities we describe in the following subsection. This framework was also used to integrate and communicate the results of all of the planned evaluation activities. Note that the Administration logic model encompasses the crosscutting program activities and expected outputs and outcomes associated with the administrative activities, including processes used to develop Investment Plans, solicit bids for projects and implement projects. In each logic model, each activity, output and outcome is assigned a letter and each link, representing a hypothesized cause-and-effect relationship, is assigned a number.

These logic models and the underlying social/economic theories are intended to serve as a single source of reference for the foundational components of EPIC including the activities; outputs; short-term, mid-term and long-term outcomes; and the market barriers associated with the Program. The logic models identify the various strategies that are designed to achieve the intended program objectives. They also describe the various positive and negative external factors that might influence the design, delivery and expected outcomes and the relationship of the Program to the activities being carried out by the other organizations and market actors. Each logic model is followed by a list of potential indicators that could be used in testing hypotheses regarding key cause-and-effect relationships. The indicators were the main source for developing research instruments.

In developing these logic models, the following activities were performed:

- Document reviews;
- Discussion with the CPUC study manager and staff from the four administrators to help define the logic model elements (these included identification of key program inputs, activities, market actors, outputs, outcomes, potential external influences and other program interactions);
- Logic model diagram construction—entailing transposition of key logic model elements into a series of boxes or circles and arrows to identify preliminary logical relationships among the elements;
- Identification of market barriers and context development; and
- Identification of potential program measurement indicators.

The initial logic models were completed in October 2016 and were used as a guide for the study research. Some of the models were revised based on updated information we gathered as the evaluation progressed, and we include the final logic models in this section and Appendix B.

4.2 Metric Development

For each of the logic models, there are a set of activities and expected outputs and outcomes. We developed performance metrics for each activity, output and short-term outcome that guided our data collection plan. The metrics are in turn linked to a data collection source or sources, and documented in a data collection table.

The format for each of the data collection tables is the same. For every program activity, each related program output and outcome is included in a table. For each output and outcome, specific metrics are created that will provide an indication of whether the underlying program logic is succeeding in practice. Each metric is then linked to specific data collection and analysis activities. In this way, all metrics are covered by data collection activities, and all data collection and analysis activities are explicitly linked to underlying elements of the program logic models. An example of such a data collection table that we developed to inform the evaluations is shown below in Table 10.

Table 10: Example Metrics and Data Collection Table: Outputs H and I (from Logic Model Activities D and E)

Outputs	Metrics	Data Source
Results in the form of data/software/fact sheets/articles	Number of projects that meet technical targets; Number of databases, software tools, fact sheets, and articles	D, IDI-P
Project progress reports	Frequency of progress reports	IDI-P
	Usefulness of progress reports	IDI-P, IDI-A
Project final reports	Number of promising technologies, tools and strategies identified	D, IDI-P
Patents/copyrights filed/issued	Number of patent applications filed	D, IDI-P
	Number of patents issued	D, IDI-P
	Number of project results copyrighted	D, IDI-P
	Number of project results licensed	D, IDI-P

Data source key: IDI-A=Administrator in-depth interviews, IDI-P=Project-level in-depth interviews, D=Project data.
Green text indicates main source, **orange text** indicates supporting source.

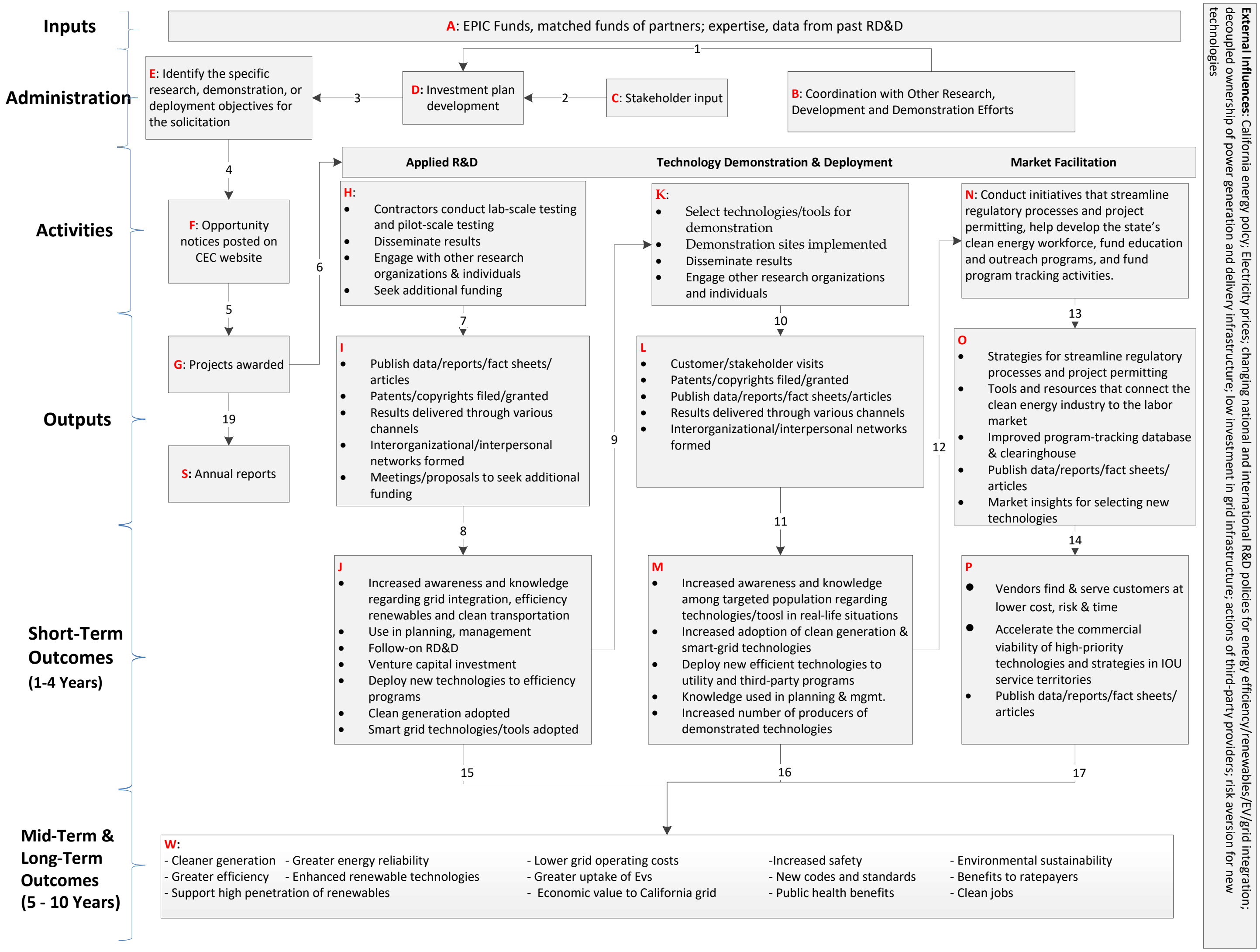
Once the metrics were developed for all outputs and short-term outcomes, we used the metrics for each data source to develop the associated data collection instrument. We tracked the metrics in the research instruments, enabling us to develop an analysis plan organized by metrics.

4.3 Overarching EPIC Logic Model

The overarching EPIC logic model in Figure 1 uses the goals and principles of the program as ultimate outcomes and shows ***pathways to these outcomes*** in the three project type areas: Applied Research and Development (R&D), Technology Demonstration and Deployment (TD&D) and Market Facilitation. For each area, the activities are expected to lead to specific outputs that, in turn, are expected to lead to specific short-term outcomes. The combined short-term outcomes from these three areas are in turn expected to lead to the expected mid-term and long-term outcomes. Note that this logic model also shows a number of external influences (e.g., changing national and international R&D policies for energy efficiency/renewables/EV/grid integration, decoupled ownership of power generation and delivery infrastructure, low investment in grid infrastructure, actions of third-party providers, etc.) that might also contribute to the observed outcomes in addition to EPIC activities and outputs.

As noted earlier, the more detailed and complex Administration, Applied R&D, TD&D and Market Facilitation logic models in Appendix B are the ones that guided our identification of multiple performance metrics that informed our data collection plan.

Figure 1: EPIC Program Logic Model



5 Portfolio Characterization

This section presents summary information about the projects that make up the current EPIC project portfolio, spanning EPIC 1 and EPIC 2 (the first two triennial plans from 2012–2017). More detail on the projects may be found in Section 11, which presents results on EPIC project impacts.

Figure 2 below provides a summary of the Program through the end of 2016. There are 296 projects across the two portfolio periods, shown by project type and administrator. As explained previously, the CEC is responsible for 80 percent of the EPIC budget and is the only administrator that may conduct Applied R&D and Market Facilitation projects. The IOUs are restricted to TD&D projects and jointly administer 20 percent of the budget.

The first EPIC portfolio period (2012-2014) is further along than the second, especially for CEC projects. The CPUC approved the administrators' first EPIC Investment Plans in November of 2013, with most projects launched in 2014 and 2015. The CEC typically has a longer period before launching projects since it utilizes a wider range of stakeholders for project development, issues solicitations and then awards projects after a lengthy bid review process. Project launch for IOU administrators may be delayed due to internal resource availability.

Figure 2: Number of Projects by Administrator and Project Type (through 2016)

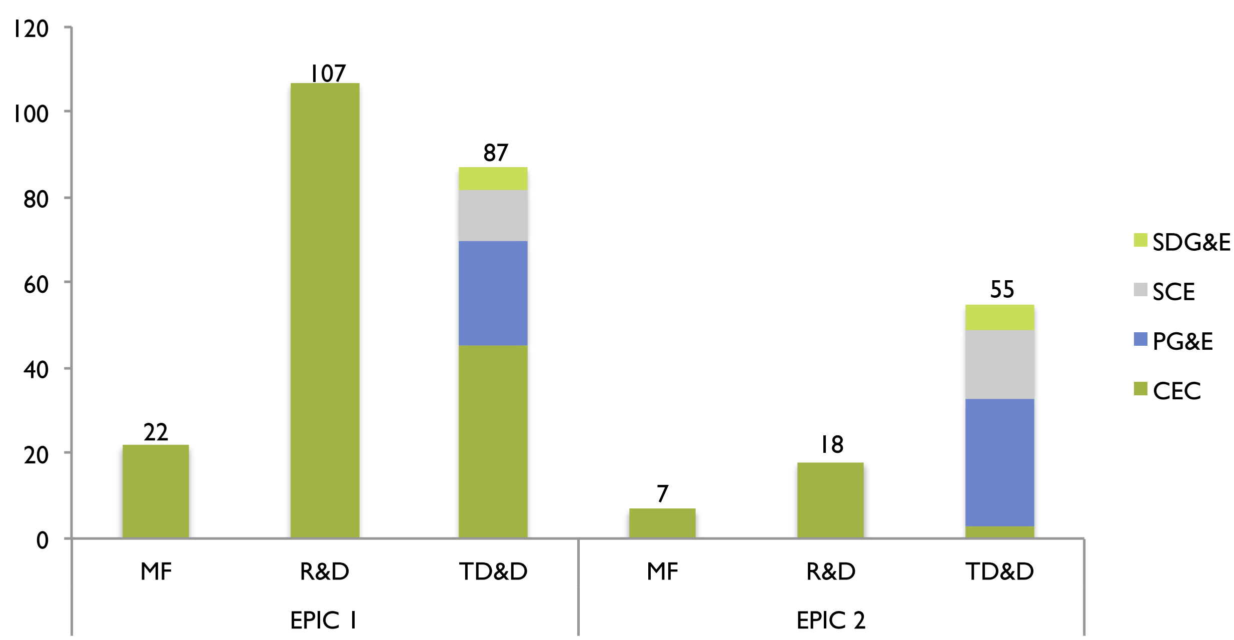
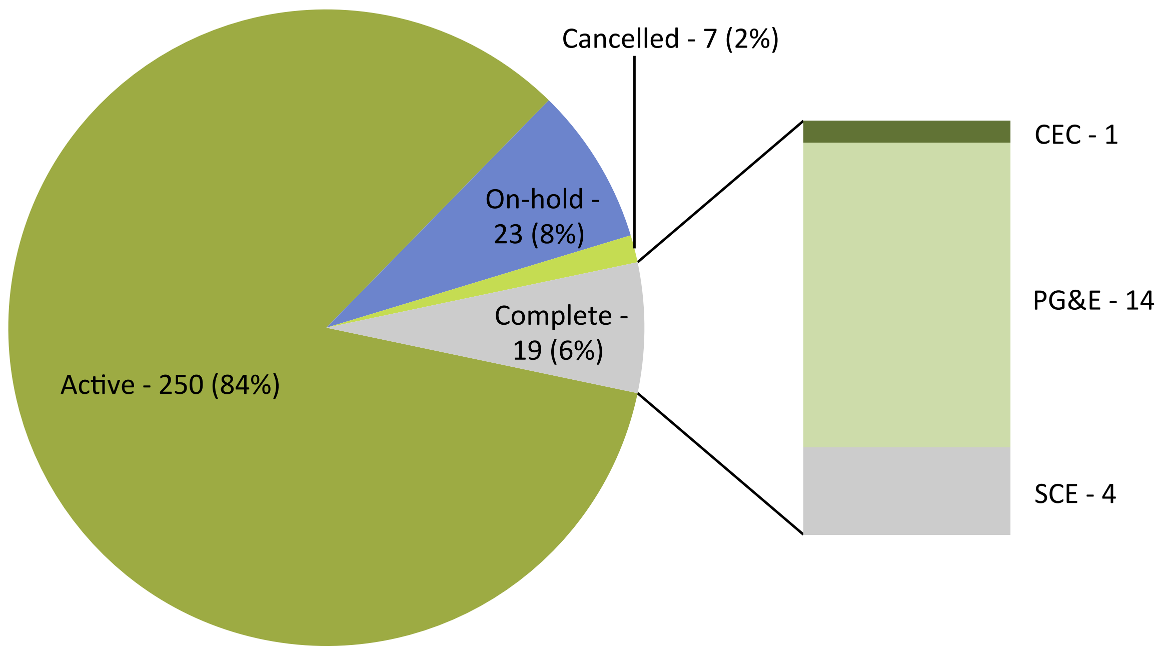


Figure 3 shows the projects by status, as of the end of 2016, with 250 active projects, 19 completed projects, 23 on hold and 7 cancelled.[36] The bar to the right of the pie chart shows how the 19 completed projects are distributed by administrator. The CEC has fewer completed projects due to its lengthier implementation process.

Figure 3: Projects by Status (through 2016)

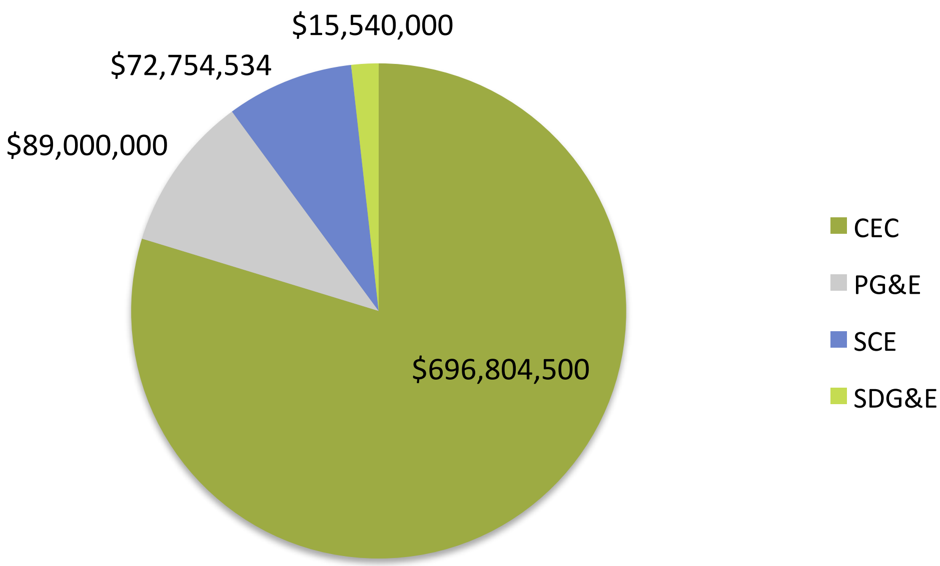


Source: Administrators' 2016 Annual Reports

[36] Figure 3 includes three projects that were listed in the Investment Plans but were cancelled before any funds were spent. These three projects are not shown in Figure 2. Figure 3 includes all seven cancelled projects—including four that spent some funds before being cancelled and are also shown in Figure 2.

Figure 4 below shows the total budget ($874,099,034) that is authorized for projects for the first two EPIC investment periods (2012–2017), with the breakdowns by administrator.

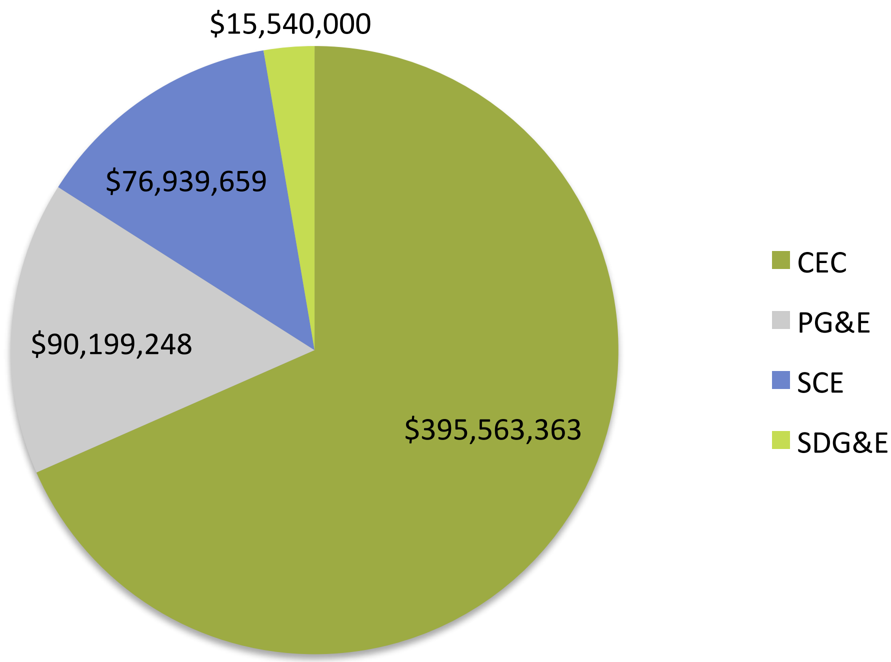
Figure 4: Total Authorized Budget (through 2016)



Source: Administrators' 2016 Annual Reports

Figure 5 shows the total budget that has been allocated to projects by administrator (a total of $578,242,270). For the IOUs, most of their budget has been allocated (or "encumbered" as the IOUs refer to assigning budget to a project) to EPIC 1 and 2 projects. The CEC had not yet issued all the planned solicitations for EPIC 1 and 2 as of the end of 2016.

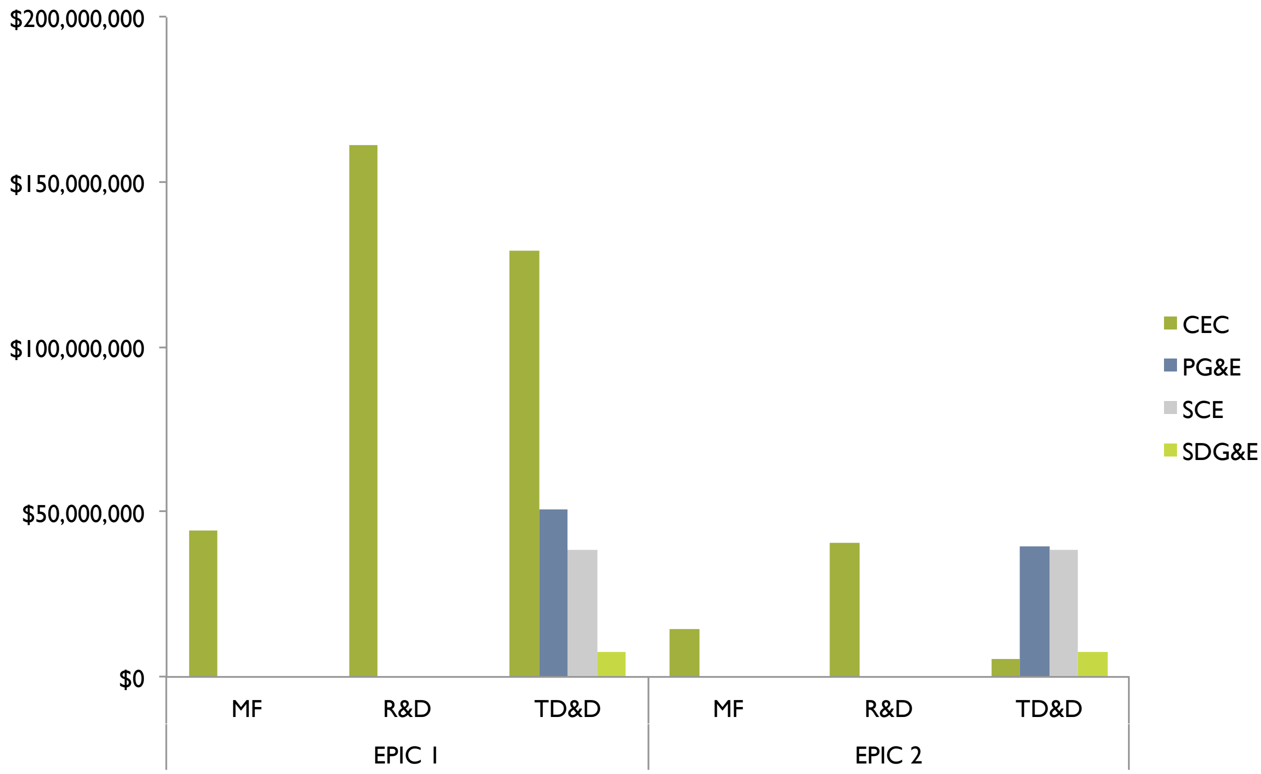
Figure 5: Budget Allocated to Projects (through 2016)



Source: Administrators' 2016 Annual Reports (based on encumbered funds)

Figure 6 shows the project budget by EPIC period, project type and administrator.

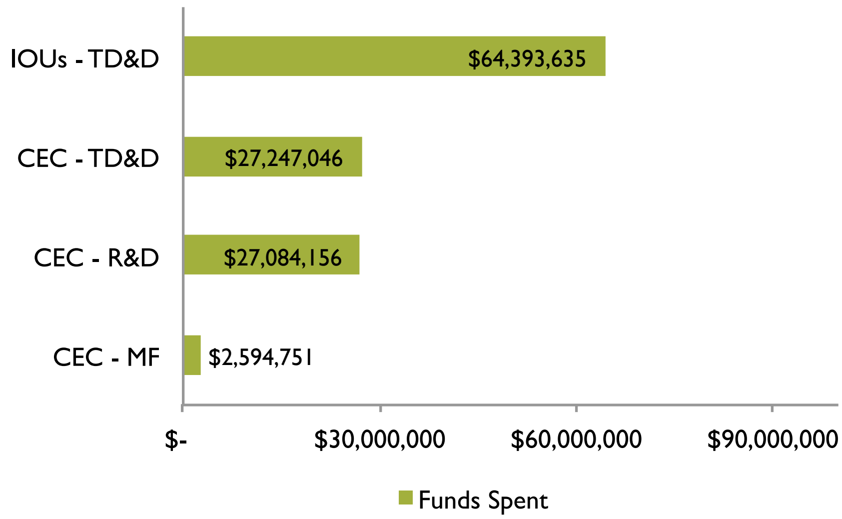
Figure 6: Project Budget by Administrator and Project Type (through 2016)



Source: Administrators' 2016 Annual Reports

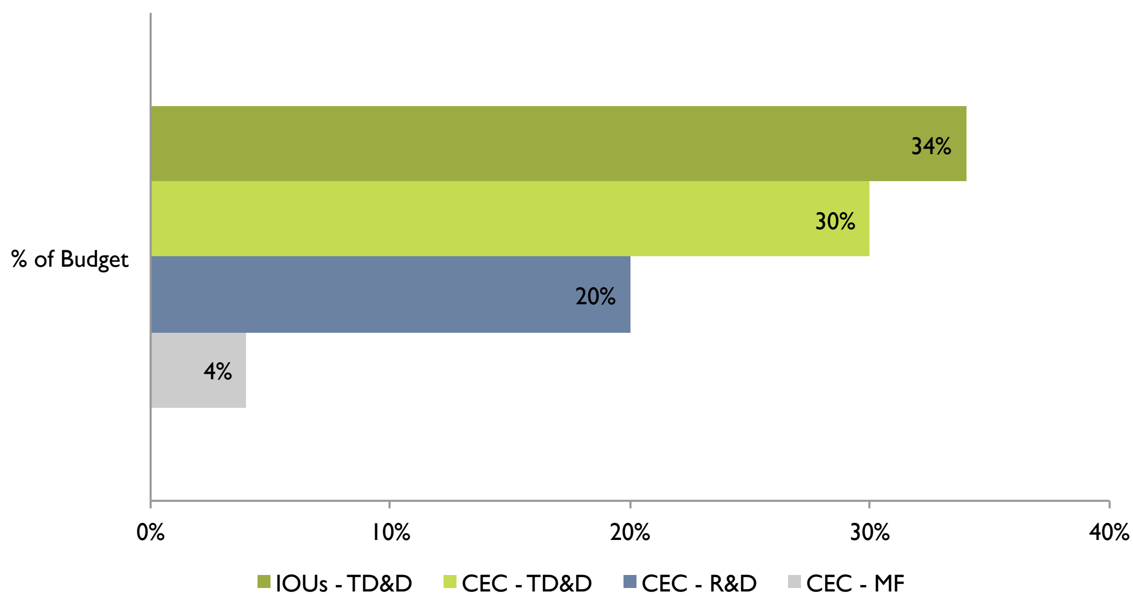
Figure 7 shows the budget that has been spent through the end of 2016, by project type and administrator. Figure 8 shows the budget spent as a percentage of allocated funds.

Figure 7: Projects by Budget Spent (through 2016)



Source: Administrators' 2016 Annual Reports

Figure 8: Percent of Allocated Funds Spent (through 2016)



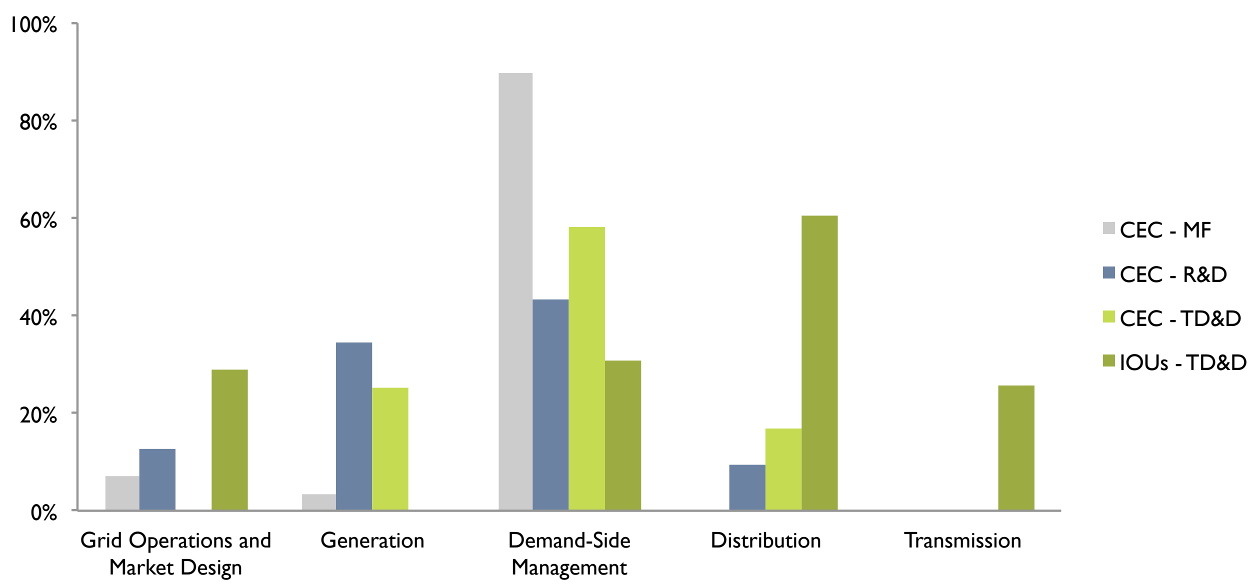
Source: Administrators' 2016 Annual Reports (based on expenditures as a fraction of encumbered funds)

The CPUC requires the administrators to map projects to the different elements of the electricity system value chain, which consists of:

- Grid operations/market design
- Generation
- Transmission
- Distribution
- Demand side management

Figure 9 shows the percentage of current EPIC projects that map to each element. The demand side management category maps to the largest fraction of projects. These projects generally promote new technologies or operational practices that will produce efficiencies in end-use consumption of electricity. Other projects primarily administered by the IOUs look at further understanding and management of end-use consumption, load profiles or other technology developments (i.e. smart-charging platforms of plug-in electric vehicles). A given project may map to multiple categories. For example, a project that will result in the increased utilization of smart-meter monitoring may also be coupled with increased distributed-energy resource penetration studies, affecting both generation and distribution. These values are assigned by administrators as reported in their Annual Reports.

Figure 9: Percentage of Projects by the Electric System Value Chain by Administrator and Project Type (through 2016)



Source: Administrators’ 2016 Annual Reports

6 Program Administration

In this section, we discuss the effectiveness of the Program's administrative processes and how they meet the program requirements, as described in the EPIC Administration logic model (see Section 13.1 for more details), which informed our data collection efforts. Program administration is a crosscutting activity in the causal chain that is expected to ultimately lead to the achievement of EPIC's mid- and longer-term outcomes. For our assessment, we conducted interviews with the management teams from each administrator (a total of nine interviews), reviewed program documents such as the Investment Plans and Annual Reports, conducted 90 project-level interviews associated with our sample of 54 projects, and conducted a best practices assessment.

The CEC and the three electric IOUs (PG&E, SDG&E and SCE) administer EPIC under the oversight and control of the CPUC. There are four primary CPUC Decisions that together established the requirements and administrative procedures for EPIC. The first Decision (12-05-037) established the purpose and governance for EPIC and funding collections for 2013-2020, providing a policy rationale for continuing public interest funding in the energy area where private capital is unlikely to provide adequate support. The Decision also established electricity ratepayer benefits as a mandatory guiding principle, defined as promoting greater reliability, lower costs and increased safety.

The IOUs' role was defined to be limited to TD&D programs, and they were prohibited from investing in generation-only projects using EPIC funds. The Decision (12-05-037) described the rationale as:

> "For activities that are completely pre-commercial in nature (applied research and technology development), a state agency with public interest objectives [the CEC] is ideally suited to administer those activities. For activities that are more related to technology demonstration and deployment on the grid, as technologies and approaches move toward commercialization, utilities may be better suited to administer the funding … since they own the infrastructure on which or through which the technologies will be tested. They also may ultimately become the consumers of technologies or processes that are designed to improve utility systems, so it will behoove them to invest in and test some new ideas. Other TD&D activities may be best suited to a state agency that does not have a business interest in any particular company or solution."[37]

The Decision also ordered that EPIC would be the primary venue for IOUs' RD&D expenditures other than RD&D proposed by IOUs as part of their budget applications for

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[37] CPUC. *Phase 2 Decision Establishing Purposes and Governance for Electric Program Investment Charge and Establishing Funding Collections for 2013-2020*. 2012. http://docs.cpuc.ca.gov/word_pdf/FINAL_DECISION/167664.pdf

energy efficiency and demand response. The IOUs could request separate funding for electric RD&D in their energy efficiency and demand response budget applications, but they are required to justify why such expenditures could not have been considered within EPIC.

Subsequent Decisions (13-11-025 and 15-04-020) approved the administrators' 2012-2014 (EPIC 1) and 2015-2017 (EPIC 2) Investment Plans and established additional requirements such as for Annual Reports, quantifying plan benefits and holding stakeholder workshops. Decision 15-09-005 clarified the process the administrators should use to introduce new projects between cycles.

6.1 Compliance with Program Requirements

EPIC was authorized by the CPUC, and a series of Decisions provides the requirements to which the administrators must adhere. Below in a series of tables, we present each requirement along with its source, and indicate whether the Program is in compliance based on our review. The tables are organized by the following categories:

- Statutory guidance
- Investment Plans
- Limitations on projects
- Contracts
- Stakeholder engagement
- Quantifying benefits / metrics
- Budget
- Annual reports
- Miscellaneous

We used a combination of sources to conduct the assessment, including program filings (e.g., Annual Reports and Investment Plans), the sample of projects for which we had more detailed information (supplemented by interviews with grantees, vendors and IOU/CEC project managers) and the sample of CEC solicitations/bids and IOU request for proposals (RFPs) and vendor bids.

Table 11 below addresses the requirements based on Public Utility Code Statutory Guidance that was referenced in the first EPIC Decision (12-05-037). Based on our review of our project sample, we found that the Program is in compliance with the statutory guidance in Public Utility Codes 740.1 and 8360 (see Appendix A).

Table 11: EPIC Requirements Checklist - Statutory Guidance

Requirement	Source	Compliant?	Comments
Guidelines for evaluating projects proposed	D. 12-05-037 / Public Utility Code 740.1 Statutory Guidance	Yes	Documented in Investment Plans and confirmed in review of sampled projects
State policy to modernize T&D system / smart grid criteria	D. 12-05-037 / Public Utility Code 8360 Statutory Guidance	Yes	Several projects in our sample of the EPIC portfolio address smart grid and T&D modernization

Table 12 addresses the requirements for the administrator Investment Plans from the first EPIC Decision (12-05-037). Based on our review, we can confirm that all these requirements have been meet for the first two Investment Plans.

Table 12: EPIC Requirements Checklist - Investment Plans

Requirement	Source	Compliant?	Comments
Map projects to electricity system value chain	D. 12-05-037 / Ordering Paragraph 12	Yes	Documented in Investment Plans
Document funds allocated to each project type category	D. 12-05-037 / Ordering Paragraph 12	Yes	Documented in Investment Plans
IOUs provide a summary of their EE/DR portfolio R&D and demonstration activities	D. 12-05-037 / Ordering Paragraph 12	Yes	Documented in IOU Investment Plans

Table 13 addresses limitations on projects from the first and second EPIC Decisions (12-05-037 and 13-11-025). The first three (of four) pertain only to the IOUs, and the last pertains to all administrators. Based on our review of our project sample, the Program is in compliance with all the requirements that place limitations on projects.

Table 13: EPIC Requirements Checklist - Limitations on Projects

Requirement	Source of Requirement	Compliant?	Comments
IOUs' role limited to TD&D projects	D. 12-05-037	Yes	All sampled IOU administered projects are classified as TD&D
IOUs cannot use funds for EE projects or Market Facilitation activities	D. 13-11-025	Yes	None of our sampled projects involve IOU-administered energy efficiency or Market Facilitation activities
EPIC funds cannot be used to fund generation-only projects for IOUs	D. 12-05-037 / Ordering Paragraph 13	Yes	None of our sampled projects involved generation-only efforts for IOUs
Funds cannot be used for market support activities or general education and outreach on basic value of renewables	D. 12-05-037	Yes	None of our sampled projects used EPIC funds for general market support, education, or outreach on the basic value of renewables

Table 14 below addresses contract requirements from the first and second EPIC Decisions (12-05-037 and 13-11-025). We reviewed the administrators' plans for contracting in their Investment Plans and the summary of their contracting in the project status report that goes with their Annual Reports, and we also reviewed the sample of CEC solicitations/ bids and IOU RFPs and vendor bids for compliance. We note some issues with the use of non-competitive bidding, which we explore more fully in Section 6.3.3.

Table 14: EPIC Requirements Checklist - Contracts

Requirement	Source of Requirement	Compliant?	Comments
Projects must be competitively bid unless justified in Investment Plans	D. 12-05-037	Yes, technically, but issues with IOU excessive use of direct award	Nearly all CEC projects in the sample we reviewed were competitively bid with the exception of three projects sole sourced through interagency agreement. 18 IOU projects (of 96 total) were sole sourced. These cases were identified in the administrators' Annual Reports. (SCE identified general cases for the use of sole source in its Investment Plan.)
The IOUs may not use EPIC funds for in-house activities where they are conducting all of the work using its own staff and facilities	D. 13-11-025 / Ordering Paragraph 12	Yes	The IOUs indicate in their Investment Plans, and corroborated by the 2016 Annual Reports, intent to use vendors for all projects
Identify type of funding mechanisms to be used	D. 12-05-037 / Ordering Paragraph 12	Yes	Identified in Investment Plans
Eligibility criteria for award of funds	D. 12-05-037 / Ordering Paragraph 12	Yes	Documented in IOU Investment Plans and for CEC, in solicitations
Adhere to IOU grant solicitation guidelines	D. 13-11-025	Yes	Documented in Investment Plans and confirmed through audit of sample projects for CEC and IOUs
IOUs must report on funds that they award to contractors, and they cannot include those costs in their Admin category	D. 13-11-025	Yes	Documented in Annual Reports, project status report
Sole sourcing is allowed, but must be reported on in Annual Reports	D. 13-11-025	Yes	Documented in Annual Reports, project status report

Table 15 below addresses requirements for engaging with stakeholders from the first and third EPIC Decisions (12-05-037 and 15-04-020). As shown, all requirements concerning stakeholders have been met based on our review of Investment Plans, meeting notices and workshop presentations. However, we note that we identify room for improvement in the effectiveness of how stakeholders are engaged in investment planning and project selection in subsequent report sections.

Table 15: EPIC Requirements Checklist - Stakeholders

Requirement	Source	Compliant?	Comments
Summarize stakeholder comments and administrators' response in Investment Plans	D. 12-05-037 / Ordering Paragraph 12	Yes	Comments summarized in Investment Plans
Solicit stakeholder input and expertise at least twice/year and notify parties on service list and related proceedings	D. 12-05-037	Yes	Input solicited via in-person meetings, webinars, and online forums
Certain types of stakeholders must be consulted (specific list included in Decision)	D. 12-05-037	Yes	All types of stakeholders are consulted
Must coordinate with input from CPUC on an annual EPIC Innovation Symposium starting in 2015 (counts as one of two required workshops)	D. 15-04-020	Yes	Workshops held on December 3, 2015 and December 1, 2016

Table 16 below addresses requirements related to quantifying benefits/metrics from the first and second EPIC Decisions (12-05-037 and 13-11-025). Based on our review of the Investment Plans and Annual Reports, the administrators are in compliance with the initial step of identifying appropriate metrics for each project they propose and implement. However, not all administrators have plans in place to quantify the metrics. At the time of our evaluation, few projects had been completed and the in-progress projects had only been operational for a short time. This precluded a comprehensive assessment of how the administrators are quantifying project benefits. We did review the processes the administrators had in place at the time of the evaluation and any activities that had been conducted on completed projects. See Section 9.2 for an assessment of benefits quantification.

Table 16: EPIC Requirements Checklist - Quantifying Benefits / Metrics

Requirement	Source	Compliant?	Comments
Indicate which metrics project's success will be measured against in Investment Plans	D. 12-05-037 / Ordering Paragraph 12	Yes	Documented in IOU Investment Plans and for the CEC, in Annual Reports
Establish a measurement plan to quantify benefits based on metrics in Investment Plans	D. 12-05-037 / Ordering Paragraph 12	Unclear	The CEC has a process in place to quantify metrics (via project benefit questionnaires). The IOUs do not have plans to systematically quantify and report on project benefit metrics.
Must identify metrics for each project in Annual Report	D. 13-11-025	Yes	List included in each Annual Report

Table 17 below addresses administrator budget requirements from the first EPIC Decision (12-05-037). As shown, based on our review of the administrators' Annual Reports, all requirements have been met.

Table 17: EPIC Requirements Checklist - Budget

Requirement	Source	Compliant?	Comments
Admin. expenses cap set at 10%	D. 12-05-037	Yes	All administrators below cap for EPIC 1 and EPIC 2 (average across both: CEC 10%, PG&E 8%, SCE 6%, SDG&E 10%)
5% limit for fund shifting across project type categories	D. 12-05-037	Yes	The CEC is in compliance per Annual Reports (IOUs effectively have unlimited fund shifting authority since they administer only one program area)

Table 18 below addresses administrator Annual Reporting requirements from the first and second EPIC Decisions (12-05-037 and 13-11-025), which have all been met.

Table 18: EPIC Requirements Checklist - Annual Reports

Requirement	Source	Compliant?	Comments
Must file by February 28 each year	D. 12-05-037	Yes	IOUs filed 2015 reports on Feb. 29, 2015
Include project-level info on # bidders passing the initial screening and ordinal rank of selected bidder (if not #1, provide explanation)	D. 13-11-025	Yes	Included in project status reports
Reports must follow a specific outline including for each project's status report	D. 13-11-025	Yes	The CEC does not match exact numbering of sections, but content is consistent with outline
Include description of each project including winning bidder	D. 13-11-025	Yes	Included in project status reports

Table 19 below addresses miscellaneous requirements from the first, third and fourth EPIC Decisions (12-05-037, 15-04-020 and 15-09-005). As shown, these requirements have been met.

Table 19: EPIC Requirements Checklist - Miscellaneous

Requirement	Source	Compliant?	Comments
Independent Evaluation: Requires at least one independent evaluation, consultant to be hired in 2016	D. 12-05-037	Yes	Evergreen team selected and contact initiated in 2016
Waiver of Program Requirements: Use Tier 3 Advice Letters to request a waiver of program requirements	D. 15-04-020	NA	PG&E submitted an Advice Letter as required to request a waiver of program requirements
New EPIC Project Approval: Use Tier 3 Advice Letters for new EPIC projects between triennial cycles, or for material changes to existing approved projects	D. 15-09-005	Yes	PG&E used this process[38]

[38] Note that in Section 8.4, we discuss Investment Plan consistency over the plan period, which includes a discussion of the Tier 3 Advice Letter requirement and the process for seeking approval for changes.

6.2 Program Management

Based on our review of program reports and information provided during interviews with the EPIC program managers at each administrator, we determined that the administrators have a very different approach to how they administer program funds and conduct projects. In essence, the CEC develops a set of initiatives as part of its EPIC triennial investment planning process, issues Grant Funding Opportunity notices to solicit project proposals, selects projects from the proposals and oversees the efforts of the grantees, who manage the day-to-day project activities. As such, the IOU subject matter experts work together to create a set of initiatives (using the Joint IOU EPIC Framework), develop projects that demonstrate technologies or solutions to address current and future grid issues, and manage vendors, who are hired to conduct specific work or provide equipment to support the projects.

In this section and throughout the report, we have tended to report on results for the CEC and IOUs (combined) due to the difference in administrative approach that we noted at the initial stages of the evaluation. However, we examined each of the four administrators' processes and projects, and where we noted differences across the three IOUs, we discuss those differences. Note that those comparisons were limited by the size of the project sample for each IOU (which reflects the relatively smaller portion of the EPIC budget that the IOUs receive as compared to the CEC).

6.2.1 CEC

Based on a series of interviews with the CEC's EPIC program management team and corroborated by review of the CEC's Investment Plans and Annual Reports, we learned that the CEC manages EPIC within its Energy Research & Development (ERD) Division, which is comprised of four offices (Energy Efficiency, Generation, Systems Integration and Market Facilitation). The Division employs around 80 staff, mostly engineers and scientists. The ERD Division regularly coordinates with other CEC divisions, particularly those focused on energy efficiency and renewables.[39]

The CEC primarily uses a grant-based process for its projects, whereby grantees propose specific projects within the confines of a competitive solicitation. This approach is consistent with the CPUC's acknowledgement in Decision 12-05-037 that the CEC as a public agency is suited to a role that stimulates innovation and creates opportunities for customers to pilot new technologies for the advancement of energy policy. EPIC projects are conducted under the oversight of CEC Commission Agreement Managers (CAMs). The CAMs oversee grantees in the development of a scope of work with milestones and regular reporting for each project, and review project progress reports and invoices and follow project developments. Each project convenes a technical advisory committee (TAC)

[39] The ERD Division also coordinates with the Fuels and Transportation Division on Vehicle Grid Integration, and the Energy Assessment Division/Siting on renewable integration/DERs.

that is made up of both internal and external experts and stakeholders that provide guidance. In addition, CEC staff and technical leads also stay engaged on project developments as they relate to specific CEC program efforts or technology and policy roadmaps. In limited cases, CEC projects may convene a policy advisory committee (PAC), where a project or set of projects could influence future policy.[40]

Based on interviews we conducted with the CEC's CAMs and grantees associated with a sample of 33 projects, we determined that the grantees drive technical aspects of projects with input from the CEC. CEC staff learn from projects to inform program areas and manage scope, contract and budgeting issues. While not necessarily experts on the technologies being investigated, CAMs are technical staff with an understanding of the technology and technical issues, internal technical resources, and a structure that allows them to manage the grants. CAMs are supported by senior staff who are technology experts.

Nevertheless, some of the 32 grantees that we interviewed commented on various challenges they have encountered related to project administration. These include:

- Slow payments and administrative processing by the CEC, which can be a challenge when working with smaller subcontractors who are used to faster payment cycles.
- The perception that CAMs were sometimes either inflexible or did not have the authority to be sufficiently flexible when circumstances required non-technical project adjustments. Specifically, 19 of 32 grantees we interviewed spoke of some inflexibility from the CEC, often dealing with challenges in reallocating project funds to employees or tasks.
- Turnover or reassignment among CAMs, which results in some discontinuity but generally does not have any detrimental effect on projects.

6.2.2 IOUs

Based on a series of interviews with each IOU's EPIC program management team, interviews with IOU project managers (21 projects), and our review of IOU Investment Plans and Annual Reports, we learned that the IOUs implement their projects in-house and use vendors to conduct a specific scope of a project, such as to provide and maintain software needed to carry out the demonstration project. Earlier in this section, we described how the CPUC authorized funding for the IOUs to conduct TD&D projects, as well as the requirement that they must outsource some portion of each project to vendors. The IOUs provide oversight of their EPIC projects via internal stakeholder and

[40] At the time we conducted our research, the CEC had convened one PAC (Long Term (2050) Energy Scenarios), which is advising three projects related to GHG reduction goals and the impacts of a changing climate on the state's energy systems.

management groups. A project manager is responsible for day-to-day management of the project in adherence to a project management plan that is developed for each project, and they regularly report to the internal sponsors who weigh in on any needed project modifications (or sometimes termination).

- **PG&E's** Emerging Technology Group[41] includes EPIC along with two other related technology demonstration programs (21st Century Energy Systems R&D and Smart Grid Pilot). The number of staff who work on EPIC projects varies, which includes staff who conduct projects (a mix of engineers, data scientists and product managers) and staff who manage projects (handling administration and contract management). Like the other IOUs, they also coordinate with many other internal departments and technical experts. PG&E has a three-person program management team that oversees EPIC: an overall program manager (100% time), a regulatory affairs manager (20% time) and the manager of the Emerging Technology Group within which EPIC is housed (25-33% time). The team handles overall project management, regulatory compliance, coordination across their internal groups and portfolio of projects, and administrative functions. The team is cross functional and brings different types of expertise based on their function—regulatory knowledge, administrative and project management experience, and technical background.
- **SCE's** Advanced Technology Group manages EPIC in coordination with other internal technical groups and experts, with nine engineering managers, each of whom works about half time on EPIC, with another 80 engineers that support the group. SCE has a two-person management team that is involved on a day-to-day basis managing EPIC. The team consists of an overall EPIC program manager who spends roughly 40 percent of his time on EPIC and a technical lead who oversees the engineers who manage EPIC projects (50% time). A regulatory affairs staff person also supports the program (25% time).
- **SDG&E's** Technology and Systems Demonstrations Group, which is housed within the Distributed Energy Resources Group, is where EPIC is managed; it also coordinates extensively with other internal departments and technical experts (such as T&D and IT departments). It has about 10 staff members working on EPIC at or near full-time capacity. SDG&E has a three-person management team: one staff person dedicated to regulatory affairs (10%), another serving as the dedicated project management lead (has ramped up to 100% recently) and an administrative support person (around 80% time). The program manager coordinates project technical leads and other technical staff that conduct the projects, as well as coordinates with other groups at SDG&E that sponsor the projects (the research stakeholders).

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[41] Not to be confused with the IOUs' Emerging Technology Program (ETP), which each IOU implements separately from EPIC. The ETP focuses exclusively on energy efficiency technologies.

The IOUs' vendor contracts are fairly straightforward to achieve a narrower scope than CEC grants, so much of the project management and coordination occurs internally using the IOU's standard business practices. We conducted interviews with vendors that the IOUs used (five vendors), and these vendors mentioned being involved in internal discussions involving project intent and scope—such as discussions concerning technology use cases—but were generally not involved in any broader coordination with stakeholders or external experts as the CEC grantees are.

We offer some observations related to the dual public agency/private utility administration of EPIC, which are related to the differences just described in how each administrator approaches projects. First, because CEC projects must go through a competitive solicitation process with outside entities proposing projects, they take longer to launch than IOU projects, which are competitively bid far less often. Once launched, CEC projects take longer to complete. This is due to the fact that the CEC, as a public agency, must implement its projects in a transparent manner, with multiple opportunities for public review and input. The IOU projects, on the other hand, are designed to serve the needs of their internal stakeholders and, as a result, are conducted in a less transparent manner.

6.3 Contracting

As mentioned previously, the CEC contracts out all of its projects, while the IOUs implement their projects in-house with the assistance of vendors to accomplish a specific component of the funded projects.

Before we present the results of our review of grantees and vendors' opinions with respect to contracting for EPIC, we offer observations about the different relationships that the CEC and IOUs have with their contractors. The CEC CAMs oversee the grantees as they perform the technical project scope of work. (CAMs also lend their expertise by developing solicitations and sharpening the scope of work; however, the grantee conducts the research.) Grantees view the Program as a funding source, and the CAMs provide oversight that those funds are spent judiciously and the project goals are met on schedule and within budget. IOU vendors conduct a much more limited number of EPIC projects; they may have a business relationship with the IOU and therefore view the IOU as their client, from whom they hope to get future business. We think it is important to note this distinction before we present results from CEC grantees and IOU vendor interviews. That is, the results are not directly comparable in the sub-sections that follow (6.3.1 and 6.3.2).

6.3.1 CEC

The CEC has an established competitive solicitation and contracting process, which is the primary method by which it awards funds for EPIC projects. After selecting winning bidders from its solicitations, the CEC develops a detailed scope of work for all of its projects that reflects the winning bid along with any necessary clarifications or modifications. The CPUC requires the administrators to competitively bid EPIC project work, and when they do not competitively bid a contract, they must report such cases and justify their use in their EPIC regulatory reporting.[42]

Our review of CEC grant documents associated with our sample of 32 CEC projects focused on grant request forms that document project details and expectations of grantees. Grant request forms are consistently in place and follow a standard format for CEC-administered projects. These grant request forms describe the following:

- Project awardee general information
- Business meeting information
- California Environmental Quality Act (CEQA) compliance
- List of subcontractors (major and minor) and equipment vendors
- List of all key partners
- Recipient's administrator/officer & project manager
- Selection process used
- Scope of work
- Budget detail
- CEC 105, questionnaire for identifying conflicts
- Recipient resolution
- CEQA documentation

We explored contracting experiences from the perspective of the 32 CEC grantees that we interviewed. Some experienced research firms put contracting with the CEC in context, indicating that the CEC contracting process seems relatively standard and resembles that of other funding sources that they are used to working with (such as IOU or CPUC research projects). Nevertheless, in grantee interviews, we did hear of occasional contracting issues that seemed moderate but noteworthy. Examples include:

- Projects that got a late start due to administrative delays; and
- Inflexibility with budget details. For example, the CEC has a policy that locks pay scales for a contract period.

[42] The CEC is also required to notify the Joint Legislative Budget Committee in accordance with Public Resources Code section 25711.5(g).

For the eight CEC-administered projects for which we have consistent data on the length of the contracting period, the median contracting time was three months. The range was one to seven months.

Overall project funding, on the other hand, has been nearly uniformly identified as sufficient, even if “more is always better.” No objections to awards were noted by the administrators.

6.3.2 IOUs

The IOUs are required to contract with vendors for all of their projects. We reviewed their 2016 Annual Reports and Investment Plans to confirm the use of vendors, and we validated that they have plans to use vendors for all 93 projects from the first two Investment Plans.

We reviewed the six projects in our 21-project IOU sample that already had a vendor contract in place, and conducted interviews with five of those six vendors to gather information about the IOUs’ contracting process and seek vendor input. The contracts for these projects describe the vendor’s task and terms of the work, but they may not capture the overall project scope of work or plan when an IOU manages the overall technical effort internally. That scope of work is summarized in the IOUs' Annual Reports (in the project status report). However, they do not share a more detailed version like the CEC’s grant request documents that are shared publicly once projects are awarded and the scope of work has been developed.

For the IOU-administered projects, vendors said the contracting process was relatively straightforward, and they did not recall any major issues. However, a couple of minor issues that were discussed include:

- Irrelevant amendments included in the contract for “Non-American” companies that prolonged the contracting process; and
- Intellectual property (IP) logistics with result-sharing across IOUs, including one vendor that noted that additional internal discussions were required because the administrator wanted to share the vendor’s results with other IOUs.

6.3.3 Non-Competitive Bidding

As noted in the compliance tables presented previously, CEC projects are consistently bid out competitively, with few non-competitive awards (the CEC sole sourced three projects through interagency agreements with the University of California).[43] The IOUs use non-competitive bid or sole source contracts much more often. The CPUC has allowed for the use of sole sourcing on a limited basis. This issue was discussed previously in Section 6.1,

[43] These awards were leveraged to help secure a water center in California, along with federal funding.

where we identified that the IOUs are using sole source contracting more frequently than we believe the CPUC intended, and that these cases are not justified as required by the CPUC.

Of the 93 active IOU projects that were described in their 2016 Annual Reports, 30 were competitively bid, 23 were sole sourced and 40 had not yet been determined. Note that there could be more cases of sole sourcing as the administrators continue to award funds for EPIC 1 and 2 projects, since 40 of the 93 IOU projects have not yet been contracted and the CEC has not yet awarded all of its EPIC 1 and 2 funds.

Table 20 summarizes the use of sole sourcing by administrator and Investment Plan period, as reported in the 2016 Annual Reports. SDG&E provided necessary information that allowed us to estimate the dollar and percent of project funds being sole sourced, which was $695,152, equal to 4 percent of the SDG&E's total project budget over the first two Investment Plan periods. The CEC sole sourced a total of $2.5 million, which was less than 1 percent of project funds that were awarded through 2016.

PG&E and SCE did not provide the necessary information that allowed us to estimate the dollar amount or percent of project funds that are being sole sourced.

Table 20: Use of Non-Competitive Bidding (EPIC 1 and EPIC 2)

	Total Number of Projects	Number of Cases of Sole Source	% of Projects with Sole Source	Sole Source Project Funding/% of Total Project Funds
EPIC Phase 1				
PG&E	25	7	28%	Unknown
SCE	12	9	75%	Unknown
SDG&E	5	0	0%	NA
CEC	174	2	1%	$1,370,000
Total Phase 1	*216*	*18*	*8%*	
EPIC Phase 2				
PG&E	30	6	20%	Unknown
SCE	15	0	0%	Unknown
SDG&E	6	1	17%	$695,152
CEC	28	1	4%	$1,130,000
Total Phase 2	*79*	*8*	*10%*	
EPIC Phases 1-2				
PG&E	55	13	24%	Unknown
SCE	27	9	33%	Unknown
SDG&E	11	1	9%	$695,152 / 4%
CEC	202	3	1%	$2,500,00 / <1%
Total Phases 1-2	**291**	**26**	9%	

Source: Administrator 2016 Annual Reports
Notes:
One SCE project is funded across both EPIC Phase 1 and EPIC Phase 2. This project is only included in EPIC Phase 1 in this table to avoid double counting.
One of the six SDG&E projects used a competitive interview process rater than a competitive RFP process.

CPUC Decision 12-05-037 allowed for some circumstances where administrators could use non-competitive bidding:

> "Finally, on the issue of competitive bidding, this is generally our selection process of choice in all areas. However, there may be limited and unique circumstances where it is not possible or desirable. In each Investment Plan, the administrators may propose a

> limited authorization for non-competitive bidding for particular purposes. An example, as suggested by the Efficiency Council in their comments on the proposed decision, could be continuation of funding for successful projects. These exceptions to competitive bidding should be justified separately and clearly for a specific purpose. During consideration of the first set of investment plans, we will also consider whether there should be a separate approval process required for any contract or grant not awarded through a competitive bidding process, to set a higher standard for the use of a non-competitive process."

SCE's EPIC 2 Investment Plan identified where it might use non-competitive bidding in general cases.

> "SCE plans to comply with the Commission's [the CPUC's] requirements for competitive bidding, but will continue to use non-competitive awards in limited instances such as when:
>
> - Material or services required are available from only one reliable source and no other supplier will satisfy utility requirements;
> - Specialized knowledge, skill, experience or expertise is needed for the work and only one supplier is determined to have what is needed;
> - Bidding is cost prohibitive relative to the cost of materials or services needed;
> - An opportunity exists to develop Diverse Business Enterprise suppliers;
> - The procurement provides special discounts, rates, or terms and conditions (i.e., cost share) that are not available under normal competitive conditions; or
> - Equipment, materials, or services are obtained for trial testing, research or experimental work."

We did not see any comments from PG&E in its second Investment Plan about the use of sole sourcing; however, in its Annual Report, PG&E offered a justification for each use of sole source projects.

We did not find any comments from SDG&E in its first Investment Plan about the use of sole sourcing. SDG&E indicated the use of sole sourcing in its Annual Report, but did not offer any justification.

We reviewed the use of sole-sourced contracting by IOUs by analyzing the reported justifications provided by PG&E to determine applicability. We also assessed the potential for justification within SCE's and SDG&E's portfolio, though explicit statements of justification were not provided in their Annual Reports. SCE only had the general set of exceptions it provided in its Investment Plan. As indicated in the excerpt above, the CPUC Decision stated that "exceptions to competitive bidding should be justified separately and clearly for a specific purpose." We determined that the PG&E justifications resulted from program changes to licensed equipment, platforms or software that could only adequately be provided by the vendors responsible for these systems. The types of projects that these sole-sourced vendors engaged in were, with the exception of one case, operating on utility monitoring, display or management of grid operations that relied on these unique tools. While SCE and SDG&E did not provide justifications in their reports, the similarity of project types indicates in our estimation that similar sole-sourced vendor-supplied services were also required for successful project implementation.

It is not clear at this time what weight the value of sole-sourced contracts has within the entire project non-administrative budget. Based on our review of the sample of IOU projects that had contracted with vendors, only a small portion of the overall project budget was applied to sole-sourced project work. The requirement to report the existence of sole-sourced contracts does not specify this level of reporting, and within current reporting protocols, the existence of any sole-sourced work, no matter how small, identifies the entire project as 'sole-sourced'.

Our assessment is that the CPUC was expecting a more specific justification to be given in the Investment Plan (on a project by project basis). The Annual Reports identify the cases of sole sourcing (which projects and firms), but SCE's and SDG&E's do not offer a specific justification, while PG&E's does. SDG&E provides estimated budget amounts to be allocated to project vendors; however, PG&E and SCE do not provide this information. The CEC provides this information for all projects, since all the project budget goes to the grantee. Such budget information could help the CPUC determine the extent to which funding is being awarded in these cases as a percentage of total IOU EPIC project budgets.

6.4 Best Practices Comparison

Our review of best practices examined issues related to administration of effective RD&D programs. This section summarizes best practices pertaining to program management, contracting and match funding. The primary peer RD&D programs[44] that we included in our assessment are:

- The Department of Energy's (DOE's) Small Business Innovation Research (SBIR) Program – awards Federal Research/Research and Development (R/R&D) grants to small businesses through various federal agencies, including the DOE.
- The DOE's Small Business Technology Transfer (STTR) Program – facilitates R&D cooperation between small businesses and research institutions.
- The DOE's Advanced Research Projects Agency-Energy Program (ARPA-E) – provides funding for technologies that are too early for private sector investment but have the potential to lead to new ways to generate, store and use energy.

[44] Fuller descriptions of the primary and secondary peer RD&D programs are included in Section 3.10.

- The New York State Energy Research and Development Authority's (NYSERDA's) Technology and Market Development (T&MD) Program – tests, develops and introduces new technologies, strategies and practices that build the statewide market infrastructure to reliably deliver clean energy to New Yorkers.

6.4.1 Program Administration and Context

Although the selection of the peer RD&D programs for the best practices review focused on key similarities between these programs and EPIC, it is important to note unique characteristics of EPIC. For example, EPIC is administered by four separate entities while most of the peer RD&D programs are overseen by one main department or agency. EPIC is also funded by ratepayers, authorized by the state's public utilities regulatory commission, and requires legislative spending approval (for the CEC). As a result, EPIC has a central focus on ratepayer benefits. These features of EPIC are important for contextualizing the findings from the best practices assessment.

6.4.2 Program Management

Findings from the literature review and in-depth interviews with peer RD&D programs show that effective RD&D programs have a core internal staff that oversees design and implementation. The program administration team facilitates relationships with investors, government agencies, small and large companies, and other organizations. Because these programs support new and emerging technologies, the peer RD&D program administrators also rely on other experts both within and outside of their respective agencies who may have specialized knowledge of specific technologies or concepts. For example, when developing a funding opportunity, the program administrators will convene industry experts to help inform the initiative. Interviewees also spoke about coordinating with other state or federal agencies and industry groups to stay current on topics affecting their work.

The interviewees from all of the peer RD&D programs cited the depth of knowledge and expertise of the program administrators, consultants and other stakeholders that contribute to effective program implementation. Each of the RD&D programs employs staff with strong technical expertise. In general, program staff are also responsible for ensuring that the Program's overall goals and objectives are reflected in the portfolio of projects.

Commercialization Supports

Program staff also coordinate with internal and external experts to support projects. Program staff and other institutional supports play an important role in facilitating technology transfer and market development mechanisms for projects. For example, two of the four primary peer RD&D programs offer support and resources to promote commercialization activities.

- ARPA-E's Technology-to-Market Team provides direct business-related technical support and assistance to grantees. In addition to providing guidance on the project team's Technology-to-Market Plan, the Technology-to-Market advisors assist projects in a variety of ways, including helping them conduct market assessments, identify potential investors, and develop and deliver a business pitch. ARPA-E also holds an Annual Energy Summit that convenes individuals and organizations from industry, academia and government and provides an opportunity for project managers to meet with potential partners, collaborators or investors.
- Projects funded through NYSERDA's T&MD Program can also access commercialization-related resources available through the Entrepreneurs-in-Residence (EIR) Program, which is very much like ARPA-E's Tech-to-Market Team. In addition, NYSERDA funds six business incubators across the state and supports a Proof-of-Concept Center where businesses can access existing intellectual property and work on commercializing it.

Helping Projects Respond to Unexpected Changes

All four of the primary peer RD&D programs have structures in place to help projects identify and capitalize on opportunities to change course, when needed, to maximize the projects' success. Because the technology innovation process is not linear, it often requires program administrators, grantees and others involved in the RD&D process to be adept at recognizing critical opportunities in order to maximize success. The SBIR Program allows projects to be able to reallocate up to 10 percent of their budget without prior approval. Because ARPA-E and NYSERDA's T&MD Program both have an explicit focus on commercialization, advisors for their respective programs actively work with project teams to identify appropriate pivots, and may help facilitate these course corrections.

6.4.3 Contracting

Contracting times vary substantially across the different peer RD&D programs. One of the secondary peer RD&D programs has the shortest turnaround of one week. On the other end of the spectrum, one of the primary peer RD&D programs takes roughly three to six months on average. Another primary peer RD&D program, which reportedly takes six weeks, allows the project team to begin working on the project at-risk up to 90 days before the contract is finalized.

6.4.4 Comparison with EPIC

In general, with one exception, we found that EPIC compares favorably with the peer RD&D programs in the best practices assessment. Like the peer RD&D programs, EPIC utilizes a core internal staff that coordinates with internal and external stakeholders. We also found that the contracting time for EPIC was within the range of the peer RD&D programs. However, compared to peer RD&D programs, EPIC has only a nominal focus on support for commercialization, limited to a requirement for a project-based technology/knowledge transfer plan and a production readiness plan (as needed).

The Program does fund commercialization assistance through Market Facilitation projects, but these supports do not directly benefit EPIC projects. The Market Facilitation projects help entrepreneurs and researchers overcome non-technical barriers to accelerate the commercial viability of their technologies. The commercialization supports include training or technical assistance related to conducting market research and analyses; assistance with developing tools to help transition research and innovations from the lab to the market; and formal networks that bring together entrepreneurs, researchers and investors to exchange ideas, best practices and information on market opportunities. As noted above, two of the four primary peer RD&D programs—ARPA-E and NYSERDA's T&MD Program—similarly offer commercialization resources activities, but these supports directly benefit their grantees. Table 21 summarizes the broad categories of effective practices that were referenced during interviews with the peer RD&D programs.

Table 21: Best Practices Comparison of EPIC and Peer RD&D Programs

Peer RD&D Programs Program Management	Current EPIC Practice	Comments
Core internal staff that coordinates with internal and external stakeholders	The CEC does this; the IOUs rely mostly on a single stakeholder.	The CEC engages external experts but manages the process internally. The IOUs work with the Electric Power Research Institute (EPRI) to determine research priorities, but manage the process internally.
Offer support and resources to promote commercialization activities (two of four primary peer RD&D programs)	The CEC does this through Market Facilitation program.	The CEC funds Market Facilitation projects, which currently do not target Applied R&D or TD&D projects.
Explicit requirement for project-based knowledge or technology plan	The CEC does this.	Process appears to be sufficient.
Help projects change course, when needed, to maximize the projects' success	EPIC does this.	Process appears to be sufficient.

7 Investment Planning Process

In this section, we discuss the effectiveness of the Program's investment planning, as described in the EPIC Administration logic model (see Section 13.1 for more details), which informed our data collection efforts. Investment planning is a critical first step in the causal chain that is expected to ultimately lead to the achievement of EPIC's mid- and longer-term outcomes. For our assessment, we conducted interviews with the management teams from each administrator (a total of nine interviews), reviewed program documents such as the Investment Plans and Annual Reports, conducted 90 project-level interviews associated with our sample of 54 projects, conducted nine interviews with EPIC stakeholders, reviewed comments submitted to the EPIC Idea Exchange and conducted a best practices assessment.

The administrators are required to file triennial Investment Plans, and to-date plans for the first three triennial program period plans have been filed. The first set of plans covering 2012–2014 was approved in November of 2013 in CPUC Decision 13-11-025, and the second set of plans covering 2015–2017 was approved in April of 2015 in CPUC Decision 15-04-020. The administrators recently filed their third triennial plans for 2018–2020, which they were required to do by May 1, 2017. The first EPIC Decision (12-05-037) that authorized the Program identified specific requirements for the Investment Plans, including:

- Screening and scoring criteria for evaluating funding proposals (which were established in the next Decision, 13-11-025);
- Metrics against which success will be measured (which were established in the next Decision, 13-11-025) (See Appendix A);
- Addressing how Public Utility Code 740.1 and 8360 statutory guidance are applied to program plans (See Appendix A);
- A summary of stakeholder comments received during the development of each Investment Plan and the administrators' responses to the comments; and
- Mapping of planned investments to the electricity system value chain.

7.1 Investment Plan Scoping

As discussed throughout this report, the CEC and IOUs have different approaches for administering EPIC. The CEC administers research grants while the IOUs conduct the research internally. This fundamental difference in administration is exemplified in their investment planning approaches. Each administrator is required to address a number of elements required by the CPUC, which we confirmed to have been addressed in their EPIC 1 and EPIC 2 Investment Plans.

As mentioned previously in Section 6, throughout the report we have tended to present results for the CEC and all three IOUs combined due to the difference in their administrative approach that we noted at the initial stages of the evaluation. However, we examined each of the four administrators' processes and projects, and where we noted differences across the three IOUs, we discuss those differences. Note that those comparisons were limited by the size of the project sample for each IOU, which reflects the relatively smaller portion of the EPIC budget that the IOUs receive as compared to the CEC.

7.1.1 CEC Plan Scoping

Based on a series of interviews we conducted with the CEC's EPIC program management team, we learned that the CEC approaches investment planning from two perspectives. First, it identifies strategic topical issues facing the state (e.g., water conservation and tree mortality for prior Investment Plans) along with the state's clean energy policy priorities for a top-down view of identifying a series of objectives that EPIC research projects should address during the next funding cycle. Next, they take a bottom-up approach with input from their in-house technical staff who conduct energy research (either in the R&D Division's energy research office or in other divisions such as Energy Efficiency and/or Renewables) who identify gaps in the available research. Often, publicly available interagency (e.g., CEC, CPUC, CARB [California Air Resources Board] and CAISO [California Independent System Operator]) research road maps inform CEC staff assessments of research gaps. The CEC's program management team also described how they orient the top-down and bottom-up processes to EPIC's guiding principles. They do this to ensure that any strategic objectives or areas on which they decide to focus their planning are in alignment with Program requirements. The guiding principles also serve as screening criteria, since any topics that might be pursued that are inconsistent with the Program's guiding principles would be screened out. They also said that they coordinated with the other administrators to prevent redundancies (such as with the IOUs' Emerging Technology Programs). Similar to the IOUs, the CEC also solicits input from experts, stakeholders and the public (which is explored in the next subsection, 7.2), to identify gaps and to prevent redundancies with other efforts.

The CEC's Investment Plan document identifies a set of strategic objectives that are intended to result in a project portfolio that selects the most promising technology solutions that align with energy policy. The plan is organized by program research area (or project type, i.e., Applied R&D, TD&D and Market Facilitation), identifying the strategic investment objectives along with a number of funding initiatives that address research gaps, as determined by the CEC and corroborated by stakeholders, for each technology area. Each objective is discussed in detail, including barriers and challenges and how any prior Investment Plan investments have already addressed some of those. For each objective, a set of initiatives is presented that focuses on a particular area of research, along with a discussion of each that includes the purpose of the initiative, relevant stakeholders of the research, and background on the research area including research findings to date on the subject and relevant policy and other developments. The plan also indicates alignment with EPIC guiding principles and key policy drivers.

We conducted analysis on the administrators' project portfolios spanning EPIC 1 and EPIC 2 to attempt to independently validate the effectiveness of their investment planning processes and frameworks in leading to a set of projects that meets the Program's goals. First, we reviewed their frameworks to identify how project funding was awarded to each element in the framework (i.e., CEC strategic objectives). Next, we assessed each project to independently validate the extent to which projects align with EPIC's guiding principles and address the state's clean energy policies. We conducted this analysis based on a review of the administrators' Investment Plans and Annual Reports. We discuss the results of both of these analyses below.

CEC Framework Review

The results of the review of CEC's framework are shown in Table 22. The CEC has a total funding amount of $395,563,363 for EPIC 1 and EPIC 2 that was allocated across 20 unique strategic objectives.[45] All but two of the strategic objectives resulted in one or more projects being funded. The two initiatives that were not yet awarded projects are currently in progress and will be included in future solicitations. This result indicates that the CEC was successful in attracting viable bids for projects for nearly all the initiatives it identified in its Investment Plan as being required to meet its Investment Plan goals across the first two funding cycles. The table indicates that two of the strategic objectives that are devoted to energy efficiency (Strategic Objective 1 (S1): *Improve Energy Efficiency Technologies and Strategies in California's Building, Industrial, Agriculture, and Water Sectors* and Strategic Objective 12 (S12): *Demonstrate and Evaluate the Technical and Economic Performance of Emerging Energy Efficiency and Demand-Side Management Technologies and Strategies*) together account for 30 percent of awarded funds. The other strategic objectives have relatively lower numbers of projects and funding amounts. The CPUC has not indicated which of the areas of policy should be prioritized, so we are not able to say whether a focus on energy efficiency (and less of a focus on other topics such as renewables and smart grid) is optimal or problematic. This type of analysis provides a useful starting point to assess the portfolio and which areas are receiving the most funding.

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[45] Strategic Objective 18 was modified from EPIC 1 to EPIC 2, as shown in the table. Strategic Objective 15 was addressed in a later solicitation that occurred after we conducted our research, and the CEC had released a Request for Comments to get further stakeholder input on the solicitation scope of Strategic Objective 19. The Request for Comments was released on February 27, 2017, with comments due on March 13, 2017. The CEC indicated it planned to release the solicitation by August 2017.

Table 22: CEC's EPIC Project Funding By Strategic Objective (EPIC 1 and EPIC 2)

Strategic Objective	$ Amount	N	Proportion of Budget
S1: Improve EE Technologies	$66,253,005	38	17%
S2: Enable Cost-Effective Demand Response	$28,136,304	9	7%
S3: Develop Innovative Solutions	$16,508,646	11	4%
S4: Develop Utility Scale Renewable Technologies	$10,869,219	8	3%
S5: Reduce the Environmental and Public Health Impacts	$19,154,881	34	5%
S6: Advance Smart Inverters to Manage Areas with High Penetrations of PV	$5,401,868	5	1%
S7: Develop Distribution Modeling Tools for the Smart Grid	$1,690,055	2	0%
S8: Advance Customer Systems to Coordinate with Utility Communication Systems	$8,870,498	6	2%
S9: Advance EV Infrastructure to Provide Electricity System Benefits	$6,681,669	5	2%
S10: Leverage CA Clean Energy Technologies & Companies	$19,435,655	6	5%
S10_2: Advance the Early Development of Breakthrough Energy Concepts	$20,211,957	1	5%
S11: Provide Federal Cost Share for Applied Research Awards	$750,000	1	0%
S12: Evaluate the Technical Performance of EE Technologies and Strategies	$49,981,350	22	13%
S13: Evaluate Clean Energy Generation Technologies and Strategies	$42,334,079	13	11%
S14: Demonstrate Integration of EE Demand-side Resources	$40,257,789	12	10%
S16: Enhance Current Regulatory Assistance and Permit Streamlining Efforts	$17,437.354	12	4%
S17: Strengthen the Clean Energy Workforce	$8,908,107	2	2%
S18 EPIC 1: Guide EPIC Investments Through Outreach Activities	$18,101,945	8	5%
S18 EPIC 2: Foster the Development of Energy Technologies into Businesses	$12,091,373	5	3%
S20: Accelerate the Deployment of Energy Technologies in IOU Territories	$2,487,609	2	1%
Total	**$395,563,363**	**202**	**100%**

CEC Assessment of Program Goals

Next, we reviewed information provided in the Investment Plans, Annual Reports and solicitations, and used our expert judgment to make an assessment of whether each project in the CEC's EPIC 1 and EPIC 2 portfolios meets each of the Program's guiding principles and whether it supports key energy policies.

The CPUC established ratepayer benefits as the Program's mandatory guiding principle; as such, we would expect that all projects would provide ratepayer benefits. The CPUC also directed the administrators to address complementary guiding principles in their Investment Plans:

- Providing societal benefits;
- Reducing GHG emissions in the electricity sector at the lowest possible cost;
- Supporting California's loading order to meet energy needs, first with energy efficiency and demand response, second with renewable energy (distributed generation and utility scale), and third with clean conventional electricity supply;
- Supporting low-emission vehicles and transportation;
- Providing economic development; and
- Using ratepayer funds efficiently.

Many of the complementary guiding principles are broad and may also overlap, and one would expect a high proportion of projects to meet many of them (such as providing societal benefits, supporting the loading order and reducing GHG emissions). Others have a narrower focus, and one would expect only a small subset to meet the guiding principles (e.g., supporting low-emission vehicles).

Table 23 shows the results of our assessment, with the number of projects and proportion of funds the CEC awarded to projects in its EPIC 1 and 2 portfolios that address each EPIC guiding principle. Based on the above analysis, all of the CEC's EPIC 1 and EPIC 2 projects are designed to provide ratepayer benefits, as mandated by the CPUC. When we reviewed the types of benefits that would accrue to ratepayers, we found that the majority (63%) of CEC projects are expected to directly benefit the entire population of ratepayers, by leading to increased reliability of the electric power grid, increased grid operational safety and reduction in ratepayer costs. The remainder of projects will initially generate benefits for a subset of ratepayers, but will eventually benefit everyone. For example, biogas capture and microgrid activities for dairy farm operators, or wastewater capture and purification process developments for specific and limited-use industry processes, are expected to initially benefit a smaller subset of ratepayers but over time will lead to more sustainable water use and lower energy usage, generating broader benefits. This mix of projects is what one might want to see, with sufficient diversity across projects to address both the broader needs that benefit all ratepayers and the unique needs that immediately impact only a subset of ratepayers, but still will benefit everyone eventually.

A very high percentage of CEC projects meet the broad complementary guiding principles, such as providing societal benefits and supporting the loading order, which is what we would want to see. A small proportion of projects meet the principle related to supporting low-emission vehicles, which is expected and indicates an appropriate focus on a more narrowly technology-focused program goal. While we cannot say whether 25 percent is the right number, we would not want a high proportion of projects being focused on one particular policy and technology area, in order to ensure a diverse portfolio that meets many policy objectives.

Table 23: CEC's EPIC Project Funding by Guiding Principles (EPIC 1 and EPIC 2)* (N=202)

EPIC Guiding Principle	N	$ Amount	Proportion of Budget
Ratepayer Benefits	202	$395,563,363	100%
Broad ratepayer benefits	122	$248,619,809	63%
Narrow ratepayer benefits	80	$146,943,554	37%
Societal Benefits	180	$361,378,599	91%
GHG Mitigation	165	$348,372,424	88%
Health and Safety	170	$346,271,648	88%
Supporting the Loading Order	163	$335,679,461	85%
Operating Efficiency and Reliability	159	$328,168,535	83%
Economic Development	118	$276,694,575	70%
Supporting Low-Emission Vehicles	40	$99,930,329	25%

*A given project along with its budget can appear multiple times in this table.

Next, we examined how the CEC's EPIC 1 and EPIC 2 projects address the following key energy policy areas (which are described in more detail in Section 2.2):

- Greenhouse gas (GHG) reduction – the state's ambitious goals to reduce GHG emissions (AB 32 that set a goal of reducing GHG emissions to 1990 levels by 2020, and SB 350's goals for 2030 to reduce GHG emissions 40 percent below 1990 levels, and 80 percent below 1990 levels by 2050).
- Renewable Portfolio Standard (RPS) – related to GHG reduction goals, the state's requirement for electricity retailers to serve 33 percent of their retail sales with renewable energy procurement, and SB 350 increased that to achieving 50 percent by 2030.

- Smart grid – upgrades to the state's existing transmission and distribution system to improve efficiency, reliability, economics and sustainability of electricity services
- Energy efficiency – supporting the state's Long Term Energy Efficiency Strategic Plan, which seeks to achieve maximum energy savings across all major groups and sectors in the state.
- The loading order – the state's energy resource guide, which is to decrease electricity demand by increasing energy efficiency and demand response, and meet new generation needs first with renewable and distributed generation (DG) resources, and second with clean fossil-fueled generation.
- Distributed energy resources (DER) – integrated resource planning efforts that will identify an optimal portfolio of resources to achieve the state's GHG goals and meet the challenge of renewable integration.
- Electric vehicles – efforts to expedite zero emission vehicle commercialization, including the development of a vehicle-to-grid integration road map
- Energy storage – collaborative efforts to meet the target for 1,325 MW of energy storage to be procured by 2020 and installed by 2024.
- Clean jobs – job creation goals associated with the acceleration of renewable energy production, energy efficiency and energy storage.

Table 24 shows the proportion of EPIC funds the CEC awarded to projects in its EPIC 1 and 2 portfolios that address each California policy goal based on our independent assessment of each project. The table shows that a very high percentage of projects meet the broad policy goals of distributed energy resources, supporting the loading order, energy efficiency and generating clean energy jobs. (Many of these broad policy goals in fact overlap, so a project focused on energy storage would also support distributed energy resources and the RPS, and would likely generate clean jobs.) A smaller proportion of funding is allocated to projects that will support meeting more narrowly-focused policy goals of energy storage, electric vehicles and the smart grid. In the next subsection, we present this same analysis for the IOU projects, where we find they have allocated a higher proportion of funding toward projects that support polices related to the smart grid and RPS in particular. As we will discuss in that section, we found that the administrators complement each other with the projects proposed for RPS, covering demonstrations to support upgrades to the grid to accommodate increases in renewables (IOUs), and Applied R&D and Market Facilitation projects sponsored by the CEC that address policy and research needs to support meeting RPS goals.

Table 24: CEC's EPIC Project Funding by California Policy Goals (EPIC 1 and EPIC 2)* (N=202)

California Policy Goals	N	$ Amount	Proportion of Budget
Distributed Energy Resources	189	$380,090,360	96%
GHG Reduction	165	$348,372,424	88%
Loading Order	164	$337,244,861	85%
Energy Efficiency	134	$296,498,362	75%
Clean Energy Jobs	118	$276,694,575	70%
Energy Storage Adoption	55	$138,219,867	35%
Renewable Portfolio Standard	53	$129,748,555	33%
Electric Vehicles	40	$99,930,329	25%
Smart Grid	57	$92,372,281	23%

*A given project along with its budget can appear multiple times in this table.

Next, we present the same set of analyses for the IOUs. We note that these analyses offer just one possible way of assessing whether administrators' planning processes are effective. Based on this way of looking at the CEC's projects, we independently verified that every project meets the required guiding principle of providing ratepayer benefits and supports at least one key energy policy area in a meaningful way. The CEC's current portfolio is diverse in terms of the types of ratepayer benefits it offers (with projects focused on both broad benefits and certain subsets of customers with specific needs) and how it addresses the broad and technology-specific policy areas. In both those cases, we found a higher proportion of funding directed where one would expect (where the policy objectives are broad and overlapping) and less where one would expect (where the policies are more narrowly focused). In addition, our analysis makes clear the challenges of assessing planning processes that address 20 strategic objectives and several guiding principles all nested within nine or more California policy objectives. Since there have not been any priorities set among the guiding principles and policy areas, we cannot determine whether the current investment planning processes lead to an optimal portfolio. However, this analysis approach provides a starting point for further review of the portfolio and development of priorities.

7.1.2 IOU Plan Scoping

Based on a series of interviews we conducted with the IOUs' EPIC program management teams and review of their Investment Plans and Annual Reports, we learned that the IOUs developed their own joint framework to guide their investment planning to ensure they offer the right mix of projects in their portfolios. The framework includes four investment areas (all within the TD&D area) that the IOUs have identified as critical areas on which to focus in order to modernize the grid. In their Investment Plan documents, the IOUs identify demonstration objectives for each of the four investment areas, which are aligned with a description of intended project benefits, EPIC guiding principles and key policy drivers and objectives. Each investment area is also mapped to the electric system value chain as indicated:

- Renewables and Distributed Energy Resources (DER) Integration – maps to grid operations/market design, focuses on renewables and distributed energy resources integration, and supports the state's RPS, GHG emission reduction and energy storage goals.
- Advanced Asset Management and Optimization – maps to T&D, focuses on grid modernization and optimization, and addresses SB 17 and smart grid planning and implementation.
- Customer Products/Service Enablement and Integration – maps to DSM, focuses on the integration of DSM with the smart grid, and supports ZNE policies.
- Cross-Cutting/Foundational Strategies and Technologies – maps across the electric value chain, and focuses on smart grid architecture, cybersecurity, telecommunications and standards development.

The IOUs use very similar processes to develop their Investment Plans. They each use a process to identify potential project areas that is focused internally, guided by their technical staff whom they refer to as their stakeholders. Each IOU EPIC program management team consults with their internal technical stakeholders to identify the most critical needs that justify a demonstration project. The IOUs, unlike the CEC, are better able to draw on the specific technical expertise of internal staff who work directly on these issues to help inform and guide Investment Plan scoping. The management team filters each potential demonstration project by whether it is market-ready and deployable, or if it has already been deployed, could it be tested in a new and novel way. They consult with their internal management to provide input on their draft plans as they develop from initial ideas to the draft Investment Plan. The IOUs, along with the CEC, jointly meet with the Electric Power Research Institute (EPRI), which conducts RD&D projects focused on electricity generation, delivery and use in collaboration with the electricity sector. This semi-annual EPRI advisory committee meeting[46] is a one-day feedback session to examine gaps, risks and potential duplication of research. The IOUs and EPRI told us during interviews that EPRI provides insight into the latest advances in energy-related technologies and research within California as well as nationally and globally. While the IOUs solicit other stakeholders besides EPRI to weigh in on their plans, their plans are very far along by the time they hold stakeholder workshops, and input provided at these

[46] Funders of specific programs meet to define work and review work on those programs. A committee meeting is for funders of a specific program, which is open to IOUs and the CEC.

forums does not appear to shape their plans substantially. (We discuss stakeholder outreach in the next section more thoroughly.)

Once they have a set of potential projects based on input from their internal stakeholders and EPRI, the IOUs indicated that they ensure that projects are relevant to state energy policies and meet all EPIC program requirements. Thus, our assessment is that these last two criteria are used as driving factors (along with their program budget) applied to their working list of projects. The main source of project origination, based on the IOUs' description of their processes and also verified by review of their projects and how they engage stakeholders, is their internal IOU stakeholders. However, because many of those internal stakeholders are often working on state energy policies, the internal needs are often complementary with state policy needs.

Next, the IOUs described to us how they use their joint framework to structure their written Investment Plans and as a final check to ensure that projects are balanced across the four investment areas. The IOUs described how they discuss their initial plans with the other IOUs during their biweekly coordination calls[47] and their meeting with EPRI to ensure no duplication, or to coordinate on a project if appropriate. We also corroborated that there is little duplication in the first two Investment Plans as a result of coordination efforts (we discuss coordination more thoroughly in Section 8.5.) However, we did note some potential areas of duplication in the IOUs' EPIC 3 plans, which suggests the need for more thorough review of IOU project plans (in the Investment Plans and throughout project implementation).

As mentioned in the previous section that focused on the CEC's investment planning processes, we conducted analysis on the administrators' project portfolios spanning EPIC 1 and EPIC 2 to attempt to independently validate the effectiveness of their investment planning processes and frameworks in leading to a set of projects that meets the Program's goals. Below, we present the results of the analysis of the IOUs' framework and assessment of program goals.

IOU Framework Review

The results of the review of the IOUs' framework are shown in Table 25. The IOUs have a total funding amount of $182,678,907 allocated across their four unique research categories. The IOUs fund projects fairly evenly across their four investment areas, indicating that they followed through and launched projects in each area that they identified in their Investment Plans. The Crosscutting/Foundational Strategies and Technologies investment framework element has the largest percentage of projects funded (33%).

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47 All four administrators meet biweekly; and on the off week, the IOU administrators meet.

Table 25: EPIC Project Funding By IOU Framework (EPIC 1 and EPIC 2)

IOU Framework	$ Amount	N	Proportion of Budget
Cross-Cutting/Foundational Strategies and Technologies	$60,093,566	8	33%
Customer Products/Service Enablement and Integration	$44,707,865	16	24%
Advanced Asset Management and Optimization	$44,543,686	29	24%
Renewables and Distributed Energy Resources Integration	$33,333,790	17	18%
Total	**$182,678,907**	**71**	**100%**

Note: Twenty-four projects are on-hold at the time of this evaluation, and the IOUs have not allocated funding for these projects. These projects are excluded from this analysis. They include 1 Cross-Cutting/ Foundational Strategies and Technologies, 5 Customer Products/Service Enablement and Integration, 14 Advanced Asset Management and Optimization, and 4 Renewables and DER Integration projects.

IOU Assessment of Program Goals

Using the same approach described above for the CEC, we independently assessed whether each project in the IOUs' EPIC 1 and EPIC 2 portfolios meets each of the Program's guiding principles and whether it supports key energy policies. Table 26 shows the results of our assessment, with the number of projects and proportion of funds the IOUs awarded to projects in its EPIC 1 and 2 portfolios that address each EPIC guiding principle.

All of the IOUs' EPIC 1 and EPIC 2 projects are designed to provide ratepayer benefits, the first category of guiding principles in Table 26, as mandated by the CPUC. When we reviewed the types of benefits that would accrue to ratepayers, we found that the vast majority (85%) of IOU projects are expected to directly benefit the entire population of ratepayers (broad ratepayer benefits in the table), increasing the reliability of the electric power grid, improving grid operational safety, and reducing ratepayer costs. These IOU projects are designed to achieve these broad benefits by addressing grid communications and interactivity and grid maintenance, optimization, planning and management. The remainder of the IOU projects, such as microgrid and vehicle-to-grid applications, and various types of market research, are expected to initially benefit a smaller subset of the ratepayers such as electric vehicle owners and grid-system operators (narrow ratepayer benefits in the table). However, if successfully demonstrated, such projects are expected to eventually lead to further system or regulatory advances that may provide greater societal benefits. This mix of projects is what policy makers might want to see, with sufficient diversity across projects to address both the broader needs that benefit all ratepayers and the unique needs that immediately impact only a subset of ratepayers, but still will benefit everyone eventually.

Looking at the rest of the guiding principles that follow the ratepayer benefits guiding principle category in Table 26, we found that a very high percentage of IOU projects meet each of the complementary guiding principles such as operating efficiency reliably and providing health and safety benefits. A smaller fraction of projects meet the last two guiding principles in the table, which are more narrowly focused. Sixteen percent of projects meet the principle related to supporting low-emission vehicles, which is expected and indicates an appropriate focus on a more narrowly technology-focused program goal. While we cannot say whether the optimal percent of projects that support low-emission vehicles is 16 percent, we do believe that, in order to ensure a diverse portfolio that meets the many policy objectives, a high proportion of projects should not be focused on one particular policy and technology area. Similarly, we cannot comment on whether the optimal fraction of projects that support GHG mitigation is 68 percent, but we would expect to see (and we do see) a high percentage.

While there is a clear tendency for the IOUs to focus more narrowly on the specific needs of their own systems (that still generate benefits for all customers), the CEC has a much broader focus (as evidenced by 70 percent of CEC projects supporting economic development versus only 35 percent of IOU projects). Perhaps this is what one should expect from the utilities given they are confronted every day with a set of very specific challenges related to their grids and a general need to focus on increasing grid reliability. Note that while the work on improving grid reliability will involve IOU employees, reducing the number of unscheduled outages increases overall productivity. Whether IOU TD&D portfolios should resemble the CEC TD&D portfolio with respect to the proportion of projects that support each guiding principle is a policy issue.

Table 26: IOUs' EPIC Funding by Guiding Principle (EPIC 1 and EPIC 2)* (N=71)

EPIC Guiding Principle	N	$ Amount	Proportion of Budget
Ratepayer Benefits	71	$182,678,907	100%
Broad ratepayer benefits	61	$154,799,682	85%
Narrow ratepayer benefits	10	$27,879,225	15%
Operating Efficiency Reliability	68	$176,878,907	97%
Health and Safety	38	$126,602,554	69%
GHG Mitigation	39	$123,596,716	68%
Supporting the Loading Order	33	$116,331,489	64%
Economic Development	15	$63,556,934	35%
Supporting Low-Emission Vehicles	12	$29,519,538	16%

*A given project along with its budget can appear multiple times in this table.

Next, we examined how the IOUs' EPIC 1 and EPIC 2 projects address key energy policy areas. Table 27 shows the proportion of EPIC funds the IOUs awarded to projects in its EPIC 1 and 2 portfolios that address each California policy goal (using a similar process as described above for the CEC). The table shows that a high percentage of projects meet the broad policy goals of distributed energy resources and supporting the loading order. The IOUs direct a much higher proportion of EPIC funding toward projects that support the smart grid compared to the CEC, and we would expect that based on the IOUs' framework and its focus on grid research areas. The IOUs devote only a small percentage of EPIC funding toward energy efficiency projects, though we note that they have their Emerging Technology Program, which focuses on new technology development and research for energy efficiency. Like the CEC, a smaller proportion of funding is allocated to projects that will support meeting more narrowly focused policy areas of energy storage and electric vehicles.

With respect to the Renewable Portfolio Standard policy area, the CEC and IOUs approach this topic very differently (with the IOUs directing more than half their project funds toward projects that support that policy versus 33 percent for the CEC). The IOUs have several types of demonstration projects that support RPS—covering planning, controls, vehicle-to-grid, integration of DG, and energy storage. The IOUs are conducting demonstration projects in these areas to help them better predict how the increase in renewables and DG will impact their grid and to test potential solutions (storage, controls) to be able to adapt. The CEC has fewer projects in these areas, mostly Applied R&D and Market Facilitation projects. CEC projects are focused on policy and research, with only a small number of demonstration projects (biomass, ZNE demonstrations.) Jointly, the projects are progressing the research on RPS, and this area may demonstrate an effective example of how having the IOUs and the CEC administer the Program can generate a complementary and comprehensive set of projects.

Table 27: IOUs' EPIC Funding by California Policy Goals (EPIC 1 and EPIC 2)* (N=71)

California Policy Goals	N	$ Amount	Proportion of Budget
Distributed Energy Resources	64	$165,729,682	91%
Smart Grid	46	$133,692,928	73%
Loading Order	34	$117,347,491	64%
GHG Reduction	34	$106,836,716	58%
Renewable Portfolio Standard	26	$99,423,298	54%
Energy Storage Adoption	24	$88,008,243	48%
Electric Vehicles	15	$66,680,120	37%
Clean Energy Jobs	15	$56,576,934	31%
Energy Efficiency	10	$20,281,727	11%

*A given project along with its budget can appear multiple times in this table.

Based on this way of looking at the IOUs' projects, we independently verified that every project meets the required guiding principle of providing ratepayer benefits and supports at least one key energy policy area in a meaningful way. The IOUs' current portfolio is more narrowly focused on grid projects as compared to the CEC's. We confirmed that every IOU project supports at least one key policy area, with a particular focus on supporting distributed energy resource and smart grid policies. Similar to the CEC analysis, we note the challenges of assessing planning processes that attempt to reconcile the IOUs' investment planning framework along with several guiding principles all nested within nine or more California policy objectives. Since there have not been any priorities set among the guiding principles and policy areas, we cannot determine whether the current investment planning processes lead to an optimal portfolio. However, this analysis approach provides a starting point for further review of the portfolio and development of priorities.

7.2 Stakeholder Outreach

Decision 12-05-037 requires the administrators to seek stakeholder input at least twice per year and to notify parties on the EPIC service list about related proceedings, to consult certain types of stakeholders, and to summarize stakeholder comments and their response in their Investment Plans. Stakeholders involved in these outreach efforts include:

- Members of the Legislature (to the extent their participation is not incompatible with their legislative positions);
- Government representatives, including state and local agencies;
- Utilities;
- Investors;
- The California Independent System Operator (ISO);
- Consumer groups;
- Environmental organizations;
- Agricultural organizations;
- Academics;
- The business community;
- The energy efficiency community;
- The clean energy industry and/or associations; and
- Other industry associations.

In a subsequent Decision (15-04-020), the CPUC required the administrators to coordinate on an annual EPIC Innovation Symposium starting in 2015, which counts toward the two stakeholder forums per year.

The administrators also each maintain an EPIC webpage that provides information about EPIC and related energy policies and proceedings, including previous and upcoming workshops and opportunities for public comments. The CEC has a specific webpage dedicated to requesting comments to inform selected solicitation development. The CEC also holds a number of different types of public workshops (described in more detail below) to assess R&D needs and opportunities around specific topics, solicit input on the CEC's administration of EPIC, and to increase awareness across the state regarding EPIC funding opportunities. The IOUs conduct a gaps workshop with EPRI as described earlier to identify priority investment areas, and they also meet with EPRI on a semi-annual basis to exchange ideas and information in order to stay abreast of emerging technologies and innovations.

7.2.1 Stakeholder Workshops

EPIC hosts public workshops to solicit input on the Triennial Investment Plans. We reviewed workshop materials and attended 2018-2020 Triennial Investment (or EPIC 3) Planning workshops[48] to observe the administrators' procedures and stakeholder engagement. Prior to the workshops, the administrators distribute a workshop notice, which includes background on EPIC, a brief description of the upcoming workshop, and instructions on how to participate remotely as well as how to provide public comment in general. During the workshops, the EPIC administrators provide a more in-depth overview of the EPIC decision and the draft Investment Plans. Each workshop has a slightly different focus. The workshops provide an opportunity for stakeholders to share their expertise and provide feedback on emerging technologies and future research needs.

The CEC and IOUs held a scoping workshop via webinar on February 3, 2017, during which the administrators offered an overview of proposed topic areas and concepts, and provided guidance on how stakeholders should submit proposed funding initiatives for the 2018-2020 Investment Plans. The CEC posted their draft funding initiatives on March 10 and presented detailed information about the initiatives on March 14, and at that workshop, asked questions of the audience to ensure the research is most impactful for their organization or sector. They also asked for challenges that are not being addressed by the draft funding initiatives. The CEC required stakeholder comments back on March 20, but considered comments until the next CEC business meeting on April 27. The CEC held an additional five topic-specific workshops between March 13 and April 11 on Distributed Energy Resources, Research on Climate Change for the Electricity and Natural Gas Sector, Incorporating Community Focused Equity in Research, Incorporating Community Focused Equity in Research, and Customers of Climate Science Research.

[48] Including a CEC and IOU scoping workshop held on February 3, 2017, a CEC workshop held on March 14, 2017, and IOU workshops held on March 9 and 24, 2017. (Note that the CEC and IOUs were only required to hold one joint public workshop).

The IOUs provided information about some of their project plans at the March 24 Investment Planning workshop, with a written comment deadline of March 31. (At prior workshops, they presented very general information about the Program and their planning framework.) According to stakeholders, the turnaround time for comments for both the IOUs and the CEC is relatively short, although it does appear that the administrators make an effort to consider and respond to them. The IOUs provided a high-level policy overview to garner stakeholder feedback and ultimately shared a draft plan on March 24, which incorporated such feedback. The content of what the IOUs provided at the earlier workshop on March 9 was not sufficient for stakeholders to provide meaningful input on the IOUs' plans. In addition, the information prepared for the March 24 workshop was too high level to provide much value for workshop participants. Some CEC staff even asked for more detail because they were concerned about duplicating efforts, but the IOUs did not supply more information on their plans.

Workshop Attendees

The findings below are summarized from workshops held to inform the EPIC 2 plans.[49] Workshop attendees came from a broad range of organizations (Table 28). The private sector, industry organizations, and academic institutions represented more than three-fourths of stakeholders who attended the workshops. The predominance of private sector and academic workshop attendees was consistent with the types of projects awarded through EPIC.

Table 28: Comments from Workshop Attendees by Organization Type (n=101)

Type of Organization	% of Organizations
Private Sector	38%
Energy Policy and Research Organization*	27%
Academic	14%
Advocacy	8%
State Agency/Organization	8%
National Lab	3%
Independent Contractor	1%

Source: Public comments shared through 2015-2017 Triennial Investment Planning workshops
* Note: Energy Policy and Research organizations include private and public sector companies focused on energy-related research and policy (e.g., EPRI, CALSTART, CEDMC). Private sector includes energy-focused companies, which provide commercial products and services (e.g., Solar City, Sunpower). They may also be focused on energy policy, but it is not their primary focus.

[49] At the time of this evaluation, planning for the EPIC 3 Triennial Investment Plan was underway and related comments were not yet publicly available. As a result, our analysis focuses on comments from the EPIC 2 Triennial Investment Plan, which includes a CEC-led scoping workshop held on February 7, 2014, a joint IOU workshop held on February 21, 2014, coordinated workshops held on March 17 and 21, 2014, and other public comments through other means.

Workshop Comments

Stakeholders' comments addressed a wide array of topics presented during the workshops (Table 29 and Table 30). Their substantive comments reflected strong engagement among stakeholders and administrators. The CEC and IOUs documented all of the comments and provided a response to the remarks in each of the Triennial Investment Plans. During the CEC-led workshop, attendees' comments regarding Applied R&D most frequently referred to issues related to DSM and energy storage. Comments regarding TD&D were most commonly focused on bioenergy and generation. Of the 23 comments regarding Market Facilitation, nearly half (10) were regarding commercialization assistance. These topics were also prevalent in the other workshops held by the CEC and IOUs.

The EPIC administrators documented and responded to stakeholders' comments in their Investment Plans as required by the CPUC. However, there does not appear to be many instances where comments resulted in a significant change in the Investment Plans. For example, one CEC workshop participant suggested that staff include "gateways" among the examples of DSM technologies. The administrators made a non-substantive change to the list of examples by adding "home automation network devices and systems," noting that "gateways" fell within the broader categories of technologies, but did not consider including the more narrow specification that the participant suggested. In most cases, the administrators acknowledged and reiterated relevance to existing funding opportunities or priority investment areas; on occasion, the administrators noted and explained why individual comments were not within the scope or focus of the Program.

Table 29: Scoping Workshop and Questionnaire Comments (CEC only)

Applied R&D (54 comments)	
Demand-side management	12
Energy storage	9
Building envelope materials	7
Modeling/Tools	7
Environment and public health	4
Building controls	3
Grid operations/Market design	3
Indoor air quality	2
Fuel cells	2
ZNE	1
Plug-load	1
Water heating	1
Ground Source Heat Pumps	1
Goods movement	1
TD&D (30 comments)	
Bioenergy	12
Other generation	7
Vehicle-grid integration	5
Offshore generation technologies	4
Microgrids	2
Clean energy and transportation	2
Ventilation and air conditioner precooling	1
Buoyant atmospheric PV systems	1
Market Facilitation (23 comments)	
Commercialization assistance	10
Data and analytics	5
Open-source standards	3
Programmatic Environmental Impact Report	2

Regulatory and Permitting	2
Workforce Development	1
General Comments / Other Topics (6 comments)	
Data and analytics	3
Nuclear energy	2
New solar homes partnership	1

Source: CEC-led scoping workshop held on February 7, 2014

Table 30: Other Workshops Comments (CEC and IOUs)

Topic	CEC	IOUs
Generation	14	4
Demand-Side Management	10	6
Market Facilitation/ Commercialization Assistance	8	2
Smart Grid Enabling Clean Energy	6	1
Siting	3	0
General Comments / Other Topics	3	10

Source: Public comments shared through 2015-2017 Triennial Investment Planning workshops

7.2.2 Idea Exchange

The EPIC Idea Exchange Docket is an electronic forum for stakeholders to provide public comments on the CEC's RD&D and Market Facilitation initiatives and on the Program in general. The Idea Exchange provides an ongoing opportunity for stakeholders to submit ideas to the CEC. These can include ideas for technology areas, administrative practices, and outreach strategies. Stakeholders submit comments to the Idea Exchange in response to various public workshops held by the CEC. The IOUs do not have a comparable process for soliciting stakeholder feedback. We note that the CPUC does not require the administrators to facilitate the Idea Exchange. Although the IOUs do not have a formal electronic forum, they do solicit input throughout the year via their individual websites and by a centralized email for the respective IOUs.

Since it was launched on July 8, 2016, over 200 comments have been submitted via the Idea Exchange. Idea Exchange topics are based on the guiding questions posted by the CEC. For example, following the September 22, 2016 public workshop focused on increasing private sector participation in EPIC, workshop participants were invited to engage further by submitting written remarks through the Idea Exchange. The Evergreen team reviewed comments submitted in response to this workshop to illustrate this aspect of stakeholder outreach. Stakeholders responded to four guiding questions related to increasing private sector participation:

1. What are some concerns and challenges the private sector, including small businesses and entrepreneurs, face when considering applying for grant funding opportunities?
2. How can the California Energy Commission better increase awareness of the research programs to California private sector companies?
3. What are some ideas to encourage private sector companies to apply for research funding?
4. Besides grant funding, what else can the California Energy Commission do to help California private sector companies to be successful?

Twelve individuals submitted written comments on this topic via the EPIC Idea Exchange. Respondents represented a range of perspectives including six representatives from the private sector, three from industry organizations, one from an academic institution, and one from a National Lab. Representation from these groups is fairly consistent with the types of grants awarded through EPIC.

According to the Idea Exchange respondents, the EPIC proposal requirements and the cost-share obligation were the most common challenges for small private sector firms interested in applying for grant funding. For both topics, five of the twelve respondents, including two of the six private sector firms, referenced concerns with these aspects of the EPIC grant requirements.

- Five of the 12 respondents stated that the EPIC proposal requirements are challenging. Specific concerns related to breadth of the application, including detail requested in the narrative as well as the number of attachments. A few respondents also commented that the time and resources required of an EPIC proposal were challenging for small businesses, start-up companies, entrepreneurs and other organizations that do not have a lot of experience with producing the level of detail needed for a successful application. This result is also corroborated by interviews with grantees.
- Five of the 12 respondents also indicated that the cost-share requirement is a burden, particularly for small businesses and entrepreneurs. A couple of respondents thought that the substantial amount of the cost-share[50] is difficult to

[50] Match funding is only required for TD&D projects. The applicant must match at least 20 percent of the requested funds. Applied R&D and Market Facilitation projects typically do not require match funding, but

secure, and indicated that the Program should offer opportunities for smaller grants and match-funding obligations.[51]

The second most commonly cited challenge for private sector companies was related to Intellectual Property (IP) terms and conditions.

- Three respondents stated that the IP terms and conditions are a significant barrier to applying to or participating in EPIC. In general, they thought that the terms and conditions were "onerous" and rather limiting for potential grantees. Two of these individuals stated that the IP provisions very likely inhibit or prevent small business and entrepreneurs from even applying for grant funding. While these respondents mentioned this barrier, only one respondent offered a solution, which is to consider adopting IP language developed for the federal Small Business Innovation Research (SBIR) Program.[52] Whether the CPUC decides to consider the IP template from SBIR or not, it appears that the Program should review existing terms and conditions, since potential grantees perceive them to be a significant barrier.

Other comments mentioned challenges related to competition between large research firms and small businesses and variable or inconsistent solicitation timelines.

Table 31 below shows the full range of responses from the Idea Exchange regarding challenges to applying for grant funding.

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applicants can receive extra points on their proposal for such funding. Up to 10 percent of EPIC funding for Applied R&D and TD&D can be used as federal cost share.

[51] The Program funds a project, California Sustainable Energy Entrepreneur Development (CalSEED) Initiative, which provides up to $600,000 in grant funding for early-stage research and development for emerging technologies.

[52] The DOE's Small Business Innovation Research (SBIR) and Small Business Technology Transfer (STTR) Programs have developed a "Model Agreement for Property and Commercialization Rights," which is a template designed to help in the develop of an agreement for allocating between small business concerns and research institutions' intellectual property rights and rights, if any, to carry out follow-on research, development, or commercialization.
https://science.energy.gov/~/media/sbir/pdf/files/manageapp/doe_model_agreement_for_property_and_commercialization_rights.pdf

Table 31: Challenges to Applying for Grant Funding

Response	Count
Proposal requirements	5
Cost-share obligation	5
IP terms and conditions	3
Competition between research institutions and small businesses	2
Variable/Inconsistent solicitation timelines	1

Source: EPIC Idea Exchange

Six of the 12 respondents thought that the CEC could increase awareness of research programs through targeted outreach and dissemination efforts.

- Examples of targeted efforts mentioned by respondents included conducting outreach to trade shows and conferences, leveraging relationships with industry associations to promote upcoming solicitations, and potentially having industry associations co-sponsor some solicitations to encourage members to apply for funding.
- In addition to working with established partners, one respondent suggested that the CEC should generally target the private sector prior to the release of a solicitation, and another stated that more advance notice of upcoming solicitations would be helpful.
- Two respondents thought that dissemination efforts that focused on successes, lessons learned, and project accomplishments would help to promote research funding opportunities.

Table 32 summarizes the outreach and dissemination strategies that the Idea Exchange respondents offered.

Table 32: Suggested Strategies for Outreach and Dissemination

Outreach	Dissemination
• Leverage industry associations to promote funding opportunities • Have industry associations co-sponsor solicitations • Conduct outreach to trade shows, conferences • Engage private sector prior to release of solicitation • Provide more notice of upcoming solicitations	• Publish successes and lessons learned • Require projects to share findings as part of the grant

Source: EPIC Idea Exchange

The most common suggestions regarding how to encourage private sector applications include comments related to funding priorities, the cost-share obligation, and the application process.

- Seven of the 12 respondents remarked on specific areas that the CEC should fund. In some cases, these areas are already funded (for example, funding to support testing and validation, proof of concept projects, and demonstration sites). There also was a contrasting perspective where one respondent thought that the CEC should fund projects with a wide range of Technology Readiness Levels (TRLs), while another thought that there should be greater opportunity for disruptive technologies. Overall, there was not a consistent theme among respondents' remarks. Most comments referred to existing priority areas, indicating that some stakeholders may not be very aware of the range of technologies and opportunities funded through EPIC.
- Five of the 12 respondents provided suggestions regarding cost-share requirements. One respondent thought that this obligation should be eliminated entirely. Another respondent reported that the cost-share should be optional, and that small businesses that secure match funding should receive weighted or bonus scores toward their applications since it is harder for them to procure such funding. Two respondents suggested the CEC should facilitate matches with other funding opportunities. One respondent proposed that the CEC provide an option for the cost-share to be offered as a loan.
- Five of the 12 respondents mentioned that the application process should be simplified. Only a few respondents provided specific recommendations, including having more of the proposal narrative be focused on the technology being

proposed, providing more clarity on the intent of specific solicitations, and reviewing details of solicitations when they are released.

- Other less common suggestions included offering an open solicitation (4), allowing for a two-stage proposal (3), and helping to facilitate teaming partnerships (2). Table 33 shows the full range of topics that respondents shared.

Table 33: Suggestions Regarding How to Encourage Private Sector Applications

Response	Count
Change/expand funding priorities	7
Change/modify cost-share obligation	5
Simplify application process	5
Offer an open solicitation	4
Offer a two-stage proposal	3
Facilitate partnerships	2
Encourage universities to serve as primes	1
Help businesses find grant writing firms (similar to partnerships)	1
Help facilitate disseminating project findings to industry	1
Host specific subject-matter workshops; engage various industry stakeholders in Investment Plans (consortia, incubators, accelerators, investors)	1
Remove common metrics from scoring and rely on CEC to track and monitor	1

Source: EPIC Idea Exchange

When asked what else the CEC could do to help private sector companies be successful, respondents generally referred to facilitating partnerships with other companies, including supporting demonstration sites, as well as with the investment community.

- Suggestions regarding partnerships included providing prescriptive partnering guidelines, offering proposal scoring incentives for targeted private sector entities, and maintaining a database of lab or research facilities that companies could team with on a proposal.
- Respondents offered a few general comments related to facilitating relationships with private funders. One respondent suggested that the CEC should promote disseminating project findings to the investment community. Another recommended creating a venture capital fund to help support commercialization

activities. Respondents did not provide a lot of detail about how these suggestions should be implemented.

7.2.3 Stakeholder Interviews

As described previously, the team conducted telephone interviews with nine program stakeholders to understand how EPIC administrators engage experts in developing the Triennial Investment Plans and to help administrators guide their projects. The stakeholders represented a range of organizations and perspectives, including state government; national labs; and industry, research and academic organizations.

In general, stakeholders thought that the EPIC administrators do a fairly good job of providing opportunities for participation in the planning process. Interviewees reported that the public nature of the workshops, meetings and conference calls allows for a high degree of transparency. In addition, stakeholders thought that the process was very inclusive since the administrators seek to engage a wide range of stakeholders. Although interviewees generally thought that these efforts were adequate, a minority of respondents raised a couple of concerns.

One stakeholder thought that while there was value in having transparency by using a public forum to solicit input, stakeholders engaged in this process may be worried about being politically correct in sharing concerns and might not share as freely as in a closed meeting setting, potentially resulting in missing needed EPIC funding opportunities. This individual had experience with the Public Interest Energy Research program (PIER)[53] and believed that the advisory committee process, which held closed meetings rather than forums open to the public, helped foster a level of comfort among all participants where they shared information more freely.

A few stakeholders that we interviewed offered suggestions regarding the process of developing the Triennial Investment Plans. A couple of them thought that there needs to be more lead time for providing comments on the Triennial Investment Plans. One stakeholder mentioned that the California ISO should have more direct involvement in the investment planning process. Comparing the EPIC and PIER management structures, one stakeholder noted that PIER used to have a standing committee that effectively served as a board of directors that, along with a supporting organization, was effective in identifying research needs. He suggested that the lack of such a board of directors is a weakness in the way EPIC is structured. The repeated reference to PIER's management structure may indicate an issue for EPIC to investigate further. Remnants from PIER such as the advisory committee process contributed to the program's success and may be worth examining further for EPIC.

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[53] PIER was the predecessor to EPIC. The CEC is still administering funding for public interest natural gas research and development projects.

7.3 Best Practices Comparison

The best practices assessment examined effective practices related to investment planning, including how peer RD&D programs conduct market assessments, identify gaps and opportunities, and determine program or portfolio-level investment priorities. This section summarizes the key takeaways from our review of the literature and interviews with peer RD&D programs.

7.3.1 Policy Alignment

Interviewees from all seven peer RD&D programs indicated that their initiatives are explicitly aligned with federal or state local policy goals. For example, as the primary author for the New York State Energy Plan, The New York State Energy Research and Development Authority (NYSERDA) played a key role in defining energy policy goals and objectives. As a result, the Technology and Market Development (T&MD) Program is closely coordinated with the Energy Plan recommendations and helps contribute to the state's energy goals. Since the SBIR and STTR Programs are administered across multiple federal agencies, the program administrators do not establish the technology areas that they fund. Instead, the program administrators work closely with the relevant R&D program offices at the Department of Energy (DOE), which typically develop their research priority areas, often driven by roadmaps or other investment planning mechanisms, that are aligned with their mission. The SBIR and STTR Programs help facilitate RD&D in these priority areas by stimulating technology innovation among small businesses.

While the DOE's Advanced Research Projects Agency-Energy Program (ARPA-E) is mission driven, it is the only peer RD&D program that intentionally is not bound by policy roadmaps and other similar directives. As a result, the program takes into consideration such documents, but specifically seeks to fund the "disruptive technologies and solutions" that may not necessarily be identified in these investment planning mechanisms. As the Strategic Vision for ARPA-E states, the program is designed to advance "high-potential, high-impact energy technologies that are too early for private sector or other DOE applied research and development investment."[54]

7.3.2 Investment Planning

All seven of the peer RD&D programs are informed in some way by external stakeholders; interviewees from the four primary peer RD&D programs noted that they have formal mechanisms to help identify and develop funding opportunities. As noted above, the peer RD&D programs are directly influenced by policy directives, which involves engagement with a variety of external stakeholders including federal and state government agencies,

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[54] Advanced Research Projects Agency-Energy Program (ARPA-E). "ARPA-E Strategic Vision 2013." October 2013. https://arpa-e.energy.gov/sites/default/files/ARPA-E_Strategic_Vision_Report_101713.pdf

legislators and legislative committees, businesses and other interest groups. The primary peer RD&D programs also formally engage external stakeholders in identifying investment areas. Staff from NYSERDA's T&MD Program worked with an external consulting firm to determine the program's investment priority areas. The DOE convenes planning workshops and other meetings that help inform funding priorities for individual research offices. These investment areas support research funding, and a portion is allocated to small business initiatives like the SBIR and STTR Programs. ARPA-E uses a different approach. ARPA-E rotating Program Directors have a considerable degree of autonomy in defining funding opportunities. ARPA-E's use of rotating Program Directors helps the program bring in fresh ideas based on their prior experience and expertise. Also, because they have a three-year tenure with ARPA-E, they typically are working within a relatively short timeframe and are attempting to make a significant impact during their time with the program. These staff members conceptualize focused technical funding opportunities, which are informed by meetings with external stakeholders. The Program Director takes the lead on soliciting input from external stakeholders as well as other Program Directors and leadership staff within the program, and ultimately has a great degree of ownership in developing funding opportunities and selecting projects.

Six of the seven peer RD&D programs offer focused and clearly-defined funding opportunities; two of the four primary peer RD&D programs—ARPA-E and NYSERDA's T&MD Program—additionally offer an open funding opportunity to encourage ideas that are not covered by focused program areas. In general, the focused funding opportunities are developed by program staff and are designed to address the mission and goals of the program. These opportunities offer funding to specific technology areas such as battery storage, building efficiency and grid modernization. To foster innovative approaches and solutions, both ARPA-E and NYSERDA's T&MD Program also offer funding beyond the traditional focused opportunities. ARPA-E offers a funding opportunity called Innovative Development in Energy-Related Applied Science (IDEAS), which accepts, on a rolling basis, proposals for single-phase projects of up to 12 months and $500,000 of funding.[55] NYSERDA similarly offers funding through The Advanced Clean Energy Exploratory Research Program (ACE Program); proposals are accepted on a rolling basis, and project funding and timelines vary.[56]

7.3.3 Comparison with EPIC

EPIC, like all of the peer RD&D programs included in the best practices assessment, is explicitly aligned with state policy energy goals. In addition, EPIC directly engages internal and external stakeholders to help inform funding and research priorities.

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[55] More detail on the IDEAS funding opportunity is available at ARPA-E's Funding Opportunity Exchange, at https://arpa-e-foa.energy.gov/#FoaIda8bdd9ec-2cb7-4349-8184-4dde00c77663

[56] More information on ACE Program funding is available at NYSERDA's funding opportunity portal, at https://portal.nyserda.ny.gov/CORE_Solicitation_Detail_Page?SolicitationId=a0rt0000000QnqdAAC

However, unlike the peer RD&D programs that tend to have a tight focus and clear policy directives, EPIC has a broader set of policy goals resulting in a more diffuse focus and increased complexity in managing the total portfolio and ensuring that it is optimized to achieve those goals.

Six of the seven peer RD&D programs offer focused funding opportunities, just as EPIC does. However, two peer RD&D programs also offer open solicitations to encourage cutting edge research, technology and approaches. To date, we believe that EPIC has only offered two open solicitations, by the CEC only.

Table 34: Best Practices Comparison of EPIC and Peer RD&D Programs

Peer RD&D Programs	Current EPIC Practice	Comments
Policy Alignment		
Help define state energy policy goals	EPIC does not do this.	This is currently beyond the purview of EPIC.
Prioritize research areas, driven by roadmaps	EPIC has a process for prioritizing research areas.	EPIC process appears to be sufficient.
Focus on white spaces not addressed by other programs	EPIC does not do this.	EPIC should consider doing this.
Investment Planning		
Planning workshops and other meetings that help inform funding	EPIC mostly does this.	The CEC does this more fully than IOUs.
Rotating Program Directors helps the program bring in fresh ideas	EPIC does not do this.	Likely not applicable or relevant to EPIC
External consulting firm helps determine investment priority areas	EPIC does not do this.	EPRI serves this function for the IOUs. The CEC engages external experts but manages the process internally.
Offer focused and clearly-defined funding opportunities to address program goals	EPIC does this (CEC).	The CEC does this more fully than the IOUs.
Offer single-phase, open funding opportunity to encourage ideas that are not covered by focused program areas	EPIC (CEC) has done this.	EPIC should continue, and perhaps consider expanding, this practice.

8 Project Selection Process

In this section, we discuss the effectiveness of the Program's project selection processes, as described in the EPIC Administration logic model (see Section 13.1 for more details), which informed our data collection efforts. Project selection is a critical second step in the causal chain that is expected to ultimately lead to the achievement of EPIC's mid- and longer-term outcomes. For our assessment, we conducted interviews with the management teams from each administrator (a total of nine interviews), reviewed program documents such as the Investment Plans and Annual Reports, conducted 90 project-level interviews associated with our sample of 54 projects, conducted nine interviews with EPIC stakeholders and conducted a best practices assessment.

8.1 Project Selection Process

The CEC and IOUs take a different approach to selecting projects for their EPIC portfolio. As mentioned previously, throughout the report we have tended to present results for the CEC and all three IOUs combined due to the difference in their administrative approach that we noted at the initial stages of the evaluation. However, we examined each of the four administrators' processes and projects, and we identify any differences in the report. Note that those comparisons were limited by the size of the project sample for each IOU, which reflects the relatively smaller portion of the EPIC budget that the IOUs receive as compared to the CEC.

8.1.1 CEC

Based on interviews we conducted with the CEC's EPIC program management team and review of their EPIC reports, we learned that the CEC outsources EPIC projects by issuing solicitations to fund the initiatives outlined in its Investment Plans. For example, the CEC issued 17 solicitations in 2015 and 11 solicitations in 2016, from both the EPIC 1 and EPIC 2 Investment Plans. Each solicitation is directly linked to one or more strategic objectives and funding initiatives outlined in the Investment Plans. The solicitations also group strategic objectives and funding initiatives by program area and Investment Plan period.

The CEC follows an established process that includes the following steps for each solicitation:

1. Posting the solicitation (either a Grant Funding Opportunity [GFO] or Program Opportunity Notice [PON]) on the CEC website;
2. Notifying interested parties through the Opportunity listserv (serving broader stakeholders engaged with the CEC, not just on EPIC), the EPIC listserv (dedicated to EPIC, issuing EPIC funding opportunity and award notices) and the LinkedIn Networking Hub;
3. Holding at least one public workshop;

4. Providing an opportunity to submit questions about the solicitation, posting responses on the CEC's EPIC webpage and sending out to the Opportunity listserv;
5. Posting a notice of proposed awards (or NOPA) on the CEC website; and
6. Providing an opportunity for a debrief with losing bidders.

The CEC also ensures that any stakeholders who have provided input on a solicitation (outside of a public forum) are not allowed to bid, including the utilities, state agencies and universities.

For each solicitation, the CEC publishes criteria by which it will score each bid in a solicitation manual, which contains eligibility requirements and submission instructions, and outlines the evaluation and award process. There is a two stage screening process, whereby applications (bids) that fail to comply with the screening criteria are rejected. Those that pass the first stage are submitted to an evaluation committee for review and scoring based on the criteria listed in the manual. The scores for each application are the average of the combined scores of all committee members. A minimum score of 70 points (out of a maximum of 100) is required to be eligible for funding, along with a minimum of 49 points for the first four criteria (out of eight total). The criteria categories are:

1. Technical merit and need (20 points)
2. Technical approach (20 points)
3. Impacts and benefits for California ratepayers (20 points)
4. Team qualifications, capabilities and resources (10 points)
5. Budget and cost-effectiveness (10 points)
6. EPIC funds spent in California (15 points)
7. Ratio of direct labor and fringe benefit rates to loaded labor rates (5 points)
8. Match funding (optional 5 points) - required only for Technology Demonstration and Deployment applications. Match funding is not required for Applied R&D or Market Facilitation projects, but applicants can receive extra points on their project for match funding.

Applications are then ranked by score, and the top projects are awarded funds. The results are posted in the NOPA.

Table 35 summarizes each CEC solicitation in EPIC 1 and EPIC 2, and includes the number of applications received and awarded for each solicitation, as well as funding by research area. Note that the CEC awarded projects to all strategic objectives identified in its first two Investment Plans, with the exception of two, which have not yet been included in a solicitation:

- S15: Demonstrate Advanced Energy Storage Interconnection Systems to Lower Costs, Facilitate Market and Improve Grid Reliability (in the TD&D area) – which was included in a solicitation released in November 2016 with $26 million in potential funding (which also included strategic objectives 3, 4 and 6).
- S19: Facilitate Inclusion of Emerging Clean Energy Technologies into Large-Scale Procurement Processes (in the Market Facilitation area) – not yet included in a solicitation to date.[57]

[57] The CEC released a Request for Comments to get further stakeholder input on the scope of the upcoming solicitation. The Request for Comments was released on February 27, 2017, with comments due on March 13, 2017. The solicitation will be released in the summer of 2017.

Table 35: EPIC 1 and 2 CEC Solicitations and Awards

Solicitation	EPIC Phase	Strategic. Objective	Number of Applications	Number Awarded	Funding for Applied R&D Projects Awarded	Funding for TD&D Projects Awarded	Funding for Market Facilitation Projects Awarded	Total Funding Awarded
GFO-15-302	1	S17	4	2	-	-	$8,908,107	$8,908,107
GFO-15-303	1	S5	13	4	$1,899,929	-	-	$1,899,929
GFO-15-306	1 & 2	S10; S18	12	6	$8,000,000	-	$6,980,000	$14,980,000
GFO-15-308	1 & 2	S1; S12; S14	38	15	$16,042,170	$14,748,290	-	$30,790,460
GFO-15-309	1	S1; S5	24	20	$9,539,187	-	-	$9,539,187
GFO-15-310	1	S1	19	9	$10,270,943	$4,819,805	-	$15,090,748
GFO-15-311	1 & 2	S2	12	9	$24,137,717	$2,007,875	-	$26,145,592
GFO-15-312	1 & 2	S12; S16	28	13	-	-	$18,924,963	$18,924,963
GFO-15-313	1	S6; S7	29	7	$7,091,923	-	-	$7,091,923
GFO-15-317	1	S1; S12; S20	34	14	$5,867,521	$11,367,282	$1,000,000	$18,234,803
GFO-15-321	1	S18	2	1	-	-	$4,999,247	$4,999,247
GFO-15-323	1	S12	8	2	-	$3,565,362	-	$3,565,362
GFO-16-301	1	S3; S4	7	1	$873,387	-	-	$873,387
PON-13-301	1	S1	48	13	$33,205,581	-	-	$33,205,581
PON-13-302	1	S8	38	5	$8,673,198	-	-	$8,673,198
PON-13-303	1	S4	18	11	$15,814,772	-	-	$15,814,772
PON-14-301	1	S14	41	9	-	$29,641,646	-	$29,641,646
PON-14-303	1	S3	27	8	$12,689,706	-	-	$12,689,706
PON-14-304	1	S12; S13	13	13	-	$41,928,723	-	$41,928,723

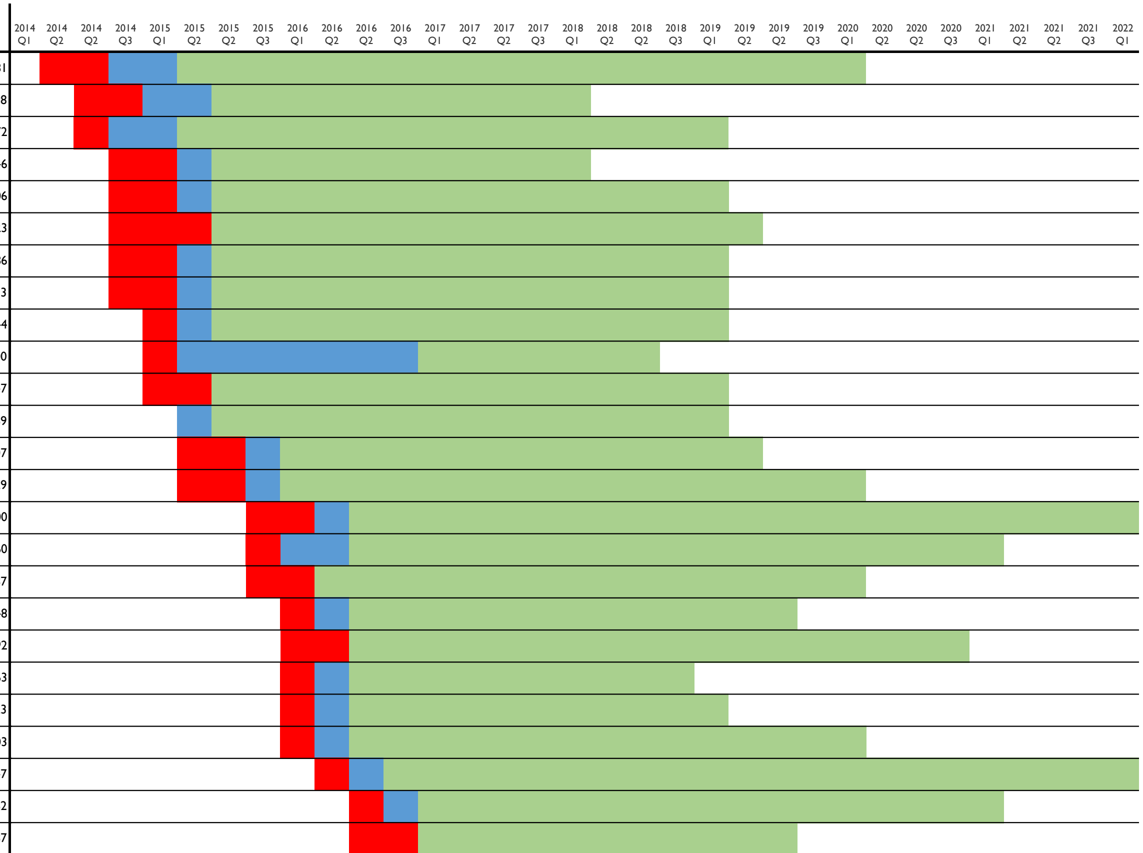
Solicitation	EPIC Phase	Strategic. Objective	Number of Applications	Number Awarded	Funding for Applied R&D Projects Awarded	Funding for TD&D Projects Awarded	Funding for Market Facilitation Projects Awarded	Total Funding Awarded
PON-14-305	1	S13	23	4	-	$13,799,386	-	$13,799,386
PON-14-306	1	S18	12	5	-	-	$2,138,713	$2,138,713
PON-14-307	1	S13	22	6	$399,818	$12,430,226	-	$12,830,044
PON-14-308	2	S11, S17	3	1	$750,000	-	-	$750,000
PON-14-309	1	S5	14	8	$6,143,247	-	-	$6,143,247
PON-14-310	1	S9	25	5	$6,681,669	-	-	$6,681,669
Other*	1 & 2	Multiple	11	11	$34,147,612	-	$16,075,358	$50,222,970
Total			**525**	**202**	**$202,228,380**	**$134,308,595**	**$59,026,388**	**$395,563,363**

* 'Other' includes three non-competitive grants and eight grants issued through Requests for Proposals (RFPs).

Figure 10 on the next page shows the timeline for each CEC solicitation. Red sections of each project timeline represent the application period. The blue sections represent the scoring and selection period. Lastly, the green sections represent the projected project implementation period, which extends through the first quarter of 2022. The first solicitation round was released in the second quarter of 2014, and projects began in the second quarter of 2015. The last solicitation round was released in the second quarter of 2016, and projects began in the first quarter of 2017.

Figure 10: EPIC 1 and 2 CEC Solicitation Timeline

ID	Investment Area	Research Area	EPIC Round	Number of Applications	Number Awarded	Total Funding
PON-13-301	R&D	EE Technology	1	48	13	$33,205,581
PON-13-302	R&D	Utility Coordination Systems	1	38	5	$8,673,198
PON-13-303	R&D	Utility Scale Renewables	1	18	11	$15,814,772
PON-14-301	TD&D	EE Demonstration	1	41	9	$29,641,646
PON-14-303	R&D	Innovative Solutions	1	27	8	$12,689,706
PON-14-305	TD&D	EE and GenerationTechnology	1	13	13	$41,928,723
PON-14-304	TD&D	Renewable Generation Technology	1	23	4	$13,799,386
PON-14-306	MF	Social Cultural Behavioural Aspects of	1	12	5	$2,138,713
PON-14-307	TD&D	Renewable Generation Technology	1	22	6	$12,830,044
PON-14-308	R&D/TD&D	Applied Research with Federal Cost Share	2	3	1	$750,000
PON-14-310	R&D	EV Infrastructure	1	14	8	$6,143,247
PON-14-309	R&D	IDSM and ZNE	1	25	5	$6,681,669
GFO-15-303	R&D	Vulnerability and Adaptation Studies	1	4	2	$8,908,107
GFO-15-302	MF	EE Workforce Development	1	13	4	$1,899,929
GFO-15-306	MF/R&D	Innovation Cllusters	1 & 2	12	6	$14,980,000
GFO-15-308	R&D/TD&D	IDSM and ZNE	1 & 2	38	15	$30,790,460
GFO-15-310	R&D	EE Technology	1	24	20	$9,539,187
GFO-15-309	R&D	EE Technology	1	19	9	$15,090,748
GFO-15-317	R&D/TD&D	EE Technology	1 & 2	12	9	$26,145,592
GFO-15-312	MF	Advanced Energy Communities	1 & 2	28	13	$18,924,963
GFO-15-313	R&D	Smart Grid Development	1	29	7	$7,091,923
GFO-15-311	R&D/TD&D	Demand Response Technology	1	34	14	$18,234,803
GFO-15-321	MF	Innovation Cllusters	1	2	1	$4,999,247
GFO-15-323	TD&D	Water and EE Demonstrations	1	8	2	$3,565,362
GFO-16-301	R&D	Utility Scale Renewables	1	7	1	$873,387
Total				510	190	$394,040,772



Application Period
Selection Period
Project Period

To evaluate the CEC's selection process, we drew a sample of five solicitations to determine how well the awarded bids align with the strategic objectives covered by the solicitations. We also reviewed all the bids submitted for the sampled solicitations (93 bids) to ensure that bids were scored based on the published criteria and that the results posted publicly (via the NOPA) were accurate. Our sample represents 18 percent of the 28 solicitations, 29 percent of total solicitation funding, and 26 percent of the 201 awarded bids, as shown in Table 36 on the next page.

Table 36: CEC Solicitation Sample

Solicitation	Investment Area	EPIC Round	Number of Bids	Number Awarded	Funding for Applied R&D Projects Awarded	Funding for TD&D Projects Awarded	Funding for Market Facilitation Projects Awarded	Total Funding Awarded
GFO-15-311	R&D/TD&D	1 & 2	12	9	$24,137,717	$2,007,875	-	$26,145,592
GFO-15-312	MF	1 & 2	28	13	-	-	$18,924,963	$18,924,963
PON-13-303	R&D	1	18	11	$15,814,772	-	-	$15,814,772
PON-14-304	TD&D	1	13	13	-	$41,928,723	-	$41,928,723
PON-14-307	TD&D	1	22	6	$399,818	$12,430,226	-	$12,830,044
Total			**93**	**52**	**$410,352,307**	**$56,366,824**	**$18,924,963**	**$115,644,094**

To determine if funding is awarded to projects consistent with EPIC policy objectives and planning processes, and project selection is guided by the Investment Plans, we reviewed the planning documentation, including the application manuals and attachments, for each of the five solicitations. Based on this review, we found each solicitation package linked directly to a strategic objective in either EPIC 1 or EPIC 2 Investment Plans. We also found each solicitation package to provide a clear and thorough outline of the requirements to prospective applicants. Table 37 presents the sampled solicitations, applicable Investment Plans and the strategic objectives each solicitation is designed to address.

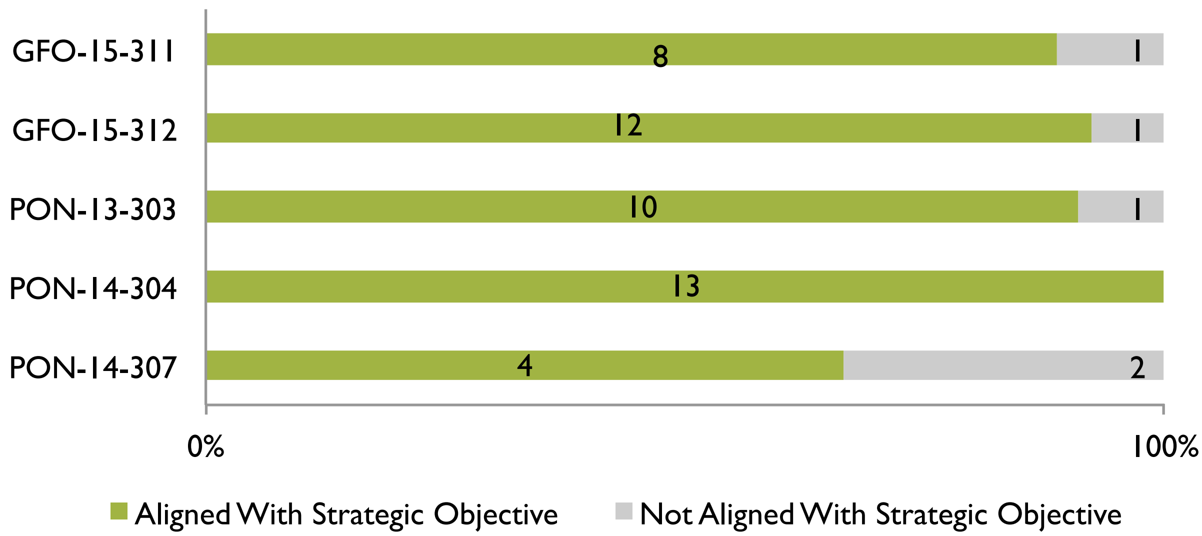
Table 37: Solicitation Alignment with Strategic Objectives in Investment Plans

Solicitation	Solicitation Name	EPIC Round	Strategic Objective
GFO-15-311	Advancing Solutions that Allow Customers to Manage Their Energy Demand	1 & 2	S2: Develop New Technologies and Applications that Enable Cost-Beneficial Customer-Side-of-the-Meter Energy Choices
GFO-15-312	The EPIC Challenge: Accelerating the Deployment of Advanced Energy Communities	1 & 2	S16: Collaborate with local jurisdictions and stakeholder groups in IOU territories to establish strategies for enhancing current regulatory assistance and permit streamlining efforts that facilitate coordinated investments and widespread deployment of clean energy infrastructure S12: Overcome Barriers to Emerging Energy Efficiency and Demand-Side Management Solutions through Demonstrations in New and Existing Buildings
PON-13-303	Advancing Utility-Scale Clean Energy Generation	1	Strategic Objective S4: Develop Emerging Utility-Scale Renewable Energy Generation Technologies and Strategies to Improve Power Plant Performance, Reduce Costs, and Expand the Resource Base
PON-14-304	Bringing Energy Efficiency Solutions to California's Industrial, Agriculture and Water Sectors	1	S12: Demonstrate and Evaluate the Technical and Economic Performance of Emerging Efficiency and Demand-Side Management Technologies and Strategies in Major End-Use Sectors S13: Demonstrate and Evaluate Emerging Clean Energy Generation Technologies and Deployment Strategies
PON-14-307	Demonstrating Clean Energy Solutions That Support California's Industries, the Environment, and the Electrical Grid	1	S13: Demonstrate and Evaluate Emerging Clean Energy Generation Technologies and Deployment Strategies

After confirming that each solicitation was guided by an Investment Plan, we reviewed project-level documentation for each approved project to confirm that the project description and planned outcomes aligned with the strategic objectives of the solicitation.

Figure 11 summarizes this review. We found that of 52 approved projects, 47 align directly with the strategic plan objective(s) in the solicitation documentation. The remaining five projects align with other strategic objectives not specifically targeted by that particular solicitation. Based on this review, we found that projects were largely guided by an Investment Plan, and selected based in part on their potential to fulfill a strategic objective outlined in an Investment Plan.

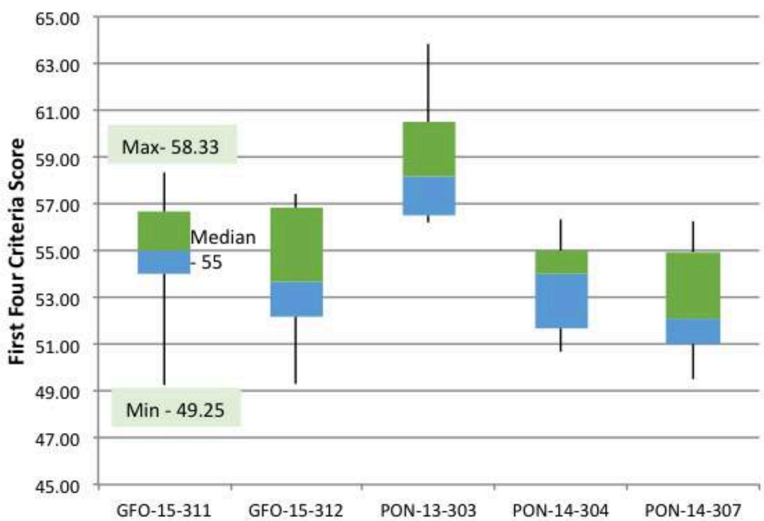
Figure 11: Project Alignment with Strategic Objectives in Investment Plans

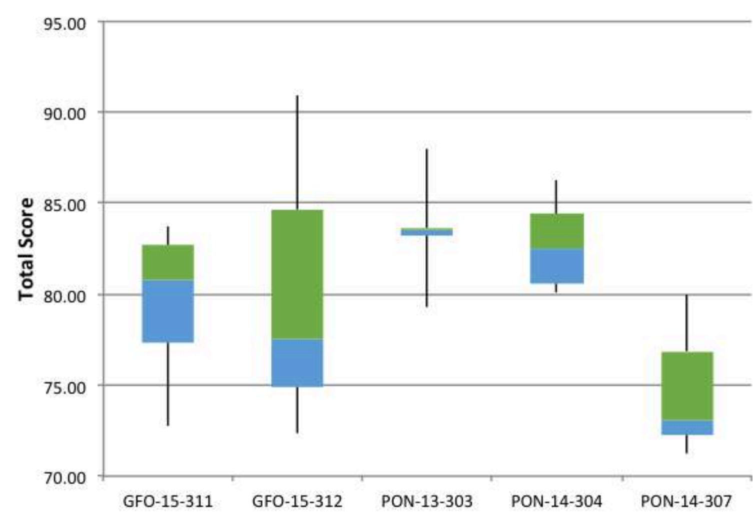


The evaluation team reviewed all documentation from the CEC for the sample, including the actual bids submitted, solicitation requirements and criteria, and scores, to confirm that the administrator selected projects according to the process outlined above, with sufficient consideration and documentation of each project's goals and objectives. The first task the evaluation team engaged in was an audit of project sample application documentation. This audit found that for four of the five solicitations sampled (GFO-15-311, GFO-15-312, PON-13-303 and PON-14-307), applications were very complete, with only one of 39 project applications not having a complete application package. The one anomaly was missing one item. PON-14-304 had less complete application packages, with only one in thirteen having all documentation. However, all approved projects had the required documentation, the application and a project summary.

The second task was an assessment of the review and scoring process for each application. Committee members scored each project based on eight criteria. The scoring and selection process occurred in two phases. In phase one, the committee selected only projects that had an average score of over 49 on the first four selection criteria. In phase two, the committee selected projects with an average total score of above 70. Funding is allocated to these projects in order from highest to lowest score until funding is exhausted. The following box-and-whisker plots present the median and range of scores for approved projects across the five sampled solicitations. The first plot shows the median and range of scores for the first four criteria across the five solicitation rounds reviewed. The second plot shows the median and range of scores across all eight criteria across the five solicitation rounds. The boxplots show the range of scores with the median score falling between the green and blue portions of each bar, and the second and third quartiles as the lower edge of each of the green boxes and the upper edges of the blue boxes, respectively. The end points of the whiskers represent the minimum and maximum scores. The evaluation team found that all approved projects scored greater than 70 overall and greater than 49 points for the first four criteria.

Figure 12: Box and Whisker Plots – Distribution of Scores for Sample Solicitations





Lastly, the evaluation team reviewed and compared all scores across all committee members to identify any anomalous scoring, indication of errors, favoritism or other issues. Based on this review, we found that:

- All project scores were calculated correctly.
- Scores deviated across reviewers for each project which we would expect, but there is no indication that one scorer had extreme scoring that would skew a project toward passing or failing.
- Scorers on average tended to rank projects in a similar order, although as we would expect, there was not always agreement between scorers across projects in terms of ranking.
- There was no indication of anomalous scoring or mathematical errors in calculating scores.

In conclusion, the evaluation team's review of CEC project selection confirms that the administrator aligned solicitations with the Triennial Investment Plans and adopted projects that addressed the specific strategic objectives and funding initiatives outlined in each solicitation. Projects selection was conducted in a clear and transparent fashion, adhering to the project selection criteria outlined by the CEC.

8.1.2 IOUs

The process the IOUs follow to select EPIC projects is significantly different than the one used by the CEC. Based on a series of interviews we conducted with the IOUs' EPIC program management teams and review of their EPIC reports, we learned that all three IOUs identify their project ideas during their internal investment planning processes, and their Investment Plans provide a general description (with no budgets identified) of the projects they may implement. However, SDG&E provides an estimated funding allocation for all projects.

Once their plans are approved, the IOUs have internal processes to scope the project, allocate budget and develop a project management plan that they use to guide the project. They coordinate internally with technical experts, and hold periodic status meetings with their management. They may defer on launching a project that is described in their Investment Plan and place it on hold (sometimes indefinitely) until they decide it is a priority at that point in time, based on consultation with their technical teams and management and/or response to external changes in public policies and markets. For PG&E and SCE, this process and criteria used to select which projects to launch, how much budget to allocate and the project scope of work is kept internal and is not transparent to the CPUC, stakeholders or the public until the IOUs file their Annual Reports each February 28 (covering the prior year). SDG&E provides a budget estimation table for each EPIC project in its Investment Plan. This table does not provide specifics;

however, it does provide total estimated funding allocation to internal SDG&E employees, outside consultants, and equipment and contractors funds.

When the IOUs seek a vendor through a competitive bidding process, they are required to adhere to specific EPIC guidelines and a general process. Each IOU is also permitted to follow its individual corporate procurement, supply management and affiliate compliance rules. RFPs are sent to pre-screened suppliers with the appropriate corporate qualifications, including certified Diverse Business Enterprises (DBE), and/or posted on IOU websites for response by all interested parties. Where competitive bids are used, utility communications, including bidder conferences and answers to RFP questions, are offered equally to all bidders under consideration. IOUs may also use a Request for Information (RFI) to request feedback from vendors about a project scope.

Potential vendors may be pre-qualified through RFI or Request for Qualifications (RFQ) process initiated prior to issuing an RFP. The RFIs and RFQs consider relevant factors such as (but not limited to):

- Potential suppliers' individual capabilities;
- Product and/or service offerings; and
- Past performance (e.g., technical work and financial status).

For each RFP, IOUs publish a document outlining the criteria by which the IOU will score and judge each bid, including eligibility requirements, submission instructions and an outline of the evaluation and award process. The IOU scoring and selection process follows a two-stage process that differs from the CEC process in the second round. The IOU administrators follow a comparable screening process as the CEC uses for an initial pass/fail round. Projects that pass the first stage are judged based on a variety of factors that are specifically chosen to meet EPIC objectives and address the project work needed. Factors are to be scored on a numeric scale and given weight based on their comparative importance to the project. Possible factors include:

- Overall technical merits of a proposed approach
- Bidder capability, skills and related experience
- Diversity
- Budget
- Proposal feasibility

The IOU administrators differ in the funding mechanisms used for vendor compensation. SCE and SDG&E use pay-for-performance contracts while PG&E uses a combination of time-and-materials and pay-for-performance contracts.[58]

To evaluate the IOU project selection processes, we reviewed a sample of six IOU projects to confirm that the projects aligned with the strategic objectives and electric system value chain mapping outlined in the IOU Triennial Investment Plans.[59] We reviewed project documentation and scoring documents to confirm that projects aligned with the Investment Plans and responses to RFPs were scored and awarded based on the published criteria. We also reviewed the 46 bids associated with the six RFPs.

Table 38: Solicitation Sample for Detailed Review

IOU and Project Number	EPIC Round	Number of Bids	Number of Awarded Vendors	Total Funding Awarded to Vendors	Total Project Funding
PG&E-1.08	1	7	1	$585,000	$2,800,000
PG&E-1.09A	1	4	1	$84,600	$1,100,000
PG&E-1.09B	1	5	2	$75,500	$550,000
PG&E-2.1	2	3	1	$1,919,735	$2,420,000
SCE-13-0158	2	22	1	$231,000	$3,995,462
SDG&E Project 7	2	5	1	$1,166,000	$1,200,000
Total		**46**	**7**	**$4,061835**	**$12,065,462**

The second task was an assessment of the IOU review and scoring process for each application. In contrast to the CEC where there is a specific set of scoring requirements, each IOU defines its scoring criteria according to key factors related to each specific project. For each IOU project, a committee of scorers consisting of key project staff from the IOU scored applications according to the unique criteria of each project.[60] The IOUs also do not have the same minimum score requirements. The IOUs select projects based on the highest scoring bidder according to the unique project scoring criteria, and in the case of a tie, choose the lowest cost bid.

[58] Recently, PG&E has moved to executing primarily pay-for-performance contracts.
[59] As described in the methodology section, we drew this sample of six projects from the sample of projects selected for interviews and documentation analysis.
[60] The composition of scoring committees is determined by project, and does not adhere to any specific guidelines.

We reviewed the scoring criteria for each project, as well as the final scoring for each vendor bid. We confirmed that the scoring criteria are clearly defined and the scoring process was well documented for each project and each vendor bid. All bids and scoring results that we reviewed complied with the IOU grant solicitation guidelines described in D. 13-11-025.

8.2 Project Scoping Process

We reviewed how the administrators develop scopes of work for projects once they select them based on interviews with the EPIC teams' management and review of project sample documents. Once projects are selected, administrators document key project components such as project scope, any identifiable market deficiency or knowledge gaps, defined project goals, key objectives, and individual metrics. As shown in Table 39, the manner in which these key components are documented and incorporated into project planning varies across administrators. CEC projects include overarching scopes of work and grant request forms, while IOU projects tend to convey the information through business and implementation plans that are developed with key project team members. The audience for the documents and whether they are made available to stakeholders or the public also varies. The IOUs typically create their planning documents for their internal use only, versus the CEC, which posts the grant request form (with project scope of work) publicly.

Table 39: Project Documentation Sources by Administrator

Admini-strator	Location in Which the Following Items are Documented					Intended Audience
	Project Scope	Identified Problem / Knowledge Gap Addressed	Defined Project Goals	Key Objectives / Targets	Metrics	
CEC	Scope of work/Grant Request Form*	Scope of work/Grant Request Form*	Scope of work/Grant Request Form	Scope of work/Grant Request Form*	Scope of work/Grant Request Form* /Implementation plan	CEC, grantee, TAC and PAC (for projects that have a TAC)
PG&E	Business Plan	Business Plan	Business Plan	Business Plan	Business Plan	IOU project management team and IOU internal stakeholders
SCE	Project Fact Sheet	Project Fact Sheet/Implementation Plan	Project Fact Sheet/ Implementation Plan	Implementation Plans/ Investment plans*	Scope of work/Implementation Plans	IOU project management team and IOU internal stakeholders
SDG&E	Project Plans	Project Plans	Project Plans	Project Plans	Project Plan/Demonstration Plan	IOU project management team and IOU internal stakeholders

*Publically shared

8.2.1 CEC

Project Scope

For sampled CEC projects that we reviewed, the project scope was either provided as a standalone scope of work document or as a key component of the grant request form. As outlined above, the scope of work documents included a short, relatively broad description of the general scope of the project and delineation of tasks to be completed as part of the grant. Figure 13 provides an illustrative example of a task list and subsequent paragraph on the overarching project scope.

Figure 13: Example Task Outline from Project EPC-14-055

A. Task List

Task #	CPR[1]	Task Name
1		General Project Tasks
2		Develop Basis of Design
3		Microgrid Algorithms
4	X	Coordinate with PG&E
5		Procure Flow Battery
6		Design Electrical and Mechanical Systems
7		Construct System
8		Prepare Commissioning Plan
9		Prepare Measurement and Verification Plan
10		Test and Commission Systems
11		Implement Measurement and Verification Plan
12		Demand Response Modelling
13	X	Develop Microgrid Blueprint
14		Evaluation of Project Benefits
15		Technology/Knowledge Transfer Activities

Note: CPR refers to the scheduled Critical Project Review meetings for the project, with an "X" indicating the task is a primary focus of the CPR meetings. (The footnote next to the CPR column heading indicates that full descriptions of the CPR can be found in Part III of the Scope of Work.)

The purpose of this Agreement is to install and demonstrate battery storage and a microgrid energy management system using existing photovoltaic (PV) systems. This agreement will fund the evaluation of the next generation of microgrid energy management systems based on a concept of an "Internet of Energy" using a standards based Energy Operating System with Energy Management Applications that can connect and communicate with any type of energy asset and can connect and communicate outside the local facility microgrid to the programs and systems of the local energy provider and regional energy coordinators. The results of this project will be described in a Microgrid Blueprint that will provide educational institutions the means to evaluate, plan and implement the addition of energy storage with smart microgrid energy management controls to their existing solar photovoltaic (PV) and other renewable energy sources.

Knowledge Gap

For sampled CEC projects, the knowledge gap was primarily presented in the "Problem" or "Solution" sections of the scope of work. In general, the knowledge gap was more indirectly referenced in comparison to other project components such as objectives and goals. Below is an example of the "Problem" and "Solution" sections for a component of project 300-15-009 (from the scope of work), a CEC project that examined microgrid feasibility in California.

Problem

Microgrids tend to be customized aggregations and optimizations of diverse distributed energy resources (DERs). Therefore, microgrids often require expensive customized engineering solutions incorporating emerging technologies such as advanced energy storage often requiring government subsidy. However, there are microgrids that are moving forward without significant government subsidies. The Energy Commission would benefit from understanding the technologies, business models, scale, and vendor landscape supporting microgrids that appear to be economically viable without significant government subsidy. However there is limited public documentation about these microgrids to support Energy Commission's needs.

Solution

The deliverables resulting from this work authorization will help fill the information gap and inform how best to promote and accelerate microgrid adoption by learning about how successful projects have been developed without government support. Drawing from existing examples throughout California, North America and the world will help build a broader understanding of how universal some proposed microgrid solutions may be and whether regulatory structures, incentives and differing vendor approaches to market development can all inform the Energy Commission about best practices for economic viability.

Objectives

Within the scope of work documentation, the CEC projects generally included only high-level objectives that serve more as a broad overview of what the project seeks to achieve than a detailed account of what each component of the research is focused on. Below is an example from the same CEC microgrid project 300-15-009:

The objectives of this WA [work authorization] are to:

- *Create a common language and definition of what a microgrid is in order to sharpen broad market understanding among stakeholders in order to pinpoint market drivers and barriers to future microgrid development.*
- *Profile successful microgrid projects developed in California, North America and the rest of the world.*
- *Better understand the business case for microgrids across different markets by comparing case studies of market participants, from around the world, and identifying common features, synergies, and business models that result in successful microgrid projects.*
- *Develop reports, based on reviewed case studies, to inform the Microgrid Research Roadmap with recommendations for growing the market for microgrids through public and private sector actions, and meeting California's energy supply, resiliency, and climate change goals.*

- *Inform the Energy Commission's future EPIC funding objectives for microgrids and DERs in general.*

Project Goals

For the sampled CEC projects, the project goals were generally outlined in the grant request or scope of work documents. In comparison to the objectives, the CEC provided a more detailed look at the desired technical goals and benefits of the proposed EPIC project. For example, as shown below, CEC project EPC-14-055 outlined how it planned to develop and disseminate information regarding its microgrid research:

- *Develop and Disseminate a Microgrid Blueprint that can be used by educational institutions statewide to evaluate, plan and install a smart microgrid that will manage and coordinate the output of their existing renewable energy assets using energy storage systems with the ability to provide benefits to the local utility grid though automating demand response and other energy services.*
- *Demonstrate the benefits to customers, utility companies and CAISO of an "Internet of Energy" concept using Institute of Electrical and Electronic Engineers (IEEE) and American National Standards Institute (ANSI) standards based Energy Operating System and standardized Energy Management Applications to control and coordinate local energy assets and enable coordination with utility programs and controls.*
- *Collaborate with Pacific Gas and Electric (PG&E) to gain a better understanding of the benefits and risks and practical realities of using behind the meter energy assets to provide grid and/or market services using real world operating data.*

Metrics

In general, the metrics were the most varied project documentation element across each individual project. For example, while all CEC projects followed similar templates for presenting objectives and goals, the metrics varied across projects, as some were more measureable technical metrics and others appeared to be more qualitative in nature. See Section 9.2 for more information about the processes to track and quantify project benefits.

8.2.2 IOUs

Project Scope

PG&E and SCE project scope documents that we reviewed contained high-level descriptions for the projects with an overview of the market the project was targeting and the project itself. The level of detail on project implementation varied, but provided less detail than most CEC project scopes. For example, one business plan divided the project into tasks with identified budgets and deliverables, but the task descriptions could be as short as a few words or three or four bullet points for a $500,000 task. SDG&E project plans provide more detail, including a description of the task, objective, a detailed approach that they will take to obtain the objective and the output/deliverables that will be produced from the task. To illustrate the level of detail and type of information included in many of the IOU plans, we provide examples from a sampled PG&E project below.

Below is a description that PG&E provided for project #1.09A on Close Proximity Switching that is illustrative of other IOU project descriptions.

> *Phase 1 of this project will focus on demonstration of a portable remote controlled switch operator tool for sub surface Load Break Oil Rotary (LBOR) switches. This tool is a field installed device operated remotely by an individual on an underground switch location. This tool is a portable field installed unit which is used, and then returned to the vehicle after job has been completed. It can be used to open and close the rotary operated oil-filled switch, a mounting hardware to securely mount the tool to different sub-surface switch manufacturers and a remote control to operate the tool. The tool will open and close the switch at a safe distance enhancing worker and public safety.*
>
> *The approach to the manufacturing requirements during this demonstration project will be to award up to three different vendors a contract to build this tool in parallel. Once the prototypes have been developed and delivered by these three firms, PG&E will be an optimal position to choose the best solution of the three to carry forward.*

Knowledge Gap

IOUs follow a similar process as the CEC, with the knowledge gap primarily presented as the "Problem" or "Solution" sections of the scope of work. We present the manner in which PG&E documented the knowledge gap for its project #1.09A below.

> *PG&E has over 2,000 legacy sub-surface oil filled switches that have no oil level indicators (pre 1976) and has had 255 reports of failed oil switches since 2000. Of these 255 reported failed oil switches, 57 were significant failures with risk to employee and public safety. Thirty-five of the failures were on switches manufactured in the 1970s or 1980s. Due to the aging distribution infrastructure, there is a higher risk of significant failure when operating older sub-surface oil-filled switches potentially endangering workers and affecting public safety. Older sub-surface oil-filled switches are operated manually in close proximity to the switch.*

Objectives

In general, the IOUs present project objectives in a similar format as the CEC. However, in some cases, the objectives were seemingly presented to show how they correspond to EPIC program goals at large. For example, for PG&E #1.09A on Close Proximity Switching, the "primary objective" on worker safety was presented as it related to EPIC's overarching goal of increase safety:

> *This project's primary objective is to enhance worker's safety by using a remote-controlled tool when operating rotary operated sub surface switches. The tool will also potentially provide*

additional benefit in reducing outage duration by eliminating the number of potential incidents caused by a significant failure when operating sub surface switches.

Project Goals

For the IOU projects, the project objectives were presented in a much more general sense as compared to the CEC, while the objectives corresponded with specific targets of each individual project. For example, the PG&E project business plans contain project goals as they pertain to PG&E's "core values" on public safety, employee safety, reliability, operational excellence, customer focus, delighted customers, and environmental leadership. For PG&E project #1.09A, project goals are described as:

This project aligns with three PG&E goals: Public Safety, Employee Safety and Reliability.

Metrics

IOU projects also included a range of metric types. In the business plan for PG&E project #2.24, the project team identified "High Level Success Criteria" for different project deliverables. For example, in the planning phase—consisting of creating the business and project plans—the key metric for success was creating "viable table-top proof of project feasibility," while the building and testing stage included more technically focused metrics based on their project models, such as "Expected test and operating results achieved" for the residential Smart AC data loggers.

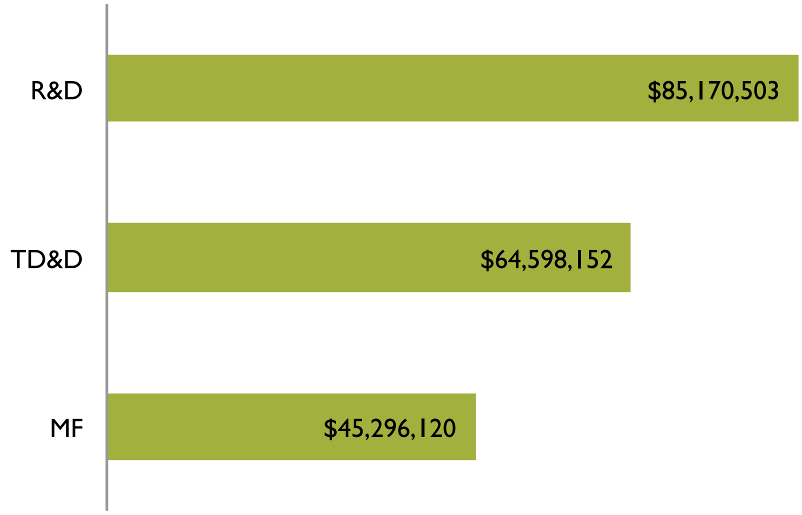
However, while these test metrics directly correspond with technical components of the project, the metrics themselves remain high level and in certain cases do not further identify the specifics of the quantitative "results" alluded to in the metrics portion of the program documentation.

Similarly, SCE includes a list of metrics with its description of upcoming projects in its Investment Plan. These lists comprise generic types of metrics to be collected and reported at the conclusion of the projects. They span technical, economic and market issues and include such varied metrics as "the number and total nameplate capacity of distributed generation facilities," "non-energy economic benefits," and "forecast accuracy improvement" associated with a project, but without further discussion or detail. SDG&E also refers to metrics in a general way in its Investment Plans, but defers their development to project-specific plans.

8.3 Match Funding

The CEC explicitly seeks match funding from bidders who respond to EPIC solicitations (it is required for TD&D projects; for the other project types, applicants receive bonus points for offering it). We compiled project data from the 2016 Annual Reports to assess the extent to which CEC projects have match funding. Figure 14 shows how the reported total sum of $195,064,775 in match funding (through 2016) was distributed by project type in their EPIC portfolio.

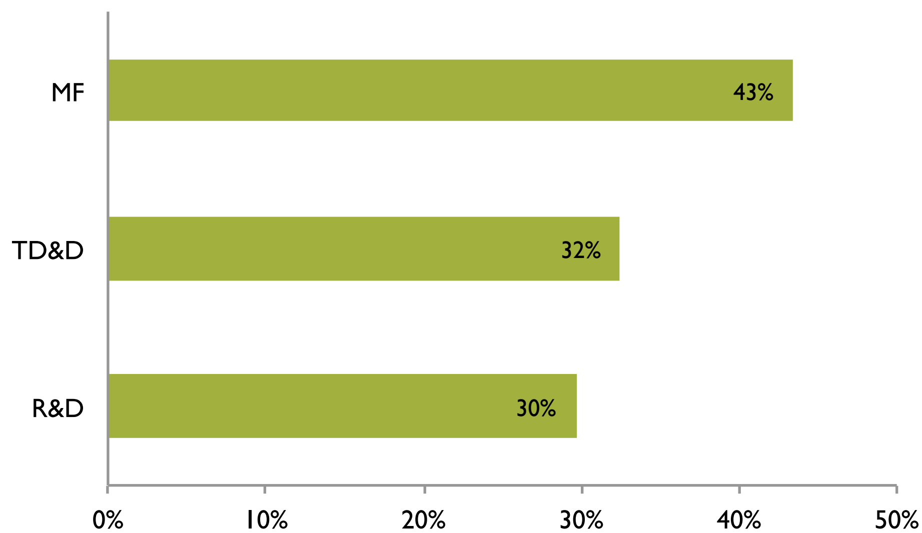
Figure 14: CEC Match Funding by Project Type (through 2016)



Source: Administrators' 2016 Annual Reports

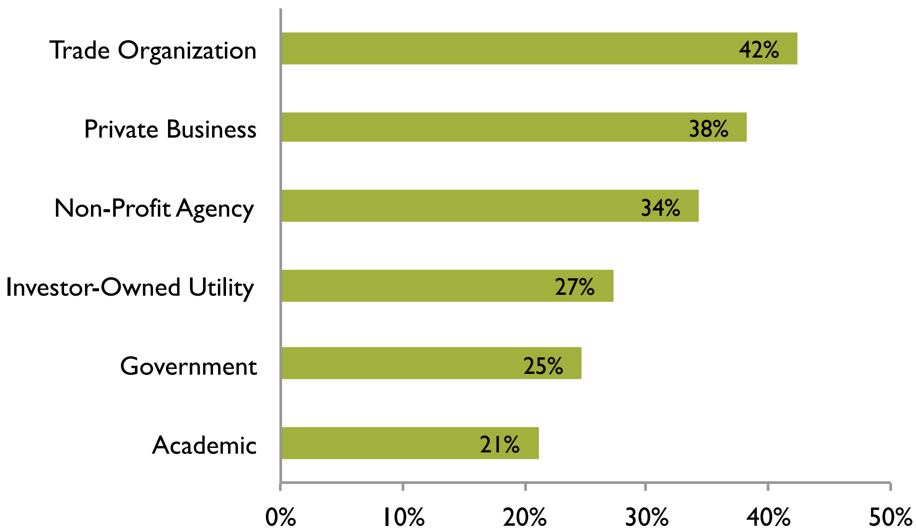
Figure 15 and Figure 16 show the ratio of match funding (equal to match funding divided by the sum of match funding and project budget), by project and grantee type. The overall ratio is 32 percent across all of the CEC's projects. As shown, Market Facilitation projects have the highest match funding ratio. Among grantees, trade organizations have the highest match funding ratio.

Figure 15: Match Funding Ratio by Project Type (CEC Only, through 2016)



Source: Administrators' 2016 Annual Reports

Figure 16: Match Funding Ratio by Grantee Type (CEC Only, through 2016)



Source: Administrators' 2016 Annual Reports

We discussed match funding with the IOU EPIC program management teams during a series of telephone interviews. The IOUs do not require match funding (what they also refer to as cost sharing or in kind support). The IOUs instead seek cost sharing indirectly by engaging in a number of practices, which they typically employ for all their subcontracting. First, they negotiate with vendors on their rates when setting up master contracts, upon initiation and at renewal. They also encourage vendors to offer discounts or even to offer services at no cost (we confirmed at least two cases of this in our sample of six vendor bids from our project sample.) They do not currently track cost sharing or in kind support.

One IOU program manager acknowledged that the CEC is better about instituting a formal process to get bidders to agree to provide match funding, but felt for the IOUs, it might be better to have an informal process for which they use their standard negotiation procedures, which they think of as due diligence on all their contracts. One IOU felt that if they were required to seek match funding, vendors may just mark up their project cost rates.

SDG&E gave some examples of projects planned for the third investment planning period where they may get match funding, based on the type of bidder (e.g., a lab and a government agency). But these potential project examples might be more on an ad hoc basis, since IOU project partners are often from the private sector, whereas less than half of CEC projects have been awarded to private sector firms.

Five of the 12 Idea Exchange respondents indicated that the CEC's match funding requirement is a burden, particularly for small businesses and entrepreneurs. A couple of respondents felt the substantial amount of the cost share[61] is difficult to secure, and felt that EPIC should offer opportunities for smaller grants and match-funding obligations.[62] One respondent felt that this obligation should be eliminated entirely. Another respondent felt that the cost share should be optional, and that small businesses that secure match funding should receive weighted or bonus scores toward their applications since it is harder for them to procure such funding. Two respondents suggested the CEC should facilitate matches with other funding opportunities. One respondent proposed that the CEC provide an option for the cost share to be offered as a loan. These concerns regarding match funding indicate that this requirement may be a specific barrier for small business applicants. The CEC might consider exploring different options to determine what might work best.

8.4 Plan Consistency

We compared the current status of our sample of projects versus what the administrators had filed in previous Investment Plans and Annual Reports to ensure consistency over time. We also referred to the latest project status reports (from the 2016 Annual Reports, filed on February 28, 2017) to provide current information about projects. Across all administrators, we found good consistency in the reporting of interim development and projected milestone achievements. These reported values aligned well across the spectrum of reports, and projected future developments were well represented in successive reports. No inconsistency was found in the most recent project status report as compared with previously reported values within the sample projects.

Note that the administrators may add, modify or cancel a project, so the current status of projects is different from what is filed in their Investment Plans. Per CPUC Decision 15-09-005 (September 17, 2015), they are required to file Tier 3 Advice Letters for new EPIC projects or for material changes to existing approved Investment Plans.

PG&E filed an Advice Letter on February 7, 2017, to request approval for several new EPIC projects. Specially, PG&E requested approval for six new projects with an estimated budget of between $8 million and $10 million out of its 2015-2017 EPIC budget of $51 million. As of the time we conducted the second round of administrator interviews, the CPUC had not yet responded to PG&E’s Advice Letter.

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[61] Match funding is only required for TD&D projects. The applicant must match at least 20 percent of the requested funds. Applied R&D projects do not require match funding, but applicants can receive extra points on their proposal for such funding. Up to 10 percent of EPIC funding for Applied R&D and TD&D can be used as federal cost share.

[62] EPIC funds a project, the California Sustainable Energy Entrepreneur Development (CalSEED) Initiative, which provides up to $600,000 in grant funding for early-stage research and development for emerging technologies.

PG&E justified its request because of changes in the policy landscape and advances in technologies which require the company to adapt its priorities. PG&E put some projects on hold in order to dedicate budget for the new projects. PG&E argued in its Advice Letter that had it waited until its next Investment Plan (filed on May 1, 2017, for the program period 2018-2020), that would have delayed the ability to use the knowledge and benefits gained. The new projects PG&E requested to add are described below:

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

In our review of these new projects, all but the Call Center Staffing Optimization project seem to be justified and added to address new technological developments. For example, Behind-The-Meter storage aggregation and dispatch is a new concept that is being explored as a product of the recent developments in the lower-cost personal home use battery system market (i.e. Powerwall and Sonnenbatterie systems). The utilization of this new product through aggregate dispatch will be a low-cost way to help the IOUs achieve their mandated 2020 energy storage portfolio mandates, through the leverage of private investment. However, it should be noted that project #2.01, Evaluate Storage on the Distribution Grid, was placed on hold to free up budget for this project. To the extent that energy storage needs assessment and siting will be required to facilitate improved grid reliability within a high DER system, it is likely that this action represents a shift in prioritization toward achieving storage portfolio standard requirements, coupled with a perception that rooftop DER build outs will continue to slow, as they have since the end of the California Solar Initiative program. It is also likely that energy storage siting, as a grid-optimization tool, is relatively straightforward and that more granular-scale storage build outs will not be cost-effective, can be better met through other adaption strategies (i.e. increased switchgear automation) or cannot be adequately performed during this period of rapid customer-driven DER adoption.

Similarly, the extremely rapid rate of technological development of autonomous electric vehicle (AEV) ridesharing platforms (currently scheduled to be in operation by 2021), the need for the development of new accompanying rate schedules for both AEV/EV operations and the continuing installation of distributed rooftop solar and accompanying battery storage systems collectively warrant a shift in the research/demonstration activities to facilitate their smooth integration into the PG&E distribution grid.

The Call Center project, however, does not appear to be something that is being added to address external developments (such as market, policy or technology changes). The project seems to be a routine optimization effort that could have been planned in advance or proposed as part of the next EPIC portfolio period.

We examined the projects to determine if they could have been fit into existing Investment Plan project areas, since the descriptions are general and no budgets are assigned, lending flexibility to introduce new project concepts mid-cycle. We found that three of the six projects, though justified as new project concepts, could have been addressed by existing project descriptions from their Investment Plans (i.e., not requiring an Advice Letter). Two of the new projects (#5 and #6 from the list above), also justified as new project concepts, would not fit within existing Investment Plan descriptions and are justifiable new projects that warrant being included in the Advice Letter request. However, one of the projects (#4) does not seem like a justifiable project to introduce mid-cycle, nor does it fit within the guiding principles of the EPIC portfolio. It could contain duplication of current call center activities currently underway within internal PG&E processes. This project is an example of an internal IOU need that does not clearly align with a state strategic policy need.

The other two IOUs also indicated they would like the opportunity to make mid-course changes in projects without having to go through the formal Tier 3 Advice Letter process, which requires approval by CPUC resolution and can take several months or longer to address. They reported that they have to anticipate the specific projects they will implement over a three-year period, and that constrains them from fully being able to respond to market and technology changes.

However, in our review of the Investment Plans and the processes the IOUs use, we found that there is significant flexibility to modify and introduce new projects, and to place projects introduced in an Investment Plan indefinitely on hold. In PG&E's request to add projects, two of the six were new projects that did not fit well under their existing Investment Plan project descriptions, so there are limited cases where new projects would require the Advice Letter process. But generally, there is extensive flexibility built into the system and based on how the IOUs interpret the requirements and administer their program.

8.5 Coordination

We assessed how the administrators coordinate with each other, and also with other energy innovation efforts across the country.

8.5.1 Coordination Across Administrators

We begin by noting that the IOUs and the CEC have agreed to pursue the following principles for cooperating and collaborating for EPIC-funded projects:

1. Information sharing and coordinated planning;
2. Leveraging funding and avoiding duplication of projects;
3. Consistent evaluation, measurement and verification of RD&D results;
4. Coordinated input and advice from stakeholders; and
5. Intellectual Property.

During the administrator interviews, we asked the administrators about how they coordinate program activities. The EPIC administrators described how they hold regular coordination meetings biweekly at minimum (all four administrators meet biweekly, and on the weeks in between, the IOU administrators meet). They also described how they coordinate program activities at various stages including investment planning, project selection, project implementation and results dissemination. For example, they coordinate to plan EPIC stakeholder meetings and workshops, jointly developing meeting agenda and deciding on meeting logistics. The four administrators also coordinate on projects that the CPUC mandates that they implement jointly. Since the CPUC set a requirement for an annual EPIC Symposium in Decision 15-04-020, they also coordinate to plan and host that event. They share project results with each other informally (e.g., during coordination meetings) and formally (by attending project presentations). However, based on these interviews and document reviews, in appears that the CEC and IOUs focus their coordination activities more on program administration activities and less on individual projects.

The IOUs coordinate more with each other on individual EPIC projects, since they may directly benefit from each others' project results, and they want to use program funds judiciously and limit duplication of efforts. There are cross-IOU technology teams that coordinate, and the Program provides a unifying framework for them to test technologies before they go to production scale. These technology teams also have routine working relationships with each other where they share information about project scopes, project progress and completed projects to ensure coordination and avoid duplication. However, each IOUs' grid is somewhat unique along with their customer bases. We asked the IOU EPIC program managers about the extent of duplication with the other IOU administrators. All the IOUs indicated there is some duplication, but little to none of this duplication is unnecessary; they described the Electric Power Research Institute's (EPRI's) involvement in their investment planning activities as the external vetting that confirms this. The IOUs' technical teams also meet on an ad hoc basis to discuss projects that have recently closed to provide lessons learned as another measure to prevent unnecessary duplication of EPIC projects. Likewise, these technical teams are in contact with external stakeholders, which is another measure they take to avoid duplication with utility projects outside the state. No administrator could think of concrete examples of coordination activities that led to significant program changes between IOUs to facilitate synergies between portfolios.

One stakeholder who we interviewed suggested that there has been duplication of TD&D projects across IOUs. The stakeholder thought that the recurrence of similar TD&D projects across the IOUs stemmed from a few different factors including lack of transparency related to funding priorities and decisions, combined with limited awareness of project accomplishments and follow-on funding. The other stakeholders had not observed any duplication.

We conducted our own assessment to determine whether we could identify unnecessary duplication across IOU projects. We conducted a cross-platform analysis of the portfolio of IOU projects (covering EPIC 1 and EPIC 2, through the end of 2016) based on the IOUs' project status reports along with information from the Annual Reports and Investment Plans. We assigned tracking metrics based on project descriptions, which we compared between individual projects that demonstrated similar technologies and processes. We selected projects that scored a high potential for duplication as a result of this first-level analysis and conducted an in-depth documentation review to determine the level of duplication (if any) between these projects.

For example, the IOU project portfolio included six projects that addressed the potential for increased integration of grid-scale energy storage technologies. Two projects, one administered by PG&E and the second by SCE, evaluated market benefits, cost-effectiveness and processes for the identification of key distribution grid locations for potential storage systems. Duplication between these projects may be observed due to the similarity of technologies and cost-assessment analysis methodologies. However, the inherent differences between distribution grid operations, including the physical distribution of generation resources, regional-scale load profiles and subsequent economic benefits of regionally-sourced storage, significantly reduced duplication impacts to portfolio efficiencies.

We also conducted a review of the IOU third triennial Investment Plans to identify potential duplication of IOU activities going forward. Similar results were found that warranted some level of necessary duplication to address the unique differences between service territories. However, other potential project duplications exist where specific and shared technologies are being demonstrated (for example, the integration of EV batteries acquired through 'second-life' purchases and configured as an additional source of grid-scale storage potential). Other potential duplications exist in methodologies of automated demand response aggregation and price-based controls. The results of this review suggest the need for an earlier external review of IOU projects before they appear in the Investment Plans to ensure no unnecessary duplication. Otherwise, the CPUC gets an opportunity to review the Investment Plans by reading each IOUs' project descriptions, and it may be difficult at that late stage with only general project descriptions to identify potential duplication.

There are opportunities for the IOUs to coordinate with the CEC on its R&D projects, which could possibly lead to demonstration (TD&D) projects.[63] However, the CEC has completed very few of its projects, while the IOUs are well into the process of planning their third investment portfolio, which specifies projects through 2020. Thus, the opportunity for intra-agency coordination and project throughput is limited at this time. There is likely the opportunity for future coordination once the CEC completes more projects, but the IOUs indicated there is not a set process in place, so any coordination would be ad hoc.

Stakeholders interviewed for this evaluation expressed mixed opinions regarding coordination between the CEC and IOUs. Because most stakeholders indicated that they worked with either the CEC or one or more of the IOUs but typically did not work with both the CEC and IOUs, they were not very aware of the extent to which administrators across all four entities coordinate their efforts. Two stakeholders generally thought that work was well coordinated, and one of these individuals also thought that coordination among the IOUs had improved over time. On the other hand, two other stakeholders thought that the CEC and IOUs came together during key times related to investment planning, but believed that much of this coordination was limited to specific investment planning events and was not sustained outside of these times.

[63] The IOUs are not allowed to bid on CEC solicitations where they provided input per CPUC Decision 15-04-020.

8.5.2 Coordination with Other Energy Innovation Efforts

In addition to coordinating across administrators, the CEC and IOUs also attempt to coordinate with R&D efforts outside the Program to exchange information. In this section, we describe the processes the administrators use as well as feedback from stakeholders. Later, in Section 9.3.2, we present a network analysis that independently validates and reports on quantitative measures of EPIC networking.

The CEC project teams formally engage technical experts through the TAC that is formed for each project (and in limited cases, a policy advisory committee [PAC]). For both IOU and CEC projects, EPIC project teams (e.g., the Commission Agreement Manager [CAM], IOU administrator, grantees and members of the TACs) make formal and informal connections with a wide range of other organizations beyond the project team to share knowledge and experience. Such organizations as government research laboratories, private research and consulting companies, universities, utility associations and manufacturers are included in this network (see Sections 7 and 9.3 for more details regarding coordination). Both the CEC and the IOUs also have internal subject matter experts who routinely coordinate with other individuals and entities in order to stay current. Both the administrators described this type of coordination and information exchange, which was also corroborated by project-level interviews.

The CEC has in-house technical experts on whom it relies to coordinate with other innovation efforts. Furthermore, the CEC works on related issues outside of EPIC and is already engaged with stakeholders for selected technologies, both at a policy level and in developing roadmaps. At the program level, the CEC also participates in the Association of State Energy Research & Technology Transfer Institutions (ASERTTI), which is a nonprofit organization whose mission is to increase the effectiveness of energy research efforts in contribution to economic growth, environmental quality and energy security, through:

- Collaboration on research projects with state, federal and private partners; and
- Sharing technical and operational information among members and associates (including the DOE [Department of Energy] and Lawrence Berkeley National Laboratory [LBNL]).

The IOUs have formalized the seeking of input from EPRI in order to minimize the chances of duplicating projects being conducted by other utilities worldwide. This feedback and IOU response are documented in their Investment Plans and Annual Reports. The IOUs also rely on their in-house technical experts, who engage with stakeholders (such as universities, academic institutions, national labs) during the course of addressing other CPUC proceedings.

In general, stakeholders that we interviewed had little insight into the extent to which EPIC investments are coordinated with other efforts led by statewide, federal, private and other research entities. One interviewee said that the Program needs more coordinated statewide or western region planning. Another stakeholder thought that EPIC and California energy policy planners in general could do more to coordinate with federal programs and initiatives. In both instances, the interviewees did not offer any concrete suggestions or strategies.

Stakeholders reported that EPIC supports California's policy goals in principle. Limited results regarding program impact makes it difficult for them to assess the extent to which the Program as a whole or individual projects are advancing various aspects of key policies such as GHG reduction and renewable energy generation. In addition, as noted above, a few stakeholders felt that the Program could be better coordinated statewide and with other regional and federal efforts, which would help identify both gaps and solutions on which the state should focus resources. Citing examples of research to improve grid resiliency and cybersecurity, one stakeholder thought that EPIC is bypassing or overlooking opportunities to play a strategic role in the work being done in these areas nationally. This stakeholder thought this oversight might be an outcome of an EPIC focus on the state-mandated goals.

8.6 Best Practices Comparison

The best practices assessment examined how effective practices related to project selection, including alignment with program goals and objectives, selection criteria, the review process and match funding. This section summarizes key findings from the literature review and interviews with administrators of seven peer RD&D programs.

The literature review showed that rigorous selection criteria, strong alignment with overall goals and objectives, and a peer review process are fairly common among RD&D programs. All six of the peer RD&D programs that offer grants (or, in the case of the DOE's Small Business Innovation Research [SBIR] and Small Business Technology Transfer [STTR] Programs, cooperative agreements) provide transparent information about RD&D funding opportunities, proposal review criteria and the selection process. Each of these programs includes information about funding opportunities on their website. In general, the funding announcements describe technology-related parameters, funding amount and duration, due date and award date. The SBIR and STTR Programs and ARPA-E also have webinar archives that provide background on the program and criteria for eligibility, as well as information on how applications are reviewed and selected for funding.

All four of the primary peer RD&D programs require applicants to provide a preliminary research description prior to developing and submitting a full proposal. The SBIR and STTR Programs require a letter of intent while ARPA-E and the New York State Energy Research and Development Authority's (NYSERDA'S) T&MD Program require a concept paper. While the specific requirements are different for each program, this preliminary description serves a few purposes. It allows program administrators to get a sense of the technology areas that are likely to be addressed in response to a particular solicitation, which helps them determine the types of external reviewers that will be needed for proposal review. It also allows the applicant to describe their proposed research with relatively modest commitment in terms of time and resources. Based on a review of the preliminary description, the programs provide applicants with a notice of encouragement or discouragement to submit a full proposal.

8.6.1 Match Funding

Three of the seven peer RD&D programs, including two primary peer RD&D programs, require projects to obtain match funding; while they do not directly assist with finding the match funding, to the extent that they can, they try to help address any barriers the project team may face. Washington State's Clean Energy Fund requires a 50 percent cost share, NYSERDA's T&MD Program requires 25 percent or 50 percent cost share depending on the size of the project, and the DOE's Advanced Research Projects Agency-Energy Program's (ARPA-E's) cost share varies by specific funding opportunity. While the SBIR and STTR Programs do not mandate match funding, it is encouraged for projects that fall under their Phase II funding, where the programs place increased emphasis on commercialization.

8.6.2 Comparison with EPIC

The CEC's model with respect to transparency about funding opportunities, proposal review criteria, and the overall selection process generally is consistent with the peer RD&D programs. The four primary peer RD&D programs use a two-stage application process where interested applicants submit a concept paper or letter of intent prior to developing a full proposal. According to interviewees, this benefits both program administrators and applicants. Program administrators receive a preview of anticipated submissions, including research and technology areas, and can start planning staffing resources accordingly. Applicants can explore a funding opportunity without committing extensive staff resources. To date, the CEC has offered four two-stage solicitations and plans to offer more of these funding opportunities under EPIC 3. Given other programs' success with this approach, this appears to be a promising development for EPIC, as it might make the program more accessible to small businesses. The two-stage process also helps them to assess if it is worth the relatively sizeable effort they would need to commit to for a full-fledged application to EPIC.

Table 40: Best Practices Comparison of EPIC and Peer RD&D Programs

Peer RD&D Programs	Current EPIC Practice	Comments
Selection Process		
Provide information about funding opportunities, including webinars and FAQs	The CEC has an open and transparent process; the IOU process is more limited vendor selection.	The existing CEC process appears to be sufficient. The IOUs are more constrained by their focus on internal system needs.
Utilize external reviewers	The CEC does this, but the IOUs do not.	The existing CEC process appears to be sufficient. The scope of the IOUs' solicitations tends to be more limited to vendor selection for specific tasks, which may make this unnecessary.
Two-stage application process	The CEC does not regularly conduct a two-stage application process, but the IOUs do not follow this practice at all.	The CEC should consider expanding this practice. However, we note that this adds time to the process (90 days or more, per the CEC). The scope of the IOUs' solicitations tends to be more limited to vendor selection for specific tasks, which may make this unnecessary.
Match Funding		
Require match funding (three of seven peer RD&D programs, including two primary peer RD&D programs)*	Match funding is required for CEC TD&D projects and encouraged for Applied R&D projects. The IOUs do not do this at all.	The CEC should explore different options, including removing the match funding requirement for TD&D or making it optional. The scope of the IOUs' solicitations tends to be more limited to vendor selection for specific tasks, which may make this unnecessary.
Assist with identifying match funding opportunities	The CEC does this to a limited extent.	The CEC should explore the possibility of providing this assistance, particularly for small business applicants. The scope of the IOUs' solicitations tends to be more limited to vendor selection for specific tasks, which may make this unnecessary.

* The SBIR and STTR Programs (programs focused on small businesses) do not mandate match funding, but they do encourage it for Phase II projects.

9 Project Assessment Process

In this section, we discuss the effectiveness of the Program's assessment processes, as described in the EPIC Administration logic model (see Section 13.1 for more details), which informed our data collection efforts. Project assessment is a critical third step in the causal chain that is expected to ultimately lead to the achievement of EPIC's mid- and longer-term outcomes. For our assessment, we conducted interviews with the management teams from each administrator (a total of nine interviews), reviewed program documents such as the Investment Plans and Annual Reports, conducted 90 project-level interviews associated with our sample of 54 projects, conducted nine interviews with EPIC stakeholders and conducted a best practices assessment.

9.1 Project Status Assessment

EPIC administrators report on existing projects in a variety of ways and formats. Based on what we learned from our interviews with EPIC program management teams (several interviews with each Administrator's management team) and project managers (21 IOU project managers and 32 CEC grantees), the common thread and most consistent reporting mechanism for on-going projects is the administrators' annual report, which is required by the CPUC per Decision 13-11-025.

The administrators are required to provide an overview of the overarching components, background information and regulatory processes of the Program as a whole. The reports also include a project status report that is in a table format, which is consistent across administrators per CPUC requirements. These tables present the following information about each active project and approved EPIC project awards:

- Project name and description;
- Date of the award and timeline;
- Budget, spending, and matching funds;
- Project partners;
- Intellectual property and project results;
- Applicable metrics;
- Grant awarding process and summary of bidders/selection process; and
- Barriers addressed by project and technological advancements.

Figure 17 illustrates a project description from an annual report.

Figure 17: Example Project Description from an Annual Report

61. **EPC-14-029**

Project Name: The West Star North Dairy Biogas-to -Electricity Project [EPC-14-029]	
Recipient/Contractor: ABEC #2 LLC, dba West Star North Dairy Biogas	
Investment Plan: 2012-2014 Triennial Investment Plan	**Project Term:** 5/15/2015 to 3/29/2019
Program Area and Strategic Objective: Technology Demonstration and Deployment S13: Demonstrate and Evaluate Emerging Clean Energy Generation Technologies and Deployment Strategies	
Issue: Despite a regulatory environment encouraging renewable energy production and greenhouse gas reductions, dairy digester development has lagged in California. Fewer than two-dozen dairies in California have installed digesters and roughly half of these projects are operating. With dairy digesters having the potential to play an important role in providing renewable baseload electricity as well as reducing California's GHG emissions, California needs to demonstrate projects, which include design, operation and management strategies, that result in successful dairy digester-to-electricity projects.	
Project Description: This project will advance digester design by building and demonstrating an innovative, double-cell covered lagoon digester and 1-megawatt (MW) generation system. The system will convert dairy manure into biogas and store the biogas above the Primary and Secondary Lagoons under an inflatable cover. The biogas will be converted into renewable electricity anticipated for sale and export to the PG&E distribution grid through a SB 1122 Bioenergy Feed-in Tariff. Further, dairy biogas systems qualify for participation in the CPUC's Assembly Bill (AB) 2514 electricity storage program. In a future phase, the biogas system may compete for an energy storage contract. The project will also improve groundwater protection by minimizing leaching of manure into groundwater.	
How the Project Leads to Technological Advancement or Breakthroughs to Overcome Barriers to Achieving the State's Statutory Energy Goals: The project will significantly reduce methane emissions and generate renewable electricity helping to achieve the State's GHG emission reduction and renewable electricity goals. The improved digester design will decrease dairy and digester operating costs while also enhancing the protection of groundwater. Other important benefits include: lowered manure handling costs and valuable co-products, such as nutrient-rich, more absorbable irrigation water.	
CPUC Proceedings addressing issues related to this EPIC project: Renewables Portfolio Standard: R.11-05-005 SB 1122 Bioenergy feed-in tariff: R.11-05-005	

<table>
<tr><td colspan="4">Applicable Metrics: CPUC Metrics- 3h, 4a, 4e
Lower Costs:
By advancing digester economics and design, through efficient manure management practices, the project will help lower dairy management and operation costs.
Increase Safety:
By employing state-of-the-art controls and best practices for safety, the proposed system will help maintain the safety of the grid as well as safety for those operating and managing the system.
Environmental Benefits:
The project supports implementation of California's energy and GHG management goals and targets through the deployment of new renewable power generation capacity and the capture and destruction of methane currently vented into the atmosphere. The double-lined lagoon enhances groundwater protection by minimizing leaching of manure into groundwater.
Consumer Appeal:
The project will improve odor control, through hydrogen sulfide removal, an issue important to the dairy employees and benefits the local community.</td></tr>
<tr><td colspan="2">Assignment to Value Chain:
Generation</td><td colspan="2">Total Budgeted Project Admin and Overhead Costs: $32,107</td></tr>
<tr><td colspan="2">EPIC Funds Encumbered:
$4,000,000</td><td colspan="2">EPIC Funds Spent:
$44,785</td></tr>
<tr><td colspan="2">Match Partner and Funding Split:
Caterpillar Financial Services Corporation: $5,000,000 (55.6 %)</td><td colspan="2">Match Funding:
$5,000,000</td></tr>
<tr><td colspan="2">Leverage Contributors:</td><td colspan="2">Leveraged Funds:
$0</td></tr>
<tr><td>Funding Method:
Competitive</td><td>Funding Mechanism:
Grant</td><td>No. of Passing Applicants/ Bidders:
23 out of 23</td><td>Rank of Selected Applicant/ Bidder:
Ranked # 2</td></tr>
<tr><td colspan="4">If not the highest scoring applicant/bidder, explain why selected:
Funds were awarded to passing proposals in rank order.</td></tr>
<tr><td colspan="4">Treatment of Intellectual Property:
Pre-existing intellectual property identified in agreement EPC-14-029 (Confidential Products and Pre-Existing Intellectual Property Lists, Attachment C-2) will reside with the recipient. New intellectual property developed under this agreement will be subject to the agreement Terms and Conditions.</td></tr>
<tr><td colspan="4">Update:
A project kick-off meeting was held in June 2015. Technical progress is underway, and all of the 2015 progress reports were delivered.</td></tr>
</table>

In addition, some administrators also report on any deliverables that have been completed, such as modeling systems, interim reports or presentations, and demonstration site updates.

Furthermore, information about some on-going projects is shared in public venues and meetings that the administrators hold on at least an annual basis, as required by the CPUC. The administrators hold a variety of symposiums and topic-specific meetings at which information about on-going projects is shared among the CEC and IOUs. In general, all administrators participate at these meetings, although some specified meetings may be held by administrators individually and include project results and updates that expand beyond EPIC. Examples include:

- EPIC Symposium: In 2015 and 2016, the CEC, in conjunction with PG&E, SCE and SDG&E, hosted the EPIC Symposium to help highlight key findings from selected projects. For example, PG&E's Close Proximity Switching EPIC project was presented at the 2016 symposium, focusing on project background and scope, technical issues, and the key findings and recommendations for their three vendors creating remote access proximity switches.
- Some project teams also participated in program-area meetings and workshops focused on specific research topics within the Program. For example, in September of 2016, the CEC held a workshop on microgrids where administrators presented their EPIC-related research. Presenters included the project team behind the Borrego Springs microgrid, who provided an overview of how they are making their microgrid more flexible and automated during power outages.
- In addition, some CEC grantees and IOUs present results of their on-going work at conferences and in peer-reviewed journals. For example, members of a grantee team looking into the use of sulfur for thermal energy storage presented aspects of their work at the American Society of Mechanical Engineers' 2016 Power and Energy Conference, and PG&E technical staff have attended the Energy Storage North America Annual Conference on numerous occasions.

Later in this section (in 9.3), we more closely examine how the administrators share project results. The remainder of this subsection focuses on how the administrators track and report on projects while they are being implemented.

As mentioned previously, throughout the report we have tended to present results for the CEC and all three IOUs combined due to the difference in their administrative approach that we noted at the initial stages of the evaluation. However, we examined each of the four administrators' processes and projects, and where we noted differences across the three IOUs, we discuss those differences. Note that those comparisons were limited by the size of the project sample for each IOU, which reflects the relatively smaller portion of the EPIC budget that the IOUs receive as compared to the CEC.

9.1.1 CEC

At the project level, the CEC Commission Agreement Managers (CAMs) generally appear to be well informed about the status and progress of individual projects based on the combination of formal project reporting and informal day-to-day interaction. The CEC contracts out its projects, and it requires grantees to track and report on information at least quarterly and often on a monthly basis in progress reports that accompany the invoices. These progress reports include:

- Planned and actual accomplishments during the prior reporting period;
- Planned accomplishments during the next reporting period;
- A comparison of progress to the implementation plan;
- Evidence of progress;
- Current and cumulative expenditures compared to the budget; and
- Status of milestones and products.

CAMs told us that they find these reports to be a useful way to follow project progress. Our review suggests that they do provide a good snapshot of project progress compared to the scope of work—sometimes with helpful graphics, pictures and interim results.

We noted some normal variation in the degree to which CAMs focus on the technical details of the projects and the frequency with which they interact with project teams between regular progress reports. Furthermore, we noted a few instances in which reassignments or personal leaves have resulted in mid-project transitions of CAM responsibilities to other CEC staff. In these instances, CEC staff sometimes appeared to have lesser familiarity with project details.

As mentioned previously, grantees are required to form a technical advisory committee (TAC) for each CEC project to provide technical expertise and advise the CAM, such as during a critical project review when lab tests results are available. The process of forming and convening a TAC takes time and may not occur immediately at the start of a project. At the time of our interviews, there were 25 projects with TACs formed (of the 32 projects in our sample), five projects with no TAC, and two projects that were in the process. Of the 25 project teams that had formed their TACs, 12 had not held a formal meeting at the time of our interview, eight project teams had met once, three had met twice and two project teams had met three or more times. In limited cases, the CEC may convene a policy advisory committee (PAC), where a project or set of projects could influence future policy.[64]

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[64] At the time we conducted our research, the CEC had convened one PAC (the Long Term Energy Scenarios PAC), which is advising three projects related to GHG reduction goals and the impacts of a changing climate on the state's energy systems.

9.1.2 IOUs

The IOUs internally administer their projects in accordance with established companywide and EPIC requirements. They have EPIC leads and internal project sponsors for each project that track the necessary project data that go into the Annual Report project status report. Their involvement on the project teams and updates to the internal project sponsor keeps them informed about project progress to supplement monthly progress reports. The IOU internal project team periodically reviews project status (typically monthly), and they have higher levels of review and reporting that happens quarterly and annually that involve management. The IOUs described how they hold periodic meetings (usually quarterly) with their management to discuss projects and any issues that have arisen. At that time, management weighs in on any decisions such as to end a project or put a project on hold. A project might be ended if early results suggested it was not productive to continue, or a project put on hold because of an external development that made that project no longer a high priority (or if it was duplicative with something else being done). Detailed processes for internal reporting, go/no-go decisions, risk management and other project management and oversight functions are utility-specific and vary accordingly.

9.1.3 Current Project Status

As of the end of 2016, 250 projects were currently in progress. A total of 19 projects have been completed (1 CEC project and 18 IOU projects), 7 projects have been cancelled and 23 projects are on hold, based on the project status reports included with the administrators' 2016 Annual Reports. We talked to CEC CAMs and IOU project managers during the course of project interviews about how occasionally projects are revised or rescoped to adjust to unforeseen circumstances or project results. Administrators may cancel a project if during the review they determine it is not productive to continue. But often, there is still knowledge created that is worth sharing. The IOUs may also decide not to launch a project if the market or technology question has shifted priorities or is no longer needed, and/or they want to reserve budget to prioritize other projects.

Among the projects we sampled for closer review, CEC CAMs and IOU project managers reported that 11 had been revised in some way. SCE was much more likely to have revised their projects (three out of seven). Typical adjustments included adjustments to timeline, technology upgrades (i.e. software updates, metering equipment), adding project partners, reshaping scope to address policy questions or adjusting the bidding process (i.e. sole sourcing versus competitive bidding). The adjustments were triggered by consultation from TAC and PAC members, critical project reviews and discussions between the administrators and grantees. Table 41 below shows the breakdown between CEC and IOU administered projects.

Table 41: Project Revisions to Scope by Administrator (n=53)

	Number of Sampled Projects[65]	Number of Projects Revised	Percent of Sampled Projects Revised
CEC	32	6	19%
SCE	7	3	43%
SDG&E	4	0	0%
PG&E	10	2	20%
Total	**53**	**11**	**21%**

Stakeholders we interviewed for this evaluation (n=9) were not very aware of project-related results. While they indicated interest in learning about project successes, it does not appear that the EPIC administrators are sharing these findings widely to the general stakeholders that we interviewed, which includes policymakers, state agencies and research organizations. However, as we present later in this section, results are shared with a significant number of organizations that are part of project-specific networks.

Although project results across the EPIC portfolio are limited and very preliminary at this point, there seems to be some interest from the stakeholders we interviewed in receiving periodic updates from the CEC and IOUs about EPIC project accomplishments. There also appears to be a desire among stakeholders for greater transparency about how to access project results to ensure that appropriate stakeholder groups, particularly those at the CPUC, are informed about projects' progress. This feedback loop is critical to helping stakeholders fully understand why the CEC or one of the IOUs might conduct additional research or deploy technology in a particular area.

9.2 Benefits Quantification

As mentioned previously, the administrators are required to identify metrics by which each project's success will be measured. CPUC Decision 12-05-037 requires the administrators to propose metrics and criteria for awarding EPIC funding in individual areas in their Investment Plans, against which the Investment Plan's success should be judged. The Decision provided a comprehensive list of metrics that administrators could consider covering a range of benefits including:

- Potential energy and cost savings
- Job creation

[65] One sampled CEC project did not complete this question set of the interview because we discovered the project had not yet started during the time of the scheduled interview.

- Economic benefits
- Environmental benefits

Decision 13-11-025 further states that:

> "The Administrators should have the flexibility to choose metrics on a project-by-project basis, and because the list of proposed metrics and potential areas of measurement is not exhaustive, the Administrators should be able to use additional metrics where appropriate. However, the Administrators must identify those metrics in the EPIC annual report for each project."

9.2.1 CEC

The CEC has a structured and transparent process in place for tracking project benefits, based on our review of documents and grantee and CAM interviews associated with the CEC project sample (n=32).

Grantees are required to complete three project benefit questionnaires—one in association with the project kick-off meeting, one during the project, and one at the end of the project. The questionnaires are designed to allow for increased customization of the benefit assessment with subsequent questionnaires. Most EPIC projects are still ongoing, so the majority has resulted in the completion of only the kick-off benefits questionnaire. In these questionnaires, project benefits appear to be sufficiently and reasonably documented either quantitatively or qualitatively based on our review of the project sample.

The actual estimates originate from the grantee and appear to be based on professional judgment or an educated guess. If the project benefits cannot be reasonably quantified at the current point in the project, the questionnaire allows for ranges of quantitative estimates to be provided or a qualitative explanation of intended benefits. Table 42 lists the benefits that are routinely tracked in the 24 questionnaires we were able to review from our sample of projects.

Table 42: Project Benefits Tracked by CEC for EPIC Grants (n=24)

Benefit	# with Quantified Estimates	# with Qualitative estimates
Potential Energy and Cost Savings	5	6
Job Creation	0	1
Economic Benefits	6	13
Environmental Benefits	9	5
Safety, Power, Quality, and Reliability (Equipment, Electric System)	3	4

Once projects are complete, the CEC includes this information in the report it is required to produce and include in its Annual Reports. We reviewed the CEC's project close out report for the single completed project in our sample, and we confirmed that the report includes information about initial project benefits.

The CEC's process appears to be well thought out and thorough, and addresses the CPUC's requirements to measure and report on project benefits. However, we could not determine whether the data being collected and reported are accurate and effective since most CEC projects are just getting started.

9.2.2 IOUs

The IOUs report on project benefits in their project close out reports. Their internal project teams, with support from internal IOU technical staff, gather and summarize data and information related to project benefits and metrics in the reports. They initially identify the types of metrics that are relevant in their Investment Plans.

We reviewed all IOU projects that were complete at the time we drew our sample (since we included all completed projects in our sample). At that time, PG&E had completed six projects and SCE had completed three, while SDG&E had not completed any projects.[66] The project close out reports included the following sections:

- Project objective
- Project scope
- Major task summary
- Results
- Issues addressed or knowledge gaps filled
- The value proposition for the project
- How the project meets EPIC program metrics

All nine of the IOU project close out reports included information about potential project benefits. PG&E's reports contained a subsection called "Project Metrics" within a Key Accomplishments and Recommendations section,[67] while SCE had a section called "Metrics" that followed Project Results. The potential benefits were broadly characterized and sometimes cross-reference another section of the report. A typical example of

[66] Note that we checked in June of 2017 to see if SDG&E had released any project close out reports, and did not find any completed projects or close out reports to review for this evaluation.
[67] PG&E also has a plan for capturing its corporate benefits (referred to as core values) via a Preliminary Project Benefits Plan, which is included in the Business Plan for each project. PG&E's core values include public safety, employee safety, reliability, operational excellence, customer focus, delighted customers, and environmental leadership

economic benefits is as follows (from PG&E project 1.01 – Energy Storage for Market Operations):

- Potential energy and cost savings
    - Nameplate capacity (MW) of grid-connected energy storage
- Economic benefits
    - Maintain/Reduce operations and maintenance costs
- Other Metrics
    - CAISO Non-Generator Resource financial statements
- Identification of barriers or issues resolved that prevented widespread deployment of technology or strategy
    - Description of the issues, project(s), and the results or outcomes
    - Increased use of cost-effective digital information and control technology to improve reliability, security and efficiency of the electric grid
    - Dynamic optimization of grid operations and resources, including appropriate consideration for asset management and utilization of related grid operations and resources, and services
    - Identification and lowering of unreasonable or unnecessary barriers to adoption of smart grid technologies, practices, and services
- Effectiveness of information dissemination
    - Number of information sharing forums held
- Adoption of EPIC technology, strategy, and research data/results by others
    - EPIC project results referenced in regulatory proceedings and policy reports

For each metric category, there is a cross-reference to the project results that provides more information. For example, for "potential energy and cost savings", there is a cross-reference to Tables 4-1 and 4-2. Table 4-1 from the project close out report is shown below.

Table 43: Excerpt from PG&E Project 1.01 Results

Table 4-1: Vaca BESS Optimization Model Inputs

Vaca BESS Optimization Model Parameters	
Constraint	**Notes**
Max Energy Available: 12.5 MWh	The BESS met its design specifications, 2MW output (DC) for 6.95 hours, for total usable energy of 13.9MWh. However, a 10% minimum State of Charge (SOC) was set in order to minimize full depth of discharge.
Max Discharge Rate: 1.85 MW	While the DC discharge power of the battery is 2MW, the effective AC charge power is reduced due to DC/AC conversion and transformer losses, and heaters used by the system to keep it at a minimum operating temperature of 300° C.
Max Charge Rate: -2.15 MW	While the DC charge power of the battery is -2MW, the effective AC charge power is increased due to DC/AC conversion and transformer losses, and heaters used by the system to keep it at a minimum operating temperature of 300° C.
Charge Curtailment: As SOC reaches 92% SOC while charging, charge power is reduced incrementally by the Battery Management System	As the SOC of the battery reaches full SOC, it automatically reduces charge power as a battery cannot be overcharged without damage. This has implications for the amount of power/energy the STES Team can bid into the market as SOC reaches 100%.
Periodic Battery String Balancing	The Battery Management System (BMS) tracks SOC at the string level. The Vaca BESS has four strings. As the battery is charged and discharged over multiple days without reaching 100% SOC, the difference between SOCs of the individual strings grows. The BMS will provide an indication when the strings need to be fully balanced at 100% SOC, which takes a full charge of all strings. As SOC approaches 100% the BMS will "top off" charge of each string successively at very low power. The practical result is that the greater the string imbalance the longer it will take to reach 100% SOC for all strings, and the optimization model needed to account for these periodic string balancing charges.
Parasitic Losses from Battery Heaters	Even when the battery is idle, the system uses energy to maintain its minimum 300° C operating temperature. It does not, however, affect the battery's SOC since the energy is going to the heaters and not to charge the battery.[29]
Efficiency (AC energy output/AC energy input)	The optimization model must take into account the battery's efficiency to determine how much charge energy versus discharge energy to bid into the market. It will take more energy to charge the battery than the battery discharges, with effects on SOC and the amount of discharge energy available. The efficiency of the NAS battery technology greatly varies with how the systems are used and efficiency is measured; for the model a value of 75% was used.
Interconnection Limitation	From May 1 to October 1 between 1500 to 2300 hours, the battery system can charge no more than 1.7 MW.
Ancillary Services	• Energy and A/S in the same hour: Yes • Regulation: Yes • Spinning Reserve: Yes

[29] From a bidding/scheduling perspective, if the STES Team bids this energy into the Day Ahead market to hedge its exposure to real-time prices, then the CAISO's SOC prediction becomes a problem. This is because it will see the energy bid to hedge heater load financial exposure as charge energy increasing to the battery's SOC, which would often result in market awards being mitigated due to incorrect assumptions by CAISO about the battery's actual SOC.

SCE addresses metrics in its closeout reports in a similar fashion. Project metrics are acknowledged and discussed, but not always quantified. For example, SCE's closeout report for its Outage Management and Customer Voltage Analytics project (from EPIC 1), discusses the project's technical details in specifics, but presents EPIC metrics in purely qualitative terms. Overall, we found details on metrics to range from a single sentence to quantification for a variety of core metrics relevant to a project.

As shown, the report includes detailed technical information on project results. However, it stops short from quantifying benefits associated with the project. It provides useful inputs that one could possibly use to quantify the benefits, but the reports are more focused on sharing project results and lessons learned, which would be useful for their own utility and other utilities and stakeholders. However, the CPUC's reason for requiring that administrators identify and track metrics was to "propose metrics… against which the investment plan's success should be judged."[68] It is clear from our review that the IOUs are not taking the necessary steps to use the data and information they have gathered, and possibly supplement it by gathering additional data, to report on the success and benefits associated with their projects in the broader realm of how these projects are contributing to the over-arching Investment Plan goals.

9.3 Results Dissemination

The following section presents two related topics, how EPIC tracks project level results, and how results and other project information and knowledge are disseminated to relevant stakeholders and market actors. In this section, we primarily report on results for the CEC and IOUs (combined) due to the difference in administrative approach we noted at the initial stages of the evaluation. However, we examined each of the four administrators' processes and projects, and where we noted differences across the three IOUs, we discuss those differences. Note that these comparisons were limited by the size of the project sample for each IOU (which reflects the relatively smaller portion of the EPIC budget that the IOUs receive as compared to the CEC).[69]

The success of research, development and deployment programs such as EPIC depends partly on the extent to which the program participants are able to transfer knowledge to a wider audience that can use or advance that knowledge. This includes communicating research results and developing relationships with the appropriate audiences and stakeholders, including industry experts and other potential technology adopters. The diffusion of project information is critical if stakeholders beyond the projects are to adopt technologies and tools developed and take innovations from being a nascent technology to commercialization. There are two key components to successful knowledge transfer:

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[68] Decision 12-05-037, p. 8., 2012

[69] The project sample included two PG&E projects, seven SCE projects, and four SDG&E projects.

- Identifying a variety of information sharing channels and activities to successfully transfer knowledge to the appropriate audience; and
- Developing relationships and networks that include industry experts and influential knowledge disseminators who can create pathways for knowledge dissemination.

To describe and assess EPIC project efforts to disseminate knowledge and develop appropriate relationships and networks, the evaluation team conducted a network analysis. The goal of the network analysis is to clarify the composition of relational networks and knowledge pathways developed through the Program. These networks are created as a result of the outreach, collaboration, marketing and information dissemination activities of the CEC and IOU administrators, CEC CAMs, CEC grantees, IOU project managers and IOU contractors. To capture all of these nuanced relationships, the network analysis was conducted at both the project level and the program level. We also reviewed the processes the administrators use to disseminate results.

This section is organized around the following topics, linked to specific activity and output boxes in the research area logic models (see Table 44).

Table 44: Network Analysis Approach and Linkage to EPIC Logic Model

Topic	Logic Model Box Text	Metrics
Knowledge Dissemination Activities	Disseminate Results Results delivered through websites, workshops, conference presentations, & professional networks	• Number of CEC projects with knowledge transfer plan developed or funded • Number of projects presenting at workshops • Number of projects presenting at conferences • Number of projects with published peer reviewed journal articles • Number of projects with other published articles or collateral • Number of unique organizations and individuals to which results were disseminated via listservs • Number of websites used with project results or information
Network Composition and Activities	Inter-organizational and interpersonal networks developed	• Diversity of organizations in networks • Overall network characteristics (cohesion and reciprocity) • Number of formal agreements to share information and resources • Number of informal agreements to share information and resources • Types of information and resources shared

9.3.1 Knowledge Dissemination Activities

In this subsection, we describe the processes the administrators use to disseminate project knowledge. Project teams engage in a variety of knowledge exchange activities. In addition to EPIC requiring each team to provide a final close out report and present interim and/or final results at the EPIC symposia, project teams may disseminate project results in other formal and informal ways. Examples of this include presenting at workshops and conferences, publishing articles in peer reviewed journals, publishing articles in trade journals and other publications, sending project results to stakeholders via listservs, publishing results or updates on websites, and through formal and informal communication arrangements with other organizations.

CEC

The CEC has an extensive process intended to disseminate results that includes:

Formal project reporting:

- Projects require final reports, which the CEC publishes.
- The CEC provides summaries of projects in its Annual Reports and features projects in the CEC Innovation Showcase.
- Projects require the completion of a knowledge transfer plan, which the grantees are expected to implement to disseminate project-related knowledge and results through channels such as published articles, presentations at conferences and workshops, and dissemination of information on grantee websites or via social media platforms.

EPIC-wide information sharing:

- The CEC and IOU administrators collaborate at the program and technology level, and these discussions include project-specific information sharing.
- The Media and Public Communications Office conducts general outreach about EPIC and its value to California via social media platforms, with additional placement in technical journals and traditional news media.

Grantee and TAC information dissemination:

- Grantees may conduct additional outreach independent of the grant, as they are often experts on their topic areas, deeply involved in their fields, and publish papers and present at technical events on their work.
- Similarly, members of project TACs are often well placed in their fields and sometimes chosen to facilitate diffusion of project-related knowledge; hence, for some projects, they may become conduits for information sharing as well.

Knowledge Transfer Plans

To determine if project teams are adhering or planning to adhere to the requirement to develop knowledge transfer plans, we asked the CEC CAMs and CEC grantees if they have completed, are preparing, or have funding set aside to complete a knowledge transfer plan.

Table 45 summarizes the status of the CEC project knowledge transfer plans. Overall, five projects have completed the knowledge transfer plan, including the one completed CEC project. The remaining projects either have set aside funding for the plan or are preparing the plan. This suggests that all project teams are adhering to this requirement.

Table 45: CEC Project Knowledge Transfer Plan Development (n=32)

	CEC			
	Applied R&D	**MF**	**TD&D**	**Total**
Knowledge Transfer Plan Complete	2	2	1	5
Knowledge Transfer Plan In Progress	0	0	4	4
Knowledge Transfer Plan Funded - Not Started	6	5	12	23
Total	**8**	**7**	**17**	**32**

* One CEC project is excluded because the interview was incomplete.

Technical Advisory Committees

For the CEC EPIC projects, the TACs provide an important source of project guidance and connection to technical and market expertise, and also provide an avenue for knowledge dissemination. For the 32 CEC projects in our sample, we requested the list of TACs for projects that have reached the stage where these groups have been formed. In total, we received information on TAC composition from 15 projects. Across the 15 projects, there were 178 TAC members, an average of just under 12 members per project TAC. The TACs range in size from four members at the smallest to 24 members at the largest. As we would expect, the TACs are made up of a variety of individuals selected for their specific expertise germane to the project, and TAC members come from a diverse range of organizations from government, research institutes, technology manufacturers, universities, utilities and industry organizations. The TAC members are engaged in the project on a voluntary basis. Administrators and grantees from these projects were generally positive about their interactions with the TAC members when we discussed them during interviews, although some project teams did note that they can have difficulty scheduling meetings with TAC members, especially for larger teams. Some teams also noted that the voluntary nature of the role also made it challenging to engage TAC members at times.

CEC Media Office

The CEC Media and Public Communications Office (the Media Office) also plays an active role in informing the public about EPIC and the Program's benefits, using individual CEC projects as examples of the Program's role in providing societal and ratepayer benefits. We asked the project CAMs associated with the 32 CEC projects in our sample if they have utilized the Media Office and, if so, how they reported the helpfulness of their involvement on a five-point scale from not at all (1) to extremely (5). As shown in Table 46, 75 percent of projects have used the Media Office, and the average helpfulness score was 3.6.

To date, the Media Office has focused on communicating about EPIC and been less involved in project-specific outreach to stakeholders and technical audiences, however. Examples of Media Office involvement from CAMs tended to emphasize assistance in holding project-related events, such as ribbon-cuttings or other events associated with projects in which public officials or citizens might be interested.

Table 46: Usage and Helpfulness of the CEC's Media and Public Communications Office (n=32)

	Have Used	Have Not Used	Total	Five-Point Rating Average
Applied R&D	7	1	8	3.2
TD&D	11	6	17	3.7
Market Facilitation	6	1	7	4
Total	**24**	**8**	**32**	**3.6**

IOUs

The IOUs also report on how they plan to disseminate project results in their project close out reports. Similar to how the IOUs treat project benefits, they rely on their internal project teams with support from internal IOU technical staff to determine and document how they plan to share project results.

As mentioned previously, we reviewed all IOU projects that were complete at the time we drew our sample, for a total of nine project close out reports. PG&E's reports contained a subsection called "Technology Transfer Plan for Applying Results into Practice" within a Key Accomplishments and Recommendations section, while SCE has a subsection called "Technology / Knowledge Transfer Plan" that is part of a Project Results section.

Technology Transfer Plans

Seven of the nine reports indicated where information about a project had been or would be presented. Five of six PG&E reports had such information in the Technology Transfer Plan subsection:

- Project 1.01 identified a total of six presentations, three conferences, one meeting and two EPIC workshops.[70]
- Project 1.09 A identified two conferences.
- Project 1.09 B identified three conferences.
- Project 1.18 identified two conferences.
- Project 1.24 identified five conferences, including three that were pending.

To illustrate a typical PG&E technology transfer plan, for Project 1.18, which evaluated the ability of commercial vendors to use PG&E smart meter data to disaggregate residential customer energy usage, we list the conferences at which PG&E either presented or planned to present the results:

- Peak Load Management Alliance (PLMA) in San Francisco, CA - April 19, 2016
- Demand Response and Smart Grid National Town Meeting (abstract pending approval) in Washington D.C. - July 11-13, 2016
- Western Load Research Association (WLRA) (abstract pending approval) in Chicago, IL - Fall 2016
- Association of Energy Services Professionals (AESP) (abstract pending approval) Summer Conference in Chicago, IL - August 16-18, 2016
- National Conference - February 13-16, 2017

Two of the three SCE reports had such information:

- Project 13-086 identified two EPIC workshops.
- Project 14-028 identified two presentations, one at SCE and another at Duke Energy.

While the number of projects we examined is small, we note that at this stage at least, PG&E is sharing its project results at significantly more conferences as compared to SCE. SDG&E has not yet completed a project so has not released a project close out report.

Analysis of Project Dissemination

We also assessed how well the administrators disseminate information about projects based on interviews we conducted with project management teams, as well as the administrators' technology and knowledge transfer plans (including the IOUs' as documented in project close out reports). We conducted analysis to report on quantitative measures of EPIC project dissemination.

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[70] The EPIC workshops are required by the CPUC (though the administrators are not required to report on every project at those workshops).

We start with looking at the number of projects for which project teams have presented information. It is important to note that not all projects have reached the point where they have sufficient project results to present. Only one CEC project (out of 32) in our sample was completed, for example, and only 9 of the 21 IOU sampled projects were completed at the time we conducted our analysis.

Project Information Dissemination

Table 47 presents the number and percent of projects with teams that reported presenting project information or results at workshops, conferences or through publications. As it is a required activity, a large proportion of projects have been presented in some form at an EPIC Symposium, with 53 percent of total CEC projects represented and 86 percent of total IOU projects. In addition to the required EPIC symposia, approximately 40 percent of CEC projects and 50 percent of IOU projects have been presented at outside workshops. Workshops mentioned include National Electric Energy Technology and Application Research Committee (NEETRAC), the Demand Response and Smart Grid National Town Meeting Forum, and the Non-Intrusive Load Monitoring International Workshop. Fewer CEC projects have been presented at conferences (19%) in comparison to IOU projects (52%), which in part is due to CEC projects being launched later than the IOUs' projects (with 8 of 21 IOU sampled projects completed). Conferences mentioned include the Electric Power Research Institute (EPRI) and the Institute of Electrical and Electronics Engineers conferences, the Energy Storage North America Conference, the Electric Vehicle Conference, the Advanced Research Projects Agency-Energy Program (ARPA-E) Annual Conference, and the Western Load Research Association Conference among others.

Overall, 66 percent of projects have been presented at workshops or conferences or have been published, which is extensive since so few projects have been completed. Information about a significant number of projects has been shared at workshops or conferences besides those required by EPIC.

Table 47: Proportion of Projects Engaged in Dissemination Activities (Workshops, Conferences and Publications) (n=53)

	CEC				IOU*	
	Applied R&D (n=8)	MF (n=7)	TD&D (n=17)	CEC Total (n=32)	TD&D (n=21)	Total (n=53)
Workshops						
EPIC Workshops / Symposia	3 (38%)	3 (43%)	11 (65%)	17 (53%)	18 (86%)	35 (66%)
Other Outside Workshops	3 (38%)	1 (14%)	9 (53%)	13 (41%)	11 (52%)	24 (45%)
Conferences	2 (25%)	1 (14%)	3 (18%)	6 (19%)	11(52%)	17 (32%)
Journal Articles	2 (25%)	0	3 (18%)	6 (19%)	2 (9%)	7 (13%)
Articles in Other Publications	1 (13%)	1 (14%)	2 (12%)	4 (13%)	4 (19%)	8 (15%)
Total	**3 (38%)**	**3 (43%)**	**11 (65%)**	**17 (53%)**	**18 (86%)**	**35 (66%)**

* There was no substantial or significant difference in dissemination activity participation between the individual IOUs.

Websites and Listservs

In addition to in-person or traditional print forms of knowledge dissemination, information is also disseminated by some projects via email listservs and through publication of project information on CEC, IOU and other websites. Listservs in particular are a very basic first step for disseminating project and program information. The CEC and IOU administrators maintain extensive listservs with a large number of subscribers that receive program level information including information about program solicitations and annual reports, as well as information on specific projects when appropriate.

Table 48 presents the number and percent of projects with teams that reported presenting project information through listservs and websites. This could include sending information through websites and listservs maintained by an IOU or the CEC, or else using those managed externally by project team members. All projects are maintaining some project information on either the CEC's EPIC website (the Energy Innovation Showcase at innovation.energy.ca.gov/) or the respective IOU administrator website. In addition, approximately 53 percent of CEC projects maintain information on an external website—typically on the grantee's website (for example, the Lawrence Berkeley National Laboratory). The interviewees reported that the IOU projects do not have an online presence beyond the IOU websites.

More than half of all projects have disseminated results via a listserv or website. With only 10 of 53 projects were completed (20%), these data indicate that the administrators have shared information about many projects even before they are completed. Within the IOU projects, PG&E projects made up the majority of projects with 6 of 10 sampled projects disseminating information via the IOU listserv, while SDG&E had one project and SCE had no projects with information disseminated via a listserv. This is in part due to PG&E having more completed projects than SCE or SDG&E.

Table 48: Projects That Have Disseminated Results via Listserv or Website (n=53)

	CEC				IOU	
	RD&D (n=8)	MF (n=7)	TD&D (n=17)	CEC Total (n=32)	TD&D (n=21)	Total (n=53)
CEC Listservs	2 (25%)	6 (86%)	6 (35%)	14 (44%)	3 (14%)	17 (32%)
IOU Listservs	-	-	-	-	7 (33%)	7 (13%)
External Listservs	-	2 (29%)	3 (18%)	13 (41%)	-	13 (25%)
CEC EPIC Website	8 (100%)	7 (100%)	17 (100%)	32 (100%)	-	32 (60%)
IOU Website	-	-	-	-	21 (100%)	21 (40%)
Other Websites	3 (38%)	7(100%)	7(41%)	17 (53%)	-	17 (32%)
Total	**8 (100%)**	**7 (100%)**	**17 (100%)**	**17 (53%)**	**21 (100%)**	**35 (66%)**

Listserv Analysis

As noted, an important avenue of knowledge dissemination is through the CEC and IOU listservs. The CEC and IOU administrators deliver annual reports, grant solicitations and other information via internal listservs. In addition, some projects also use these listservs to disseminate written information about their projects (44 percent of CEC projects and 33 percent of IOU projects reported delivering information though these listservs). There are as many as 80 listservs between the CEC and IOU administrators, but four CEC listservs and one aggregated listserv for each IOU are used most frequently. We obtained the domain names from each subscriber from these listservs from the administrators. From the CEC, we obtained the opportunity listserv that disseminates information about EPIC grant opportunities, the EPIC listserv that disseminates general information about the Program, the news release listserv that delivers project and program-specific news releases from the CEC Media and Public Communications Office, and the research results listserv that is used to deliver project-specific results, including interim findings and final close out reports. From the IOUs, we obtained each of their aggregate listservs that they use to disseminate the Annual Reports.

Details of these listservs are presented in Table 49. We are able to present counts of total subscribers and unique organizations; however, for confidentiality reasons, we were unable to obtain full email addresses so cannot provide more detailed analysis of listservs.

The EPIC listservs disseminate information to a very wide array of individuals and organizations with several thousand recipients. The IOU listservs are more limited, with subscribers numbering in the hundreds. Both sets of listservs consist of a diverse range of recipients—including government officials; utility staff; investors; California ISO staff; and individuals from the business community, environmental groups, the clean energy industry and other industry associations—and there is a large amount of crossover between the IOU and EPIC listservs.

Table 49: CEC Annual Report Listserv Summary

	Total Number of Subscribers	Total Number of Unique Organizations
CEC		
EPIC	1,355	672
Opportunity	4,926	2,228
News Releases	1,446	810
Research Results	2,275	970
IOU		
SDG&E	337	148
PG&E	346	121
SCE	395	134

Based on the evaluation team assessment, the four-administrator model for EPIC may cause some barriers and limitations to information dissemination, as there is no program-wide communications vehicle or central repository of project information. While the administrators do collaborate on the required EPIC symposia, outreach is conducted separately even though there is possible overlap in stakeholder interest across technologies investigated by the administrators. Similarly, the CEC Media Office focuses on CEC projects and does not disseminate any information about IOU projects. Each administrator uses its own website and listserv(s) to distribute information. While this is appropriate, it highlights some limitations to the four-administrator model.

9.3.2 Network Composition and Activities

This subsection focuses on the organizations and individuals who may be receiving information about EPIC projects. In addition to the above information dissemination activities and avenues, the second key component to successful knowledge transfer is development of relational networks with appropriate audiences and stakeholders. To this end, the EPIC project teams may engage with organizations and individuals outside their project teams to exchange information. The CEC project teams formally engage technical experts through the TAC that is formed for each project (and in limited cases, a PAC). For both IOU and CEC projects, EPIC project teams (e.g., the CAM, IOU administrator, grantees and members of the TACs) make formal and informal connections with other organizations beyond the project team to share knowledge and experience. We conducted network analysis to independently validate and report on quantitative measures of EPIC networking.

These information exchanges can occur in both directions, sending information from the project to outside organizations and individuals, and receiving information from outside organizations and individuals. These relationships can be formal or informal, and the knowledge exchanged can be either directly related to the EPIC project or related to other projects but with information germane to the EPIC project. To understand the magnitude and composition of networks of knowledge sharing organizations and individuals, as well as the types of information being shared and the level of formality of information sharing, we asked project teams for the following, for the CEC and IOU project sample:

- A list of up to 15 of the most important organizations both inside and outside California with whom they are sharing information, collaborating, or sharing resources (expertise, equipment, etc.) during the implementation of an EPIC project;
- For CEC projects, a list of the TAC members;
- The level of frequency with which information is shared;
- If information shared is related to the EPIC project, related to other projects with similar topics, or both; and
- If the relationship is formal or informal.

We received networking information for 36 of the 53 sampled IOU and CEC projects (25 CEC projects and 11 IOU projects). Many of the remaining 17 projects are not far enough advanced for extensive networks or information sharing to be established. The following exhibits provide a description of the composition of the external networks, the level and frequency of information sharing, and the formality of the information sharing arrangements.

Project Networks

Table 50 presents the total number and types of organizations reported by each of the 36 project teams that responded. We investigated each organization mentioned and categorized it as either a public or private organization, and as one of ten organization types. Note that the government category includes military and civilian government agencies, as well as the California regulatory agencies (the CEC and the CPUC). The manufacturer category includes both manufacturers of hardware and software technologies.

On average, the CEC engages with 19 organizations per project, while the IOUs engage seven. The types of organizations the CEC and IOUs engage with differ to a great extent. Ninety percent of organizations that the IOUs engage with are private compared with 49 percent for CEC TD&D projects. This distinction may explain why the stakeholders we interviewed had not heard anything about completed EPIC projects (which at the time of our interviews, consisted mostly of IOU projects). The IOUs' networks consist mainly of manufacturers, private companies and other utilities, with very few government/policy-making organizations included.

Among the CEC research funding areas, there was also some difference between the public and private organization composition of networks, with TD&D projects more likely to engage with public entities than Market Facilitation or Applied R&D projects. On average, CEC projects engage with more organizations (18) than IOU projects (7). Note that this includes CEC engagement with the project TACs, each of which includes on average eight organizations.

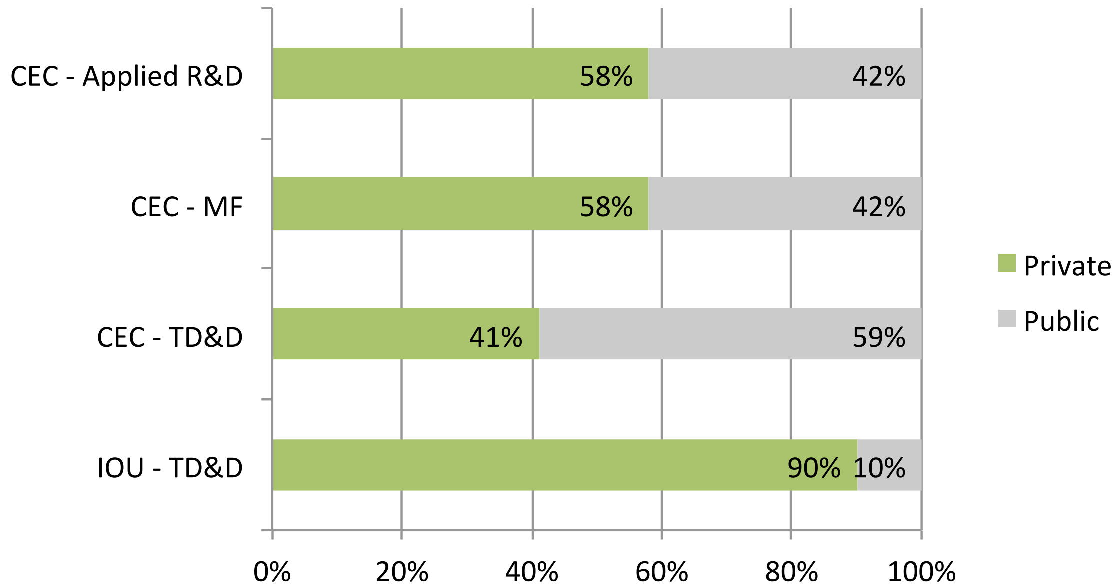
We also investigated differences across the IOU administrators. There were differences in the number of organizations that projects have engaged with across the IOUs in our analysis. SDG&E engaged with the most outside organizations per project having, on average, ten organizations per project in their network, compared with an average of six organizations for PG&E and four for SCE. Note that the sample of projects for each IOU is small, so this may not be reflective of the entire portfolio of IOU projects.

Table 50: Types of Organizations Involved in Project Networks (n=35 Projects, 338 Organizations)

	CEC				IOU
Projects	**Applied R&D (n=7)**	**MF (n=8)**	**TD&D (n=9)**	**Total (n=24)**	**IOU (n=11)**
Total Organizations	**132**	**137**	**167**	**436**	**80**
Public vs Private Organizations					
Private	76 (58%)	80 (58%)	68 (41%)	224 (51%)	72 (90%)
Public	56 (42%)	57 (42%)	99 (59%)	212 (49%)	8 (10%)
By Type					
Government	22 (16%)	25 (18%)	63 (38%)	110 (25%)	7 (9%)
Government Research Labs	9 (7%)	4 (3%)	8 (5%)	21 (5%)	1 (1%)
Implementer	7 (5%)	5 (4%)	8 (5%)	20 (5%)	1 (1%)
Innovation Incubation Organization	9 (7%)	5 (4%)	-	14 (3%)	-
Manufacturer	10 (7%)	13 (9%)	12 (7%)	35 (8%)	20 (25%)
Non-Profit Industry Association	28 (20%)	30 (22%)	9 (5%)	67 (15%)	4 (5%)
Other Business Customer	8 (6%)	5 (4%)	15 (9%)	28 (6%)	4 (5%)
Private Research & Consulting Company	18 (13%)	17 (12%)	19 (11%)	54 (12%)	25 (31%)
University	13 (9%)	17 (12%)	9 (5%)	39 (8%)	-
Utility/CAISO/Utility Associations	18 (13%)	16 (12%)	25 (15%)	59 (14%)	18 (23%)
Mean Number of Organizations per Project	**19**	**17**	**19**	**18**	**7**

Figure 18 below presents the proportion of private versus public network members for each administrator by project type. This figure illustrates the major difference between the CEC and the IOUs that was introduced in the previous exhibit.

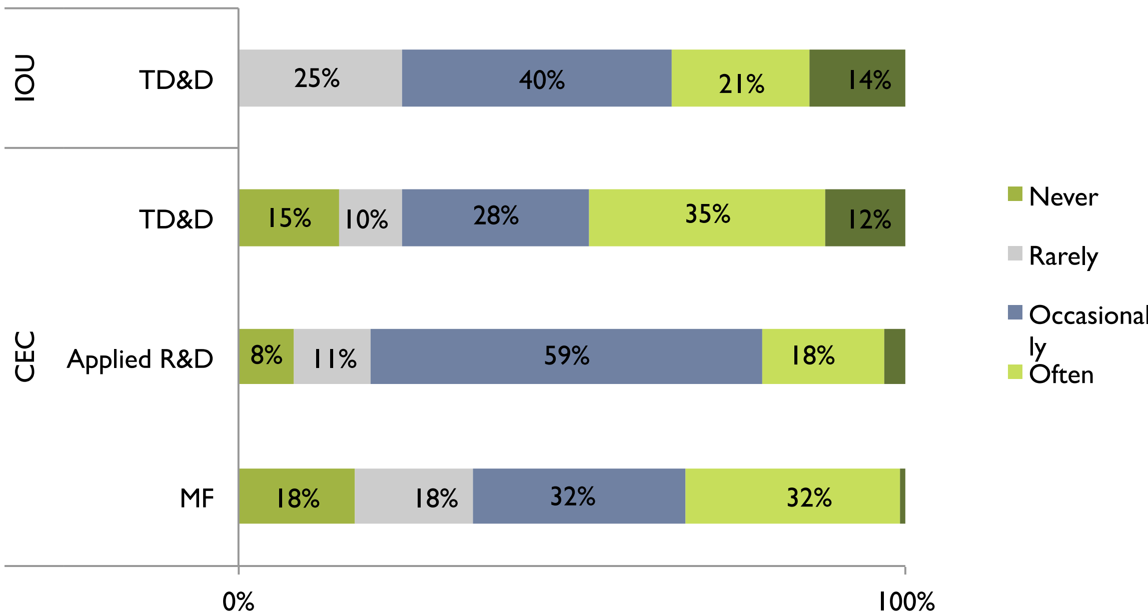
Figure 18: Project Network Composition by Administrator



Frequency of Information Exchange

Frequency of information exchange between project teams and the network of outside organizations also varies between IOU and CEC projects, as reported during project interviews (Figure 19). The reported frequency of information exchange suggests that CEC TD&D projects tend to exchange information more frequently with outside entities (57% reporting always or often) than IOU TD&D projects (35% reporting always or often). We found no significant or substantial difference between IOU administrators in terms of frequency of information exchange with their network.

Figure 19: Frequency of Information Exchange between Projects and Network Organizations (CEC n=24; IOUs n=11)



Network Relationships

Lastly, we examined the formality of relationship agreements between the EPIC project teams and their network of outside organizations. We asked the CEC CAMs and IOU project managers to tell us which projects in our sample had formal information sharing agreements with the external organizations, which we defined as having a written contract agreeing to share information. As shown in Table 51, approximately 20 percent of outside organizations engaged by IOU projects have such formal agreements in place, while 57 percent of outside organizations (including TACs) engaged by the CEC have formal agreements in place. CEC projects have, on average, a higher number of organizations per project with a formal information sharing agreement in place than IOU projects (9.7 organizations on average versus 2.0 organizations, respectively). We compared the formality of relationships across the three IOUs and we found no significant difference.

Table 51: Formal Versus Informal Relationship Agreements (n=35 projects, 338 organizations)

	CEC				IOU
	Applied R&D (n=6*)	MF (n=8)	TD&D (n=9)	Total (n=23)	IOU (n=11)
Total Organizations	**125**	**136**	**166**	**394**	**80**
Mean Number of Organizations per Project					
Formal Relationship	11.6	6.8	11	9.7	2.0
Informal Relationship	9.1	11.6	7.5	9.3	6.1
Proportion of Total Organizations By Type					
Formal Relationship	70 (56%)	55 (40%)	98 (59%)	223 (57%)	16 (20%)
Informal Relationship	55 (44%)	81 (60%)	68 (41%)	171 (43%)	61 (76%)
No Response	**0**	**0**	**1**	**1**	**3**

*One RD&D project in this sub-sample was in a very early stage, and the organizations in the project network were unable to report on the type of sharing that was occurring or would occur.

While most projects are still in the early to mid stages with only 19 of 177 project completed, this analysis of knowledge dissemination activities and the relational networks of each of the sampled interview projects suggests that projects are actively engaged in developing networks of stakeholders and other market actors. Furthermore, the wide range of entities that is already engaged in projects suggests that the projects are well positioned to lead to wide knowledge dissemination once they are completed. While projects appear to be on a good trajectory to lead to knowledge dissemination, it is too early in the life of the program to collect more instances of concrete knowledge benefits such as patents, journal articles and existence of follow-on research. (We discuss these potential EPIC project benefits in Section 10.) It is also premature at this time to assess if these activities will be sufficient to encourage further research and technology adoption after the EPIC projects are completed.

9.4 Best Practices Comparison

The best practices literature recognized the importance of identifying metrics and systems for tracking progress. Six of the seven peer RD&D programs use formal metrics to track project performance. Although the metrics of the peer RD&D programs vary based on their stated focus and technology, the interviewees generally reported that they do track such indicators on a regular basis. Among the primary peer RD&D programs, common project-based metrics include patents, copyrights and publications. Metrics tracked across program portfolios typically include indicators such as progress toward commercialization, identifying potential funders and investors, conducting sales pitches, sales revenues and leveraged funding.

All seven of the peer RD&D programs stated that projects are required to report regularly on their progress. For example, projects funded through the New York State Energy Research and Development Authority's (NYSERDA's) T&MD Program provided monthly or quarterly performance reports, which the assigned Project Manager uses to track progress on milestones identified in the Statement of Work. Many T&MD projects also receive support through the Entrepreneurs-in-Residence (EIR) program, a resource available to companies engaged in commercialization activities (described above under Program Management and Administration). Through these interactions, the main points of contact between the EIR program and the project often develop close relationships, and the EIR advisor is often privy to project status updates on an ongoing basis. Interviewees representing other peer RD&D programs similarly reported regular interaction between program administrators and grantees through written reports (monthly, quarterly or annual), on-site visits or phone calls.

Five of the seven peer RD&D programs, including all four of the primary peer RD&D programs, use an external evaluator to assess the program's performance. In addition to internal tracking reporting mechanisms, interviewees from the primary peer RD&D programs stated that they have used third-party evaluations to aggregate, assess and report on program-wide outcomes. The National Academies of Sciences recently published assessments of the DOE's Small Business Innovation Research (SBIR) and Small Business Technology Transfer (STTR) Programs.[71,72] NYSERDA also has a separate evaluation group, which works with a third-party to evaluate the T&MD Program's effectiveness.[73] ARPA-E recently completed an independent evaluation, which is forthcoming. Interviewees generally indicated that these external efforts help provide objective insights regarding the programs' performance and are useful for reporting to external program stakeholders.

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[71] National Academies of Sciences, Engineering, and Medicine. *STTR: An Assessment of the Small Business Technology Transfer Program.* Washington, DC: The National Academies Press, 2016. https://www.nap.edu/catalog/21826/sttr-an-assessment-of-the-small-business-technology-transfer-program

[72] National Academies of Sciences, Engineering, and Medicine. *SBIR/STTR at the Department of Energy*. Washington, DC: The National Academies Press, 2016. https://www.nap.edu/catalog/23406/sbirsttr-at-the-department-of-energy

[73] New York State Energy Research and Development Authority. "NYSERDA Technology and Market Development Program Semiannual Report through June 30, 2016, Final Report," 2016. https://www.nyserda.ny.gov/-/media/Files/Publications/PPSER/NYSERDA/tmd-report-2016jun.pdf

9.4.1 Comparison with EPIC

In addition to providing monthly reports to their CAM, EPIC grantees are required to submit annual and final reports. This level of reporting is similar to the peer RD&D programs. Like the peer RD&D programs, the metrics reported by EPIC grantees depend on the focus of the individual projects, which vary by technology, research area and other factors. To date, EPIC has not provided a summary of findings across the entire portfolio, due, in part, to the wide-ranging research and technology areas. This evaluation is the first program-wide assessment, and since so few projects have been completed, we were not able to make a definitive assessment of project results and benefits and effectiveness of processes to measure and disseminate them. Table 52 below provides a comparison in these areas between EPIC and the peer RD&D programs.

Table 52: Best Practices Comparison of EPIC and Peer RD&D Programs

Peer RD&D Programs	Current EPIC Practice	Comments
Formally track program-wide metrics	EPIC does not do this.	EPIC should develop a set of common, high-level metrics based on technology type and/or policy area.
Require regular progress reports (monthly or quarterly)	EPIC does this.	EPIC currently requires regular project status reports.
Use third-party evaluation to assess program impact	EPIC does this.	The CPUC has commissioned its first evaluation of EPIC.

10 Policy Alignment and Project Impacts

This section examines the wider impact of the EPIC projects beyond the program administration, investment planning, project selection, and project assessment topics discussed in previous sections. Specifically, this section addresses the fifth and final research topic area:

- **Policy Alignment and Project Impacts**: Looking beyond project- and administrator-specific considerations, what impacts does the program overall have in a wider context? This category seeks to evaluate EPIC's place in the broader innovation and policy landscape." We base these findings on the results from interviews with sampled project administrators, grantees and vendors, as well as detailed reviews of project proposals, benefits questionnaires, close-out reports and other documentation.

This section assesses the performance of Applied R&D, TD&D and Market Facilitation projects across five important big-picture areas that are sub-categories of the project impacts and policy alignment research topic area:

1. **Policy Alignment** – we explored how well EPIC projects are integrated into the broader innovation[74] and policy landscape and support the key overarching policy goals of the State of California.
2. **Portfolio Diversity** – we examined projects by research area to determine how diverse the EPIC portfolio is in terms of the technologies it is addressing, the extent to which those technologies are expected to become commercialized, and the timing of project completion. These measures of diversity are related to the assessment of the portfolio's alignment with the state's energy policy objectives.
3. **Public Interest Focus** – we reviewed the extent to which EPIC projects meet the mandatory guiding principle to provide public benefits and benefits to electricity ratepayers.
4. **Program Equity** – we assessed the extent to which EPIC funds have been invested in disadvantaged communities, which is one of the policy areas on which the CEC has explicitly focused.
5. **Indicators of Project Performance** – based on our review of project data and interviews with CEC CAMs and grantees and IOU project managers and vendors,

[74] A product innovation is defined by the Organization for Economic Co-operation and Development (OECD) as ". . . the introduction of a good or service that is new or significantly improved with respect to its characteristic or intended uses. Product innovations can utilize new knowledge or technologies or be based on new uses or combinations of existing knowledge or technologies." X. Tinguely. *The New Geography of Innovation: Clusters, Competitiveness and Theory*. 2013.

we provided an early assessment of whether projects either are or are likely to produce their expected outcomes and impacts.

As mentioned previously in Section 6, throughout the report we have tended to present results for the CEC and all three IOUs combined due to the difference in administrative approach that we noted at the initial stages of the evaluation. However, we examined each of the four administrators' processes and projects, and found no significant or substantial differences across the three IOUs in the topics addressed in this section. Note that those comparisons were limited by the size of the project sample for each IOU, which reflects the relatively smaller portion of the EPIC budget that the IOUs receive as compared to the CEC.

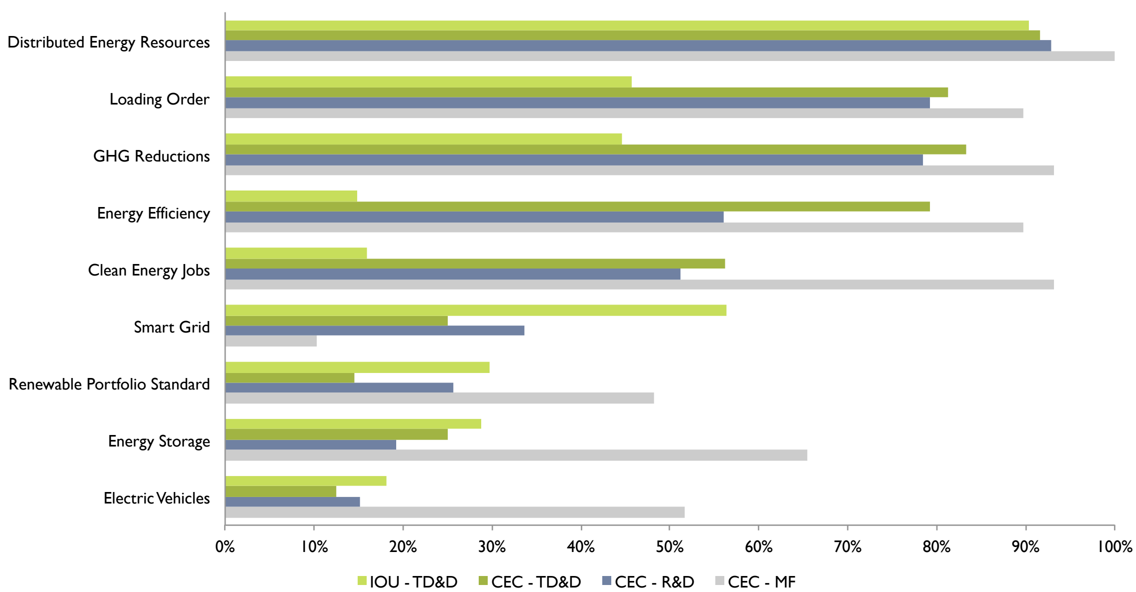
10.1 Policy Alignment

EPIC is a key element of the State of California's efforts to meet its energy policy goals. Specifically, the Program is designed to support innovation in clean energy technologies and strategies through public interest investments that will benefit California ratepayers, and drive California toward meeting its ambitious clean energy and climate policy goals while maintaining an affordable, safe and reliable energy supply. According to the administrators' EPIC 2 Investment Plans, the Program supports the following policy areas:

- **Greenhouse Gas (GHG) Reduction Legislation (SB 350)** establishing clean energy, clean air and GHG reduction goals for 2030 and beyond;
- The **Renewable Portfolio Standard** requiring retail sellers and publicly owned utilities to procure 50 percent of their electricity from eligible renewable energy resources by 2030;
- **Grid Infrastructure (Smart Grid)** upgrades necessary to the state's existing transmission and distribution systems. SB17 mandates implementing and planning a smart grid to improve efficiency, reliability, economics and sustainability of electricity services;
- **Energy Efficiency and the Loading Order** that provides a foundation for energy resource procurement policies, and consists of decreasing demand through energy efficiency and demand response, and meeting new generation first with renewable and distributed generation resources;
- Optimal portfolio integration of **Distributed Energy Resources** to achieve the state's GHG goals and meet the challenge of renewable integration; and
- **Governor Brown's Clean Energy Jobs Plan** to produce a half a million clean energy jobs in the next ten years.

In Section 7, we provided a portfolio-level analysis of project alignment with the above policy goals indicating that to a large extent, the EPIC program portfolio addresses each of the California policy goals. At the program-area level, we see similar trends across the policy areas, as shown in Figure 20. TD&D project funding is largely aligned with addressing issues that support the integration of distributed energy resources as well as the loading order and GHG reduction policies. We do see a differing emphasis in project type between CEC and IOU TD&D projects, with CEC TD&D projects more focused on the loading order, GHG reductions and energy efficiency, while IOU projects have a greater emphasis on grid infrastructure (Smart Grid), and meeting the Renewable Portfolio Standard. Applied R&D has a similar alignment, with somewhat more funding allocated to these areas. Market Facilitation projects most closely align with distributed energy resources, loading order, GHG reductions, energy efficiency and clean energy jobs. Relatively fewer Market Facilitation projects address the Smart Grid research area.

Figure 20: Research Area Alignment with California Policies



Our analysis shows that many projects effectively address more than one of these principles and policy goals. In particular, projects that aimed to increase end-user adoption of energy efficiency measures or overcome technical barriers to the end-user adoption of distributed generation also addressed other areas such as reducing GHG emissions and meeting requirements of the Renewable Portfolio Standard (RPS). Additionally, the Regional Energy Innovation Cluster projects align with numerous policy objectives including GHG reduction, the loading order and clean energy jobs. However, other projects, such as a study of the effective placement of fast-charging stations, may have strong GHG reduction, health and safety benefits (associated with air pollution reduction) and other environmental benefits, but they do not necessarily address other policy areas such as energy use reductions or the loading order.

It is not surprising to find some differences between the CEC and the IOUs with respect to their TD&D projects. For example, the IOUs have a greater focus on projects that address smart grid, RPS, energy storage and electric vehicle (EV) policies. This makes sense since these types of projects are the ones that would have the greatest impact on the electric systems of the IOUs.

In Section 11, we recommend that the CPUC establish priorities among the many energy policy goals. This analysis serves to provide a current snapshot of how EPIC projects are supporting policy. We also recommend that the administrators categorize projects by technology areas and policy goals to support future analyses and project reporting to ensure priorities are being adequately addressed.

10.2 Project Diversity

To achieve EPIC's objectives and support numerous energy policy goals requires a diverse portfolio. Below, we characterize the diversity of the EPIC portfolio in terms of the types of technologies and studies, their commercialization status and the timing of projects. This type of examination is useful to inform how well the EPIC project portfolio is aligned with the highest priority policy objectives and how it can be used to support the development of priorities and inform adjustments to future investment plan strategies.

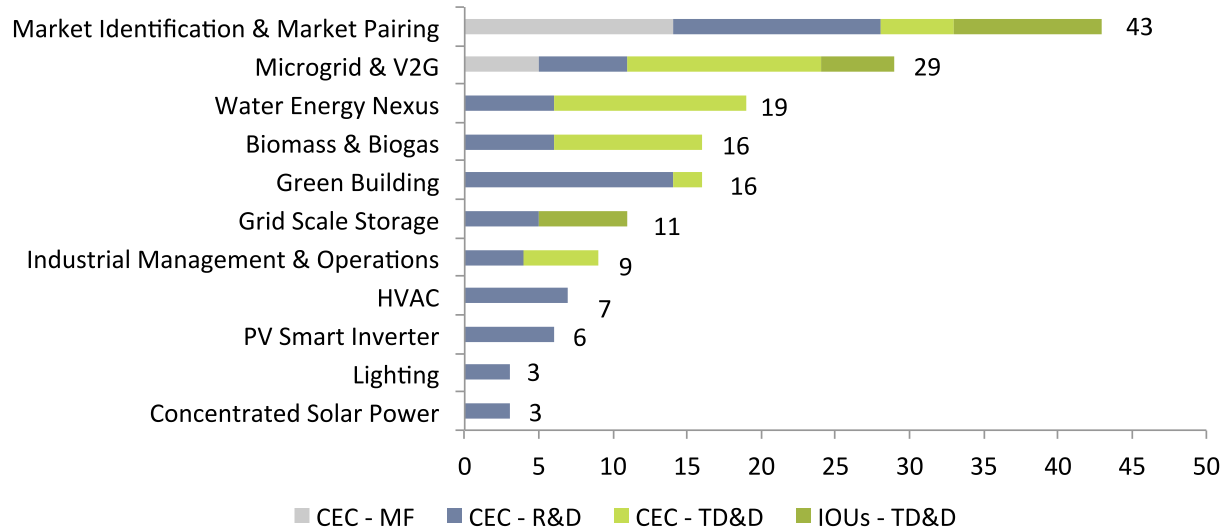
10.2.1 Technology and Study Characterization

Through examining project-level publications and analyzing administrator and grantee interviews, we developed an assessment of the technology types and study topics that each program area serves. This categorization identifies the primary technology types that are directly impacted through successful project implementation. However, not all projects include development of discrete technologies or processes, with many projects instead focusing on sociological or grid-operation studies. We split the 296 projects into two groups:

1. Projects that produce discrete identifiable technologies or develop market identification or market pairing opportunities for discrete technologies; and
2. Projects with broader focus on groups of technologies, or that develop methodologies, or sociological or grid-operation studies.

Figure 21 summarizes the first group (n=162), by technology, administrator and program area.

Figure 21: Project Outputs - Technology by Administrator and Program Area (n=162)

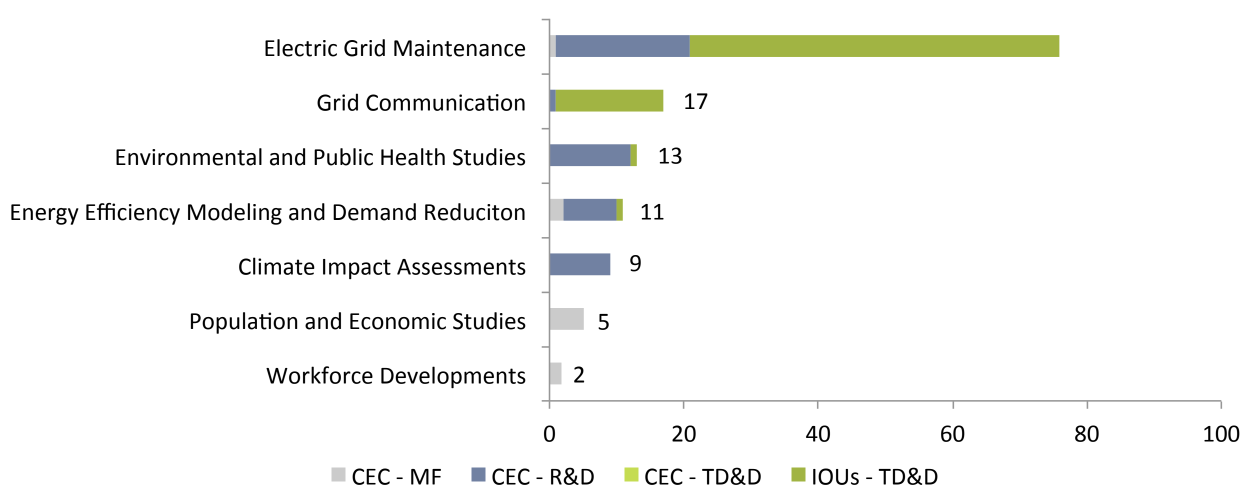


Source: Administrators' 2016 Annual Reports

Of these projects, about 27 percent of the projects are *Market Identification & Market Pairing* types of projects that focus on sociological or grid-operation studies while the remaining 73 percent of the projects focus on discrete identifiable technologies. One can also see that the IOU TD&D portfolio in this group is comprised entirely of *Market Identification & Market Pairing* and *Microgrid & V2G* projects while the CEC TD&D portfolio is much broader. Only the CPUC can decide whether these distributions are optimal.

Figure 22 summarizes the second group (n=133), by general project type, administrator and program area.

Figure 22: Project Outputs - General Project Type, by Administrator and Program Area (n=133)



Of these projects, about 70 percent focus on electric grid maintenance and grid communication types of projects, of which the IOUs are responsible for the vast majority. Again, only the CPUC can decide whether these distributions are optimal.

Table 53 provides additional detail regarding the types of Market Facilitation projects, all of which are active.

Table 53: Types and Frequency of Market Facilitation Projects

Types of Projects	Frequency
Fostering Commercialization	4
Facilitating Procurement	0
Enhancing Permitting	14
Market & Technical Analysis	9
Other*	3
Total	**30**

*The evaluation team included one project funded through Applied R&D, but included it in this area since its activities are more aligned with the Market Facilitation strategic goals.

These Market Facilitation projects are clearly consistent with the aim of addressing non-technical barriers. As one can see, projects aimed at enhancing permitting and market and technical analysis predominate, thus far. Also note that while there are no projects that are aimed primarily at facilitating procurement, there are projects that include procurement as a component (e.g., EPC 15-065: Berkeley Energy Assurance Transformation (BEAT) Project).

Similar to the policy area analysis presented earlier in this section, analysis of projects by technology can inform an assessment of how well EPIC projects are supporting Program and state policy goals.

10.2.2 Commercialization Status

Another way to characterize EPIC project portfolio diversity is by assessing the Applied R&D and TD&D projects with respect to their commercialization status: intent to commercialize versus no intent to commercialize.[75] Assigning each project to one of these

[75] Commercialization is not an issue for Market Facilitation projects since only two grantees indicated that they did not plan to commercialize their product.

two categories is more challenging that the earlier assignment of projects to technology and study types.

We begin by noting that in the CEC Triennial Investment Plan, the mission of Applied R&D and TD&D is to address gaps in the funding necessary to help innovative energy technologies and approaches bridge the "Technological Valley of Death" (TVD) and "Commercialization Valley of Death," (CVD) respectively (Jenkins and Mansur 2011).

- The TVD occurs early in the development of a technology, as breakthrough research and technological concepts aim to achieve commercial proof-of-concept. At this stage, innovators and entrepreneurs conducting basic and applied research need further capital to undergo a process of developing, testing and refining their technologies in order to prove to private funders that these technologies will be viable in markets beyond initial success in the laboratory. However, private investors are typically reluctant to fund such early-stage research and product development, largely due to the high technical, market and management execution related risks and long development horizons associated with as-yet-unproven technological concepts. As a result, many entrepreneurial start-up firms and research laboratories fail to accumulate the necessary capital to see their innovative research concepts translated into commercial products and ventures.
- The CVD exists between the pilot/demonstration and commercialization phases of the technological development cycle and aligns with a gap between the traditional role of venture capital and the later stage investments of project finance and debt/equity investors. Demonstrations of multiple, integrated demand-side management technologies are required to document the synergies, overall economics and other benefits of combining technologies that would result in the greatest ratepayer benefits. These demonstrations are especially necessary to establish the right mix of technologies for particular applications, document technical and economic feasibility, and minimize risk to building owners/operators. Public funding for demonstrations to bridge the CVD is essential. The private sector does not typically conduct applied research and is risk-averse regarding new, unproven technologies, often lacking the resources to analyze and evaluate various technologies. Frequently, new technologies are developed in academic communities that do not have the funding for large-scale demonstrations. Typically, the private sector only offers funding after a successful field demonstration.

This orientation suggests that the goal of all projects is eventual commercialization of one or more technologies. However, the diversity of EPIC Applied R&D and TD&D projects is more complex and nuanced than this mission suggests. Based on project-level data provided in the Annual Reports, and interviews with grantees and administrators, we assigned each project in the Applied R&D portfolio to one of two categories described below:[76]

1. **Commercialization**: Projects that either:
   a. Develop discrete new technologies or tools for which the goal is commercialization; or
   b. Investigate a combination of commercially available technologies within a discrete service or innovative platform that qualifies as a unique and innovative product for commercialization.

In the case of *a.*, developing discrete new technologies, the path to commercialization entails the successful development of the technology or technologies (with EPIC support) leading to the eventual availability of the technology or technologies in the market as either a business-to-business or business-to-consumer product or service. For example, EPC-15-057 "Customer-controlled Price-mediated, Automated Demand Response for Commercial Buildings" (an Applied R&D project) is developing an end-user tool to manage small commercial energy consumption, for eventual sale to customers. Another example is EPC-14-065 "Demonstration of Forward Osmosis to Produce Juice Concentrate, Purify and Reuse Wastewater and Reduce Energy Use" (a TD&D project) which is demonstrating a new technology innovation to reduce the energy, chemicals and maintenance required for food and beverage processing and waste concentration.

In the case of *b.*, combining commercially available technologies, the path to commercialization entails project teams combining existing technologies in an innovative new way that constitutes a new product, and developing this product (with EPIC support) to the point it is available in the market as either a business-to-business or business-to-consumer product or service. An example of this type of project is EPC-15-074 "Meeting Customer and Supply-side Market Needs with Electrical and Thermal Storage, Solar, Energy Efficiency and Integrated Load Management Systems" (an Applied R&D Project), which involves the packaging of efficiency products into a services platform for small-commercial retrofits or the development of a packaged combined energy storage/Distributed Energy Resources (DER) platform for end-use consumers. Another example is EPC-15-042 (a TD&D project), the ZERO-CA demonstration project that will serve as proof of concept for large-scale deployment of Zero Net Energy (ZNE) single-family homes in California. The product, in this case, that is being commercialized is the ZNE home.

[76] While others might develop a somewhat different classification scheme, we believe that the basic conclusion would remain the same: *the EPIC portfolio is quite diverse with respect to its commercialization status*. Of course, an even more complex typology could have been developed, but this relatively simple typology adequately conveys the basic message.

2. **Non-Commercialization**: Projects can include innovative methodologies, tools or other processes that open new opportunities for deploying existing technology, or help users understand the potential applications and risks of deploying existing technology in new ways. For example, EPC-14-069 "Develop Analytical Tools and Technologies to Plan for and Minimize the Impacts of Climate Change on the Electricity System" (an Applied R&D project) will advance the understanding of key parameters of long-term energy scenarios and GHG abatement options in the California energy system. This project will achieve this by further developing detailed scenarios and modeling capabilities of the California electricity sector, as well as interactions between the electricity sector and other sectors, and by exploring the implications of particular policy choices on the electricity system in the medium (2020-2030) and long term (2050). Wider adoption of this public-domain software by other planning organizations in other jurisdictions is the goal rather than commercialization. Another example is SCE Project 7 (a TD&D project) which will demonstrate a Substation Level Voltage Control (SLVC) unit working with a transmission control center Supervisory Central Voltage Coordinator (SCVC) unit to monitor and control substation voltage. The technical details of how this project was designed and implemented will be made available in the public domain so that other utilities can adapt it to their own systems.

In Table 54, we show the results of our analysis for Applied R&D projects.

Table 54: Commercialization Status for Applied R&D Projects

Commercialization Status	CEC
Goal: Commercialization	49
Goal: No Commercialization	72
Total	**121**

This analysis shows that 60 percent of the Applied R&D projects are being developed for the public domain rather than for commercialization. Their goal of such projects is not profit but the wider adoption of existing and new technologies and tools to solve problems in order to advance key policy objectives.

In Table 55, we show the results of our analysis for TD&D projects.

Table 55: Commercialization Status for TD&D Projects

Commercialization Status	CEC	PG&E	SCE	SDG&E	Total
Goal: Commercialization	44	1	2	0	47
Goal: No Commercialization	4	33	23	11	71
Total	48	34	25	11	118

One obvious pattern is that about 92 percent of the CEC projects have commercialization as a goal, while only 4 percent of the IOU projects have this as a goal. Traditionally, public funding for demonstrations is described as essential for bridging the CVD. However, as was also the case for the Applied R&D program area, we see that public support for TD&D projects should not be understood as strictly devoted to the commercialization of new technologies but also to the wider adoption of existing and new technologies and tools that can produce important benefits such as improved planning and grid reliability.

This diversity of projects with respect to technologies and studies and commercialization is consistent with the CPUC's directive to support clean energy technologies and approaches for the benefit of (IOU) ratepayers, with projects directly developing new clean energy technologies; packaging existing technologies into innovative bundles to address a new problem; or developing new processes, tools or methods to promote existing technology adoption in direct or indirect ways that will be added to the public domain. The question is whether this current EPIC portfolio contains the optimal mix of projects with respect to technology and study types and commercialization. However, determining whether this is the optimal mix would require that the CPUC prioritize its policy objectives. The CPUC can then compare the policies supported by the EPIC portfolio to determine the extent to which they align with these priorities in terms of budgets and expected benefits. To the extent it does not align well, the CPUC can then recommend changes in the types of technologies and studies and the proportion of projects that are intended to be commercialized.

10.2.3 Schedule of Project Results

We analyzed the EPIC 1 and EPIC 2 portfolio (collectively spanning years 2012–2017) in terms of the average time required to complete a project, the number of active and completed projects, and the number of active projects expected to be completed in future years. The timing of project completion may be an important consideration when project results are critical to supporting time sensitive energy policy decisions. Table 56 presents the results for Applied R&D and Market Facilitation projects. Note that the majority will be completed in 2019 or later.

Table 56: Project Status for Applied R&D and Market Facilitation Projects

Program Area	Mean Time to Completion (yrs.)	Completed	Due End of 2017	Due End of 2018	Due 2019+
Applied R&D	3.3	1	7	35	82
Market Facilitation	2.9	0	2	17	10

On average, Applied R&D projects take an average of 3.3 years to complete from the time they are launched. There is one completed Applied R&D project, and seven that have a projected completion date at the end of 2017, while an additional 35 projects have a scheduled completion date at the end of 2018. Market Facilitation projects are expected to take an average of 2.9 years to complete. Through the end of 2017, only two Market Facilitation projects are projected to be completed, while an additional 17 are scheduled to be completed by the end of 2018.

Table 57 presents the results for TD&D projects. The majority of IOU projects are either completed or scheduled to be completed by the end of 2017, while the majority of CEC TD&D projects will be completed in 2019 or later.

Table 57: Project Status for TD&D Projects

Administrator	Mean Time to Completion (yrs.)	Completed	Due End of 2017	Due End of 2018	Due 2019+
CEC	3.5	0	0	16	32
PG&E*	2.6	14	10	9	1
SDG&E	2.4	0	11	0	0
SCE	4.1	4	10	6	2

* There are an additional 21 PG&E projects that are "on-hold."

On average, CEC TD&D projects are expected to take an average of 3.5 years to complete, slightly more time than Applied R&D and Market Facilitation projects. The IOU TD&D projects have taken or are expected to take an average of 2.7 years to complete, slightly less time than Applied R&D and Market Facilitation projects.

Of the 48 active CEC TD&D projects, none are projected to be completed by the end of 2017. CEC projects on average start later than IOU projects since the CEC uses a solicitation process (which introduces additional time), and they take about nine months longer to complete, once launched.

What emerges from this analysis is that the diversity of projects with respect to technologies, commercialization and timing of results in the EPIC portfolio that has been formed by the four administrators adequately addresses the multiple policy goals. However, whether each administrator is expending the right level of effort to address each of these policy goals, delivering project results quickly enough and bringing important innovations to market or the public domain cannot be determined until these policies are prioritized. It is also clear that portfolio optimization is an on-going process that must respond to changing priorities and budgets in a rapidly changing technological and environmental landscape.

10.3 Public Interest Focus

One of EPIC's guiding principles, specified in the foundational EPIC program Decisions, is to provide public benefits to electricity ratepayers in the form of greater reliability, lower costs and increased safety.[77] To address this public interest focus, the evaluation team reviewed the portfolio of projects and closely examined the sample of 54 projects to ascertain:

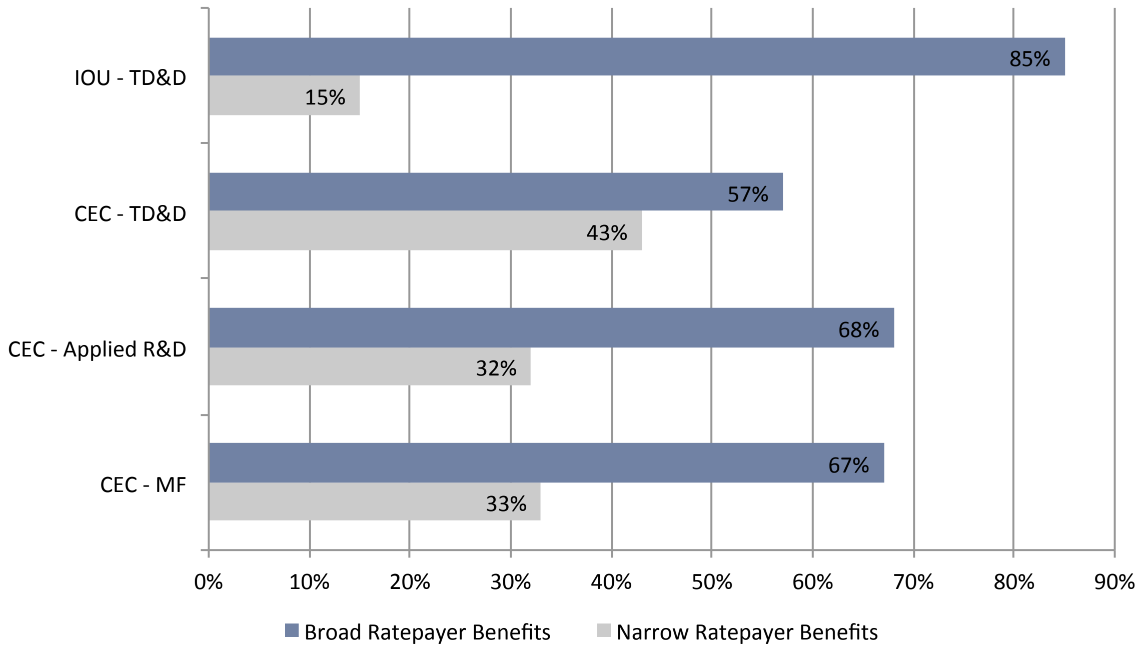
- To what extent were projects selected to provide broader public interest benefits?
- To what extent did projects propose work that could not be or was not being conducted by the competitive market at the time it was funded?

10.3.1 Broad Public Benefits

Using the same approach described in Section 7.1 to assess program alignment with guiding principles and policy goals, we assessed the potential for ratepayer benefits by investment area. All EPIC projects are designed and selected to provide ratepayer benefits, as mandated by the CPUC. We reviewed the types of benefits that would accrue to ratepayers, and categorized them as either providing direct benefits to all ratepayers (broad benefits) or initial benefits to a smaller subset of ratepayers such as EV owners or grid-system operators, with greater societal benefits in the longer term (narrow benefits). Figure 23 shows the results of our assessment. A high percentage of Applied R&D, Market Facilitation and IOU TD&D projects meet the criteria for broad benefits such as providing societal benefits and supporting the loading order. A smaller fraction of CEC TD&D projects meet the criteria for broad benefits.

[77] D.12-05-037

Figure 23: EPIC Funding by Ratepayer Benefit, by Program Area



We cannot say whether each administrator is expending the right level of effort addressing broad versus narrow ratepayer benefits. The CPUC should explore more deeply the cost and benefits of broad versus narrow benefits and the optimal proportions of each. This type of project-level analysis is similar to the policy alignment and project diversity analyses we presented previously. These analyses provide a current snapshot of how projects are fulfilling various Program and policy goals and the diversity of the portfolio with respect to technologies addressed and timing of project results. These analyses may be revisited at a later date to support future investment planning efforts and the setting and revising of priorities.

10.3.2 Net Public Benefits

It is critical that EPIC produces benefits that would not have been realized otherwise, i.e., to some extent, these benefits must be attributable to EPIC. Establishing a causal link between EPIC-funded activities and measureable changes in metrics associated with the mid- and long-term outcomes begins with how projects were selected for funding. The prudent expenditure of EPIC funds requires that they be targeted at technologies and tools that, absent EPIC funding, would not survive the TVD or the CVD or have their progress to market significantly slowed, and at studies that produce new knowledge. To assess the extent to which this is the case, we asked project personnel whether, absent EPIC funding, their projects would not have been done or would at least have been delayed. Across the three program areas, there is good evidence that EPIC is investing in sound projects that have no other source(s) of available funding. Below, we provide more details regarding our results.

We begin by repeating that approximately 40 percent of the grantees of the CEC Applied R&D portfolio and 92 percent of the grantees of the CEC TD&D projects intend to commercialize their products, while about 4 percent of IOU project managers of TD&D projects intend to commercialize their products. It is for these projects that the TVD and CVD pose a threat. For projects in which the goal is commercialization, we interviewed a sample of Applied R&D and TD&D grantees as well as IOU project managers of TD&D projects and asked whether, absent EPIC funding, their project would have fallen into the TVD or the CVD. For the Market Facilitation projects, for which there is almost never any intent to commercialize, we asked project managers whether the results expected from their projects are currently available from other sources, i.e., whether their research unnecessarily duplicates existing research.

With few exceptions, Applied R&D and TD&D grantees and IOU TD&D project managers indicated that their projects would have fallen into one of the two Valleys of Death or their progress toward commercialization would be slowed. Nearly all of the Market Facilitation grantees indicated that the expected results of their projects were not currently available. Clearly, CEC grantees and IOU project managers felt that EPIC funding is necessary, although not sufficient, for their projects to be commercialized.

The issues of whether, absent EPIC funding, a technology or tool would likely fall into the TVD or CVD or whether the expected results are already available from other sources were also assessed as part of the investment planning process and during the proposal review process.

During the investment planning process, the CEC develops expert- and stakeholder-driven documents, referred to as research roadmaps, which provide strategic guidance on prioritizing funding initiatives. These roadmaps summarize current research, data gaps, connections to state policy, potential impact by cost, urgency and timeliness of outcomes, and potential partnerships with other funding entities. As part of the 2015-2017 EPIC Investment Plan development process, the CEC used the numerous research roadmaps as well as U.S. Department of Energy (DOE) roadmaps to identify gaps and funding opportunities. For example, the gaps analysis in the Plug-in Hybrid Electric Vehicle Research Roadmap (CEC-500-2010-039) found an abundance of basic chemical and battery formatting research conducted by battery manufacturers but minimal research into the second use of batteries after the primary vehicle application.

In addition, the CEC reviewers (some of whom are third-party reviewers) require bidders to justify their projects based on market forecasts and penetration estimates, and provide a compelling argument why EPIC funds are needed (i.e., bidders need to justify the need for EPIC funding, including an explanation of why the proposed work is not adequately supported by competitive or regulated markets). Bidders who cannot justify the need for EPIC funds are much less likely to be successful in obtaining an EPIC grant.

In addition, the framework established by the CPUC within which the IOUs operate helps to ensure that IOU TD&D projects would not be done absent EPIC funding:

> "For activities that are more related to technology demonstration and deployment on the grid, as technologies and approaches move toward commercialization, utilities may be better suited to administer the funding, as they point out, since they own the infrastructure on which or through which the technologies will be tested. They also may ultimately become the consumers of technologies or processes that are designed to improve utility systems, so it will behoove them to invest in and test some new ideas."[78]

It is in the interest of each IOU to find new technologies or combinations of existing technologies that address the unique needs of their electric system (and the needs of other utilities both inside and outside California that could possibly adapt them). Each IOU is also motivated to assess whether the technologies and tools that address their particular problem currently exist. If they do not exist, then the IOUs are far more likely than anybody else to investigate these new technologies and tools (i.e., in the current framework, absent EPIC funding, it is unlikely that these TD&D projects will be conducted). The Decision also ordered that EPIC would be the primary venue for the IOUs' RD&D expenditures other than RD&D proposed by IOUs as part of their budget applications for energy efficiency and demand response. The IOUs can request separate funding for electric RD&D in their energy efficiency and demand response budget applications, but they are required to justify why such expenditures could not have been considered within EPIC. To date, separate funding has never been requested.

In summary, the various planning documents and CPUC Decisions combined with the comments from the CEC administrators and TD&D grantees as well as the IOU administrators and TD&D project managers support the conclusion that due diligence is being done to identify projects that, absent EPIC funding, would not move forward or move forward more slowly. Again, this is a necessary but not sufficient condition for establishing a causal connection between EPIC-funding activities and any measureable changes in metrics associated with the mid- and long-term outcomes. The probability that these outcomes will eventually be achieved will increase substantially only through the combination of successfully designed and implemented EPIC projects and the diffusion of

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[78] CPUC. *Phase 2 Decision Establishing Purposes and Governance for Electric Program Investment Charge and Establishing Funding Collections for 2013-2020*. 2012. http://docs.cpuc.ca.gov/word_pdf/FINAL_DECISION/167664.pdf, p. 27

these technologies and tools over time in their targeted markets. Of course, a more complete case for attribution must be built on an on-going, theory-driven evaluation that, based on the preponderance of the evidence, will assess the extent to which these mid- and long-term outcomes have been achieved and the extent to which EPIC is responsible for any of these achievements, and whether the preponderance of the evidence suggests that the benefits of EPIC exceed its costs.

10.4 Program Equity

We reviewed program equity in terms of EPIC projects providing benefits or services to disadvantaged communities. The CEC has an explicit goal of assisting disadvantaged communities as stated in its formal Diversity Policy Resolution adopted in April of 2015. Figure 24 below shows the proportion of each CEC investment area that serves disadvantaged communities in some capacity. Seventeen percent of CEC TD&D projects serve disadvantaged communities to some extent, followed by 8 percent of Applied R&D projects and 3 percent of Market Facilitation projects.

Figure 24: Percentage of CEC Projects that Serve Disadvantaged Communities

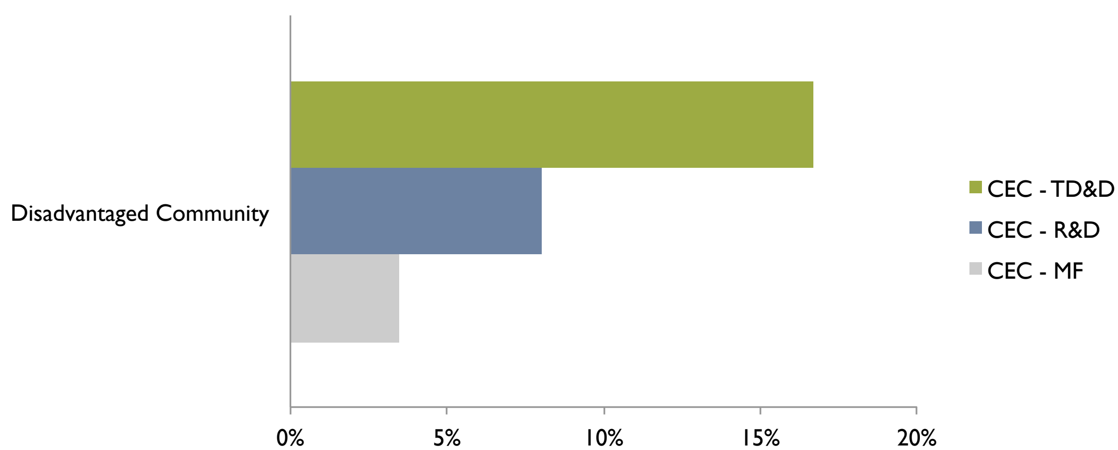
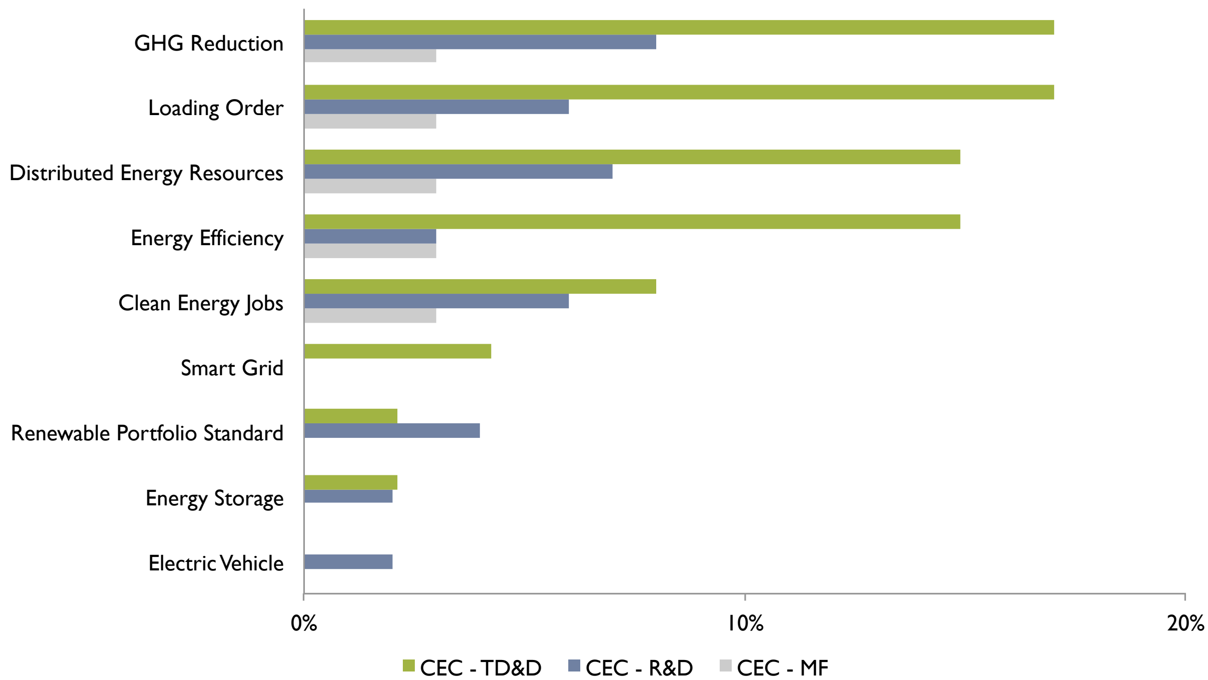


Figure 25 below shows the proportion of each CEC research area that serves disadvantaged communities by California policy goals. All Applied R&D, TD&D, and Market Facilitation projects that are serving disadvantaged communities are also aligned with meeting GHG reduction and the loading order policy goals. A small percentage of projects serve disadvantaged communities within the Electric Vehicle and Energy Storage California policy goals, with 4 percent of Applied R&D projects and 2 percent of TD&D projects including these communities in some capacity.

Figure 25: Percentage of CEC Projects that Serve Disadvantaged Communities by California Policy Goals



CEC programs can have both direct and indirect benefits to disadvantaged communities. We reviewed annual reports, program documentation and interviewed administrators and grantees to understand how specific projects were targeted to directly or indirectly benefit disadvantaged communities and whether they have thus far been successful. Below, we provide two examples of projects that are intended to provide benefits to disadvantaged communities among the 54 sampled projects:

- The stated goals of EPC-15-010 were to recruit workers from disadvantaged communities into an apprenticeship program, and provide them with comprehensive classroom and on-the-job training on the installation and maintenance of AutoDR communications equipment. The project aims to pilot a new California Advanced Lighting Controls Training Program course focused on installation and maintenance of AutoDR communications equipment for lighting applications and will recruit small and medium buildings located in disadvantaged communities to serve as on-the-job training sites for the apprentices enrolled in the program. While the project is at an early stage, the administrator and grantee are pleased with the progress of the project and noted successes with early recruitment of apprentices and developing the training curriculum. In addition, the project serves communities designated as disadvantaged communities using CalEnviroScreen.[79]

- EPIC-14-029 intends to convert dairy manure into biogas and store the biogas under an inflatable cover. The biogas will be converted into renewable electricity anticipated for sale and delivered to the PG&E distribution grid through a Bioenergy Feed-in Tariff. Furthermore, dairy biogas systems qualify for participation in the CPUC's Assembly Bill (AB) 2514 electricity storage program. In a future phase, the biogas system may compete for an energy storage contract. Among other benefits, this project is expected to reduce GHG and improve the quality of groundwater, both of which affect disadvantaged communities. The project also serves communities designated as disadvantaged communities using CalEnviroScreen.
- EPIC-14-027 is demonstrating a pre-commercial flow battery storage control system at a Regional Wastewater Treatment Plant located in a disadvantaged community as designated using CalEnviroScreen. The expected benefits of the project align with policies around energy storage, GHG reduction and clean energy job provision all of which, if realized, can provide tangible benefits to disadvantaged communities.

Although the IOUs do not have an explicit goal of assisting disadvantaged communities, their projects nevertheless benefit them. When we asked the IOU program management teams about whether they may add a focus on disadvantaged communities in future EPIC Investment Plans, they indicated that the nature of their TD&D projects does not lend itself to a focus on a specific community. For example, because their projects are usually conducted in-house, they do not lead to localized job creation which could generate benefits to a disadvantaged community. Rather, their projects are intended to benefit their whole service territory, including disadvantaged communities, through improvements to the grid that make it easier to incorporate distributed energy resources. Based on our examination of the IOUs' projects, we agree with their assessment. The IOUs added that some of their other (non-EPIC) initiatives, such as the ratepayer-funded Local Government Partnerships, focus on providing services to disadvantaged communities.

We have provided some initial, baseline measurements of how well the CEC projects are supporting disadvantaged communities, one of the state's key policy goals. Such measurements can be repeated to assess progress over time. Moreover, the CEC intends to focus even more on this issue in the future. Given this, the CPUC might choose to set a goal with respect to serving disadvantaged communities.

[79] CalEnviroScreen is a tool developed by CalEPA to designate California communities as disadvantaged pursuant to Senate Bill 535. The tool was used to help identify California communities that are disproportionately burdened by multiple sources of pollution.

10.5 Indicators of Project Performance

Based on a detailed review of our sampled projects (including project data and telephone interviews), this sub-section summarizes the performance of each of the three program areas. Guided by the logic models we developed (see Sections 13.2, 13,3, and 13.4 for more details), we collected and analyzed data related to the project activities, outputs and short-term outcomes to assess, using the preponderance of evidence approach, the extent to which the Program is on track to achieve its mid- and long-term outcomes. In Sections 13.2, 13.3 and 13.4, we explicitly link our more detailed results to the specific boxes that describe the activities, outputs and outcomes of each logic model so that one can better assess the extent to which the collection of hypothesized causal linkages is functioning as expected (e.g., is a given activity leading to the expected output and are the expected outputs leading thus far to the expected outcomes). As C. H. Weiss notes: "If the evaluation can show a series of micro-steps that lead from inputs to outcomes, then causal attribution for all practical purposes seems to be within reach."[80] In other words, is EPIC on track to produce benefits beyond what would have happened anyway? Please see Appendix E for more detailed results from our review of project performance.

10.5.1 Applied R&D Projects

Our review of a sample of Applied R&D projects suggests that this part of EPIC's portfolio is progressing toward the ultimate goal of furthering the adoption of innovation and technology advancement related to clean energy. Existing projects appear headed toward successful completion or are on track to investigating the research questions at hand. However, we do note that progress is taking time, as most EPIC Applied R&D projects are multi-year research efforts, and none are yet completed. Hence, even as we hear that technology is changing rapidly, advancement of EPIC-supported technology is measured in years, not months.

It is also apparent that EPIC-supported research does not always match the program logic assumption that technologies start as an Applied R&D project, proceed to TD&D, and, with the support of Market Facilitation projects, eventually make it to market. While many EPIC-supported research efforts do involve privately developed technologies that are intended to be commercialized, some will result in tools or information that will be available in the public domain and others are supportive of existing technologies. Hence, the path toward technology adoption varies by project. Furthermore, even among the commercialized technologies, the path toward commercialization is not always linear, and some projects will require additional research while others appear poised for commercialization even without additional EPIC involvement.

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[80] C.H. Weiss, "Theory-based Evaluation: Past, Present and Future," in *Progress and Future Directions in Evaluation: Perspectives on Theory, Practice and Methods*, eds. D.J. Rog & D. Fournier (1997), 41-55.

Overall, when viewed as a portfolio, EPIC's Applied R&D projects do show movement toward knowledge and awareness among potential users, follow-on research and development, technology demonstrations, potential private investment, patents and early adoption. However, some of these projects are unable to show such progress since they are in their early stages.

10.5.2 TD&D Projects

Since 78 percent of the TD&D projects are still active, our primary focus was on the outputs and short-term outcomes, which are considered to be leading indicators of whether the TD&D projects are on track to contribute to the achievement of the mid- and long-term objectives.

The data collected from our sample of the nine completed IOU projects indicate that they have met their technical targets, verified their expected benefits, gained knowledge, and increased their confidence in the performance of the technology. For the active IOU projects and for many of the CEC projects, nearly all of the project teams felt that thus far they are on track to be as successful as the completed projects. For the active and completed projects, the knowledge that has been gained is being reported in mostly monthly progress reports or final reports and is being used by the Commission Agreement Managers (CAMs), members of the TACs, IOU project managers, and other organizations apart from the EPIC project teams. However, while patents, copyrights and licenses are important indicators that knowledge is being produced, none were reported. It should be noted that many of these projects were in mid-cycle development, and it was determined that any patents, copyrights and licenses, if they were to occur, would likely take place near the end of a project and prior to technology dissemination activities.

For those projects for which commercialization is the goal, most project teams felt that, absent EPIC funding, their technologies would have fallen into the CVD. Some reported that while it would not have fallen into the CVD, EPIC funding was able to accelerate its development, which is still an important benefit. Respondents also indicated some level of understanding of their respective markets, while many of the CEC CAMs indicated that it was too soon to tell. In general, respondents felt that their projects were scalable, cost-effective at commercial scale, and commercially viable. Nevertheless, very few grantees have met with interested parties to form partnerships, and only one has actually added a partner. In addition, none of the grantees reported that they had discussed possible acquisition of their company with any manufacturers or venture capital firms. Of the 22 projects with the goal of eventual commercialization, six project teams indicated that new manufacturers had entered the market, which is a strong indicator of potential demand and profitability.

In general, the TD&D portfolio appears to be on track, thus far, in meeting its short-, mid- and long-terms objectives. However, we also observed some interesting differences between the CEC and IOU TD&D projects that merit mentioning. More specifically, there are substantial differences with respect to whether there is an intent to commercialize the technology being investigated, the types of technologies being investigated, and follow-on TD&D research.

Differences by Administrator

In this section, we present the differences we observed between the CEC and IOU projects. There are substantial differences with respect to whether there is intent to commercialize the technology being investigated. Of the CEC projects, 95 percent have commercialization as the goal, while only 4 percent of the IOU projects have this as a goal. For those projects for which commercialization is the goal, most felt that, absent EPIC funding, they would have fallen into the CVD. Others reported that while it would not have fallen into the CVD, EPIC funding was able to accelerate its development, which is still an important benefit. Respondents also indicated some level of understanding of their respective markets while many of the CEC CAMs indicated that it was too soon to tell. In general, respondents felt that their projects were scalable, cost-effective at commercial scale, and commercially viable. Nevertheless, very few grantees have met with interested parties to form partnerships, and only one has actually added a partner. In addition, none of the grantees reported that they had discussed possible acquisition of their company with any manufacturers or venture capital firms. More information about the performance of the technology might be needed before talking to potential partners and investors. That these projects are new might also explain to some extent why none of the projects reported any activity with respect to patent, copyrights and licenses.

Another interesting difference is that about 83 percent of the IOU projects address *grid communications and interactivity* and *grid maintenance, optimization, planning and management,* while none of the CEC projects address these topics. While ideas for projects originate from multiple sources including their own staff, the staff of the other IOUs, EPIC, manufacturers, government laboratories such as LBNL, the DOE and universities, these ideas are organized by the IOU joint framework that includes four investment areas (all within the TD&D area) that the IOUs have mapped to the electric system value chain as follows:

- Cross-Cutting/Foundational Strategies and Technologies – maps across the electric value chain.
- Customer Service and Enablement – maps to demand-side management (DSM)
- Grid Modernization and Optimization – maps to transmission and distribution (T&D)
- Renewables and Distributed Energy Resources (DER) Integration – maps to grid operations/market design

This framework is what one should expect from the utilities that are confronted every day with a set of very specific challenges related to their grids, while the CEC has a much broader focus. When prompted, each IOU noted that, while their projects are narrowly targeted toward the unique needs of their systems, they are certainly relevant to the needs of the other utilities both inside and outside California. We have no comment on whether the IOU TD&D portfolios should resemble the CEC TD&D portfolio with respect to technology types (and commercialization) since this is a CPUC policy issue.

Finally, when comparing the active CEC projects with the completed IOU projects, more than half of the CEC project teams indicated that they plan to conduct additional TD&D research based on the results of their projects thus far, while nearly all of the IOU project teams indicated that they do not intend to conduct any additional TD&D research. At least some of these differences might be due to the fact that the IOU projects are more narrowly defined for a very specific application and entail less risk since they are often based on a combination of existing, commercially available components.

10.5.3 Market Facilitation Projects

Based on our review, we found that EPIC's Market Facilitation projects are clearly consistent with the aim of addressing non-technical barriers with projects aimed at enhancing permitting and market and technical analysis predominating, thus far. Also note that while there are no projects that are aimed primarily at facilitating procurement, there are projects that include procurement as a component of their project (e.g., EPC 15-065: Berkeley Energy Assurance Transformation (BEAT) Project). In addition, both the CAMs and grantees reported that their projects generally are on track to achieve their research objectives and expected benefits. Many also reported that these same benefits could be achieved if these projects were replicated in other states and jurisdictions.

We reviewed benefit questionnaires from four of seven Market Facilitation projects to identify the types of projected benefits. Three of the four projected economic benefits, and two projected energy and cost savings, environmental, and electrical system safety and reliability benefits.

However, the coordination between the Market Facilitation program area and the Applied R&D and TD&D program areas appears to be less than ideal. As mentioned earlier, interviewees were not as likely to cite the CEC Applied R&D grantees or TD&D grantees as primary audiences. Grantees were even less likely than CAMs to do so. While the reasons for this are largely a function of the timing of the EPIC portfolio, in the future, a more systematic assessment of the needs of those conducting projects that are upstream from the Market Facilitation projects should be undertaken. The CEC administrators are aware of this gap and report that they are committed to addressing it.

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11 Findings and Recommendations

In this section, we present our findings and recommendations that are based on the preponderance of evidence gathered from various sources throughout this evaluation and organized using the logic models presented in Sections 13.2, 13.3 and 13.4.

As discussed throughout this report, the CEC and IOUs have different approaches for administering EPIC. Table 58 provides a comparison of how the administrators approach various administrative processes, highlighting key differences. We also identify whether EPIC administrative practices are consistent with other peer RD&D programs. A check mark indicates that the administrative process is consistent with peer programs.

Table 58: Comparison of EPIC Administrative Processes to Peer RD&D Programs

<table>
<tr><th>Administrative Process</th><th>CEC</th><th>IOUs</th></tr>
<tr><td rowspan="3">Program Management and Administration</td><td>Awards grants to external organizations that conduct their research.
✓</td><td>Conduct their research using internal staff with use of vendors.</td></tr>
<tr><td colspan="2">Administration is managed by a core team with RD&D program expertise, with technical support provided by both internal and external experts.
✓</td></tr>
<tr><td colspan="2">Four-administrator model</td></tr>
<tr><td rowspan="2">Investment Planning</td><td>Identifies a series of strategic objectives with strong and transparent linkages to state policy goals.
✓</td><td>Develop Investment Plan priorities internally, predominantly relying on their own technical experts and management to identify and prioritize research areas, with linkages to policy less transparent.</td></tr>
<tr><td>Relies mostly on input from multiple external stakeholders; develops its Investment Plans transparently and engages external stakeholders throughout the process.
✓</td><td>Rely mostly on external input from a single utility-focused stakeholder; insufficient transparency in developing Investment Plans.</td></tr>
<tr><td rowspan="2">Project Selection</td><td>Uses a transparent and public process for selecting projects and shares project scopes of work in a timely manner.
✓</td><td>Use a less transparent, internal process for selecting projects and do not share project scopes of work in a timely manner.</td></tr>
<tr><td colspan="2">Due diligence is being done to identify projects that, absent EPIC funding, would not move forward or would move forward more slowly.
✓</td></tr>
</table>

Administrative Process	CEC	IOUs
Project Assessment	**Shares information** about projects while they are being implemented but less frequently than optimal.	
	Uses a robust process for collecting the necessary quantitative data needed to comprehensively report on project benefits and disseminate results. ✓	**Lack a robust process** for collecting the necessary data needed to comprehensively report on project benefits and disseminate results.

✓ = consistent with peer RD&D program practices

Throughout the evaluation, we examined each administrators' processes and projects. When we compared across the four administrators, the main finding was the difference in how the CEC approaches program administration as compared to the IOUs. However, we did note some differences in processes across the three IOUs in this report, which we summarize below in Table 59. Note that those comparisons were limited by the size of the project sample for each IOU (which reflects the relatively smaller portion of the EPIC budget that the IOUs receive as compared to the CEC).

As shown, program management and administration is fairly similar, with only minor differences in administrative spending across IOUs. PG&E was the only IOU to submit a request to the CPUC for new and revised projects. With respect to Investment Plans, the IOUs provide a similar level of detail describing their plans; however, SDG&E is the only IOU to include project budget allocations. We identify the need for the IOUs to share more information about projects later in this section.

All three IOUs are deficient (as is the CEC) regarding justifying their use of non-competitive bidding. We discuss this issue in Section 11.1 below.

PG&E and SDG&E have slightly larger organizational networks than SCE with which they engage and share project results, and PG&E has shared project results more frequently than SCE.[81] Note that with a small fraction of projects completed at the time we conducted our research, the sample sizes are small. Once more projects are completed, this analysis could be repeated with larger sample sizes to identify trends and facilitate comparisons more robustly. Finally, nearly all of the IOUs' projects (in EPIC 1 and 2) are not intended to be commercialized as shown in the last category of the table. We discuss this issue in Section 11.5.

[81] SDG&E had not yet completed project at the time of our research.

Table 59: Differences in EPIC Program Administration by IOU

Administrative Process		PG&E	SCE	SDG&E
Program Management and Administration	Administrative spending	8%	6%	10%
	Submitting a waiver of program requirements / for new or revised projects	Submitted an Advice Letter	Has not sought to waive program requirements	Has not sought to waive program requirements
Investment Planning	Level of project detail provided	Does not provide budget information	Does not provide budget information	Provides project budget estimate
Project Selection	Use of non-competitive bidding	24% of EPIC 1&2 projects	33% of EPIC 1&2 projects	9% of EPIC 1&2 projects
	Justifying use of non-competitive bidding	Offered justification for each case in their Annual Report	Offered general justification for use of non-competitive bidding in their Investment Plan (but did not offer justification for specific cases)	Only indicated the use of non-competitive bid, did not offer justification for each case in their Annual Report
	Providing vendor budget information for competitive bidding	Not provided	Not provided	Provided in the Annual Report
Project Assessment	Revisions to projects	20% of projects revised (EPIC 1&2)	43% of projects revised (EPIC 1&2)	0% of projects revised (EPIC 1&2)
	Project Results Dissemination	PG&E has disseminated project results to listservs for 60% of sampled projects (n=10)	SCE has not disseminated any information via listservs for sampled projects (n=7)	NA (no projects completed at the time of our evaluation)
	Project Networks	PG&E has an average of 6 organizations per project network (n=31	SCE has an average of 4 organizations per project network (n=8	SDG&E has an average of 10 organizations per project network (n=41

Administrative Process		PG&E	SCE	SDG&E
		organizations associated with project sample)	organizations associated with project sample)	organizations associated with project sample)
	Project Schedule	Mean time for project completion is 2.6 years	Mean time for project completion is 4.1 years	Mean time for project completion is 2.4 years
		71% of EPIC 1&2 projects expected to be completed by end of 2017	64% of EPIC 1&2 projects expected to be completed by end of 2017	100% of EPIC 1&2 projects expected to be completed by end of 2017
Project Impacts and Policy Alignment	Commercialization of projects	3% of EPIC 1&2 projects expected to be commercialized	8% of EPIC 1&2 projects expected to be commercialized	0% of EPIC 1&2 projects expected to be commercialized

Key study findings and recommendations are discussed below, organized by study research area. Recommendations are numbered by section (which also correspond to the five evaluation research topics, plus two additional sets of recommendations that are cross-cutting).

11.1 Program Administration

The key research question that we sought to address under this study research area is:

Are the administrators effectively complying with program requirements?

Based on our review of program administrative procedures, we find that the four administrators are in compliance with program requirements.

We examined the numerous CPUC requirements that fell into the following nine categories.

- Statutory guidance
- Investment Plans
- Limitations on projects
- Contracts
- Stakeholder engagement
- Quantifying benefits/metrics
- Budget
- Annual reports
- Miscellaneous

To verify compliance with these requirements, we relied on a combination of sources, including program filings (e.g., Annual Reports and Investment Plans), the sample of projects for which we had more detailed information (supplemented by interviews with grantees, vendors and IOU/CEC project managers) and the sample of CEC solicitations/bids and IOU request for proposals (RFPs) and vendor bids. We then compared the IOU administrative practices to other peer RD&D program practices and observed a number of areas where performance could be improved.

Based on our review, we find that the EPIC administrators have sufficient administrative and technical expertise and capabilities and devote adequate staffing to EPIC-related positions. Administration is managed by a core team with RD&D program expertise that handles design and implementation, with technical expertise provided by internal experts as well as by external experts, which is consistent with other peer RD&D programs.

Likewise, administrative roles and responsibilities are well defined. The administrative project management teams are staffed sufficiently with cross-functional teams, consistent with other peer RD&D programs, fulfilling the range of required duties: administrative, technical and regulatory. They have effective processes in place to continually track and comply with EPIC requirements.

However, we identified two specific cases where the administrators are technically compliant, but they are not meeting the intent of the requirements.

In particular, there are two areas where we determined that the administrators are not meeting the intent of EPIC program requirements: non-competitive bidding practices (all administrators) and benefits tracking (the IOUs). With respect to competitive bidding, we recommend that:

- ***1a) The administrators provide more detailed justification for non-competitive bidding*** in their Annual Reports. The current administrative processes do not provide enough information to allow for appropriate oversight.
- ***1b) The CPUC consider requiring a review of the non-competitive bidding cases before they are contracted,*** since they are not being presented in the Investment Plans, where the CPUC could review these cases before contracts are awarded. By the time the administrators report on such cases in their Annual Reports, it is too late for review. (The CPUC intended that administrators indicate their non-competitive bidding plans in their Investment Plans, but typically, the CEC and the IOUs are not far enough along with project plans to provide the determination and possible justifications in the Investment Plans.) We note that if there is a lengthy review period, there is the potential risk of delaying a project.
- ***1c) The CPUC require the IOUs to specify the funding amount for the non-competitive award*** to make it easier to assess the fraction of funding that is being directly awarded. (SDG&E provides budget information for vendors in its Investment Plans, so such information is available for SDG&E. However, budgets may change once projects are implemented and vendors are selected, so the actual budget amount being sole sourced should be confirmed.) Such information would be useful to determine how much project funding is being directly awarded versus competitively bid.

We discuss deficiencies in how the IOUs quantify project benefits in Section 11.4.2.

We also identified additional areas where the minimum requirements are not sufficient to ensure best-in-class program administration (such as stakeholder engagement, coordination and information sharing.) In these cases, the administrators are technically compliant but could better fulfill the spirit or intent of the requirements. We discuss these items throughout the rest of this section.

11.2 Investment Planning Process

The key investment planning research question we sought to address is:

Is the triennial investment planning process effectively identifying a broad range of potential energy RD&D objectives, evaluating those objectives according to sensible criteria, and ultimately producing Investment Plans with a high likelihood of producing benefits for California ratepayers and achieving other EPIC goals?

We address this research question in the following three sub-sections.

11.2.1 Administrator Investment Planning Processes

The CEC's investment planning process produces plans that have a high likelihood of producing benefits for California ratepayers and achieving other EPIC goals.

While each IOU project is related to at least one area of the state's energy policy, their TD&D portfolios focus on a much narrower set of investment areas compared to the CEC.

The CEC's administrative model is consistent with other peer RD&D programs in that there is strong explicit alignment of program initiatives with relevant energy policy goals and transparency in investment planning.

IOU project ideas predominantly originate from internal IOU staff, and are organized by the IOU joint framework that includes four investment framework elements (all within the TD&D area), each of which the IOUs have mapped to the electric system value chain. As a result, the IOU projects are more narrowly focused primarily on grid communications and interactivity and grid maintenance, optimization, planning and management. The IOUs noted that, while their projects are narrowly targeted toward the unique needs of their respective systems, they are certainly relevant to the needs of the other utilities both inside and outside California and benefit all ratepayers.

- We have no recommendations related to whether the IOU TD&D portfolios should resemble the CEC's broader focus since this is a CPUC policy decision.

11.2.2 Portfolio Optimization

EPIC's objectives are broad, but, based on our best-practices review, we did not find that a broad approach to project selection was a problem. However, given the many policy areas EPIC is attempting to address, we have identified a need to prioritize among these broad objectives.

Based on our assessment, the administrators' investment planning processes result in a collection of projects that together meet all the various EPIC program requirements, support state policy and address research gaps. For example, we confirmed that every EPIC project provides ratepayer benefits, but there is variation in how broad and/or direct those benefits are. Likewise, we identified that a high percentage of CEC projects focus on energy efficiency, but since the CPUC has not established priorities, it is not possible to determine if the administrators' investment planning frameworks are effective in creating a portfolio that has the *optimal* mix of projects.

EPIC is a broadly focused program compared to other RD&D or emerging technology programs that have much more narrowly focused mandates. The EPIC portfolio of projects must strike a balance between maintaining its broad focus and concentrating on the state's highest policy priorities.

We have identified a need to prioritize the principles, policies and strategic objectives and operationalize what it means for a portfolio to be optimized, though we acknowledge that such prioritization must also balance the desire to "allow a thousand flowers to bloom" to ensure sufficient opportunities to sow broad innovation. Once prioritized, the administrators could then assess the extent to which each project addresses these principles, policies and strategic objectives. Doing this would assist decision makers in gaining a better understanding of what it means for a portfolio to be integrated into the broader innovation and policy landscape and the extent to which the EPIC portfolio meets that standard. A more refined assessment of the policy alignment then could be conducted to determine whether the portfolio is optimized.

We recommend that:

- ***2a) The CPUC establish priorities among its current policy goals and funding criteria to better guide the administrators in their investment planning.*** Each project is vetted, and they all meet the various criteria. However, funding is finite, and allocating that funding across too many policy goals and funding criteria runs the risk of diluting EPIC's impact.
- ***2b) The administrators collaborate in categorizing and summarizing projects*** (such as by technology type and/or policy area) and review projects by topic areas to ensure that the portfolio of projects effectively supports key policy goals.
- ***2c) The administrators' Investment Plans are closely reviewed to ensure they not only meet program requirements, but that they are also effective in advancing the energy policy priorities that the CPUC identifies.*** Such a review could focus on ensuring the CEC's strategic objectives are in line with state priorities and are not overly responsive to priorities that may be temporary (such as tree mortality).The review could ensure that IOU projects are effectively advancing state policy, beyond just being related to policy and proceedings. Later in this section, we recommend that EPIC be independently evaluated regularly, providing an opportunity for on-going assessment of Program planning and implementation.

11.2.3 Stakeholder Engagement

The CEC provides comprehensive information about its Investment Plans to a broad array of stakeholders.

The IOUs have a much narrower stakeholder group on which they typically rely for input.

Stakeholders (besides the Electric Power Research Institute [EPRI]) are engaged relatively late in both the CEC's and IOUs' investment planning processes, and plans have not changed significantly as a result of stakeholder input.

The CEC provides comprehensive information to stakeholders about its Investment Plans, and its processes are consistent with other peer RD&D programs.

The internal IOU stakeholders and EPRI (an electric utility-focused organization) are the main sources of expertise on which the IOUs rely to determine their EPIC investment priorities. EPRI identifies gaps and any redundancies with other utility efforts nationwide.

The EPIC administrators hold stakeholder workshops, document public comments and respond to these remarks in each of their Investment Plans, as required by the CPUC. However, the IOUs do not provide comprehensive information about their draft plans when they conduct stakeholder workshops, and, according to stakeholders, allow little time for input. The CEC also allows little time for input, though it offers more information and gives more time for input than the IOUs. Compared to other peer RD&D programs, the EPIC administrators appear to rely more on their own internal technical experts (and for the IOUs, EPRI), seeking input from external stakeholders after investment planning goals are established. However, we note that the administrators' internal staff routinely collaborate with other external subject matter experts. The peer RD&D programs we reviewed engaged industry experts to help shape the focus of their initiatives. We recommend that:

- ***2d) The administrators engage more stakeholders earlier in the investment planning process, and***
- ***2e) The IOUs provide more comprehensive information, to allow time for more meaningful engagement***. With the current IOU approach, the Investment Plans are so close to final that stakeholder input at workshops does not materially change their plans. This issue is exacerbated by the fact that once the plan is approved, little information is shared with the public until the projects are described in the IOUs' Annual Reports.

11.3 Project Selection Process

The key research question related to project selection by the administrators that we sought to address is:

> *Is the project selection process being conducted in an open, effective, and efficient manner and resulting in funds going to projects that are consistent with EPIC policy objectives and planning processes?*

We address this research question in the next five sub-sections.

11.3.1 Administrator Project Selection Processes

The CEC has established rigorous selection criteria, strong alignment with overall program goals and objectives, and a peer review process for selecting and awarding project grants.

There is a lack of transparency in the IOUs' project selection and research planning processes. The IOU project selection criteria could also be more transparent.

The CEC's project selection processes are rigorous and transparent, and are consistent with other peer RD&D programs.

Based on our review of IOU processes, we find that the IOUs' project selection criteria are not as robust as other peer RD&D programs or the CEC's, which identifies a series of strategic objectives around which initiatives are organized. While the IOUs are technically in compliance with investment planning, project selection and annual reporting requirements, they are not as robust and transparent as other peer RD&D programs. We recommend that:

- ***3a) The IOUs develop more transparent project selection criteria***, which determine the project areas that are described in their Investment Plans as well as the specific projects that are eventually implemented**.** Once the CPUC establishes priorities, these criteria could be reviewed and revised over time to ensure an appropriate focus on the highest priority areas for advancing state energy policy.

There is typically a substantial lag between the time when the IOUs decide whether or not to launch a project once their Investment Plans are approved and when they share information about each project in their Annual Reports, including such information as the budget, overview of project scope, and its current status (active, completed, cancelled or on hold). We do note that SDG&E provides project budget information (including a breakdown of SDG&E versus vendor budget) in its Investment Plans.

The IOUs do not share their detailed project research plans publicly or with the CPUC, so there is less transparency as compared to CEC projects (where detailed scopes of work are posted publicly once they are developed). The brief description in the Investment Plans and Annual Reports are all that is available to the CPUC and the public (with the exception of projects that are featured in presentations at EPIC workshops and the annual symposium or ad hoc communications). The IOUs may not conduct all projects that are described in the Investment Plans, so the Annual Reports are the best sources for determining which projects are being implemented. Though the IOUs comply with EPIC program requirements, we have identified the need for more timely reporting on projects after the Investment Plans are approved to increase transparency and ensure more effective CPUC oversight. We recommend that:

- ***3b) The IOUs share project research plans and budgets with the CPUC and the public***, at least one month prior to launch.

11.3.2 Administrator Coordination

All four EPIC administrators coordinate program administrative activities on a regular basis, and the IOUs coordinate on individual projects; however, there is less coordination between the IOUs and the CEC at the project planning level. We have identified the potential for future increased coordination between the IOUs and the CEC once Applied R&D projects begin to mature.

While the IOUs have effectively coordinated on the EPIC 1 and EPIC 2 project portfolios, we found some cases of *apparent* duplication in the IOUs' EPIC 3 plans.

The administrators share project results with each other informally (e.g., during their routine biweekly coordination meetings) and formally (by attending project presentations). There is the potential for more project coordination once the CEC's Applied R&D projects begin to mature. (We offer a related recommendation in Section 11.5.)

To minimize duplication, the IOUs coordinate with each other on project plans. There are cross-IOU technology teams that coordinate, and the Program provides a unifying framework for them to test technologies before they go to production scale.

We reviewed the IOUs' three Investment Plans. In the first two plans, we did not identify any unnecessary duplication. However, we did note some cases of *apparent* duplication in the IOUs' EPIC 3 plans. Once the projects are launched and more detailed research plans are developed, the IOUs should make those plans available (similar to what the CEC does) to allow for more vetting of projects (which we recommended above). We recommend that:

- ***3c) The CPUC review the IOUs' project research plans (which we have recommended that they make public as they are developed) to ensure that there is no unnecessary duplication in their EPIC 3 projects.***

11.3.3 Match Funding

The CEC explicitly seeks match funding (consistent with three of the seven peer RD&D programs), while the IOUs use informal means for attracting cost sharing from their vendors.

Some stakeholders indicated the CEC's match funding requirements may be too onerous, especially for small companies that lack the resources or track record to attract such funding.[82] Moreover, our review of best practices of other peer RD&D programs found that two primary peer programs which focus on small businesses, the SBIR and STTR Programs, do not mandate match funding during the projects' Phase I implementation, but it is encouraged during Phase II when these projects are more established and better positioned to secure such funding. We recommend that:

- ***3d) The CEC consider modifying the match funding requirement for TD&D projects and make it optional***, giving bonus points to their scores like they typically do for Applied R&D and Market Facilitation projects, to ensure they are not rejecting good projects that are unable to secure funding (such as those from small businesses). This might encourage more bids, especially from small businesses that in general have fewer options for securing match funding.

11.3.4 Intellectual Property Terms

Some stakeholders reported that the Program's Intellectual Property (IP) terms were a barrier to participation. We observed that peer RD&D programs have more flexibility, but EPIC is very different from its peers because of the legislatively mandated ratepayer benefit requirement, which effectively constrains how IP may be treated for EPIC-funded projects. However, it is possible that there may be more flexibility than what the CPUC has communicated in EPIC Decisions. We recommend that:

- ***3e) The CPUC review IP rules or guidance developed for the Department of Energy's Small Business Innovation Research (SBIR) Program to explore possible opportunities for easing IP requirements. Regardless of the outcome of any such efforts, the CPUC should ensure that IP requirements are communicated effectively***.

[82] This barrier was mentioned by five of the 12 respondents who submitted comments to the Idea Exchange which followed the September 22, 2016 public workshop on increasing private sector participation. The 12 respondents included six representatives from the private sector, three from industry organizations, one from an academic institution, and one from a National Lab. Although we did not explicitly address this issue during the interviews with 17 TD&D project grantees and administrators, none of them volunteered that this is a barrier to applying to EPIC.

11.3.5 Flexibility

Despite the IOUs' assertion that the need to submit an Advice Letter to add, modify or cancel a project is onerous, the evaluation team found that the IOUs have sufficient flexibility to make changes to projects that have been described in their Investment Plans as well as to put projects on hold indefinitely.[83]

The CEC differs from other peer RD&D programs in that it does not always have the necessary flexibility to adjust a project scope of work to respond to rapid changes in technologies and markets.

The administrators are permitted to add, modify or cancel a project by filing a Tier 3 Advice Letter with the CPUC. The IOUs indicated this is an onerous requirement since the approval process takes several months. They would need to submit an Advice Letter to add a completely new project that is not covered by one of the existing general descriptions in their Investment Plans. In such cases (we identified two out of six projects that PG&E included in their Tier 3 Advice Letter, with justifiable reasons for adding them mid-cycle), the lengthy review period could be a problem. However, before the CPUC considers any changes to this process, we recommend that the IOUs address the issues we have identified in this report related to transparency and information sharing. We recommend that:

- ***3f) The administrators should use the Advice Letter process only for requesting substantive changes to projects or adding new projects that are not covered by one of the existing general descriptions in their Investment Plans.*** Recently, PG&E submitted an Advice Letter that included three projects that could have been implemented within the existing approved project descriptions in its Investment Plan. The administrators should only introduce new projects in between Investment Plans (necessitating a lengthy Advice Letter approach) in response to new market or technology developments. Other projects, such as a call center-related project submitted by PG&E, that are not new projects being introduced mid-cycle in response to market or technological developments, could be better anticipated and included in the investment planning process. The Tier 3 Advice Letter approach takes time, and should be limited only to projects when it is necessary.

As a public agency, the CEC does not always have the necessary flexibility to adjust a project scope of work to respond to rapid changes in technologies and markets. Other peer RD&D programs have structures in place to help projects identify and capitalize on opportunities to change course, when needed, to maximize a projects' success (e.g., the SBIR Program allows projects to be able to reallocate up to 10 percent of their budget

[83] in Section 8.4, we discussed Investment Plan consistency over the plan period, which includes a discussion of the Tier 3 Advice Letter requirement and the process for seeking approval for changes.

without prior approval). Because the technology innovation process is not linear, it often requires program administrators, grantees and others involved in the RD&D process to be able to quickly modify their scopes of work to maximize benefits. We recommend that:

- ***3g) The CEC explore how and whether it could add more flexibility to its grant request forms and/or research planning process*** to be able to respond to market and technology changes that occur between the time the project is proposed and the project is launched.

11.4 Project Assessment Process

The first key research question related to the assessment of EPIC projects that we sought to address is:

What is the status of EPIC investments?

As of the end of 2016, based on the project status reports included in the administrators' 2016 Annual Reports, 250 projects were active and 19 projects have been completed (1 CEC project and 18 IOU projects). Of active projects, about half are scheduled to be completed by the end of 2018 and the remainder in 2019 or later.

11.4.1 Project Status Reports

The second key research question related to the assessment of EPIC projects that we sought to address is:

Do the administrators do everything possible to track the progress of funded work?

The administrators each have adequate processes in place to internally track the progress of projects and ensure effective project implementation.

All administrators could improve upon the frequency, usefulness and transparency of project status reports.

The administrators internally track project progress frequently, and their processes are consistent with other peer RD&D programs. While the administrators are in compliance with EPIC program requirements, we identify the need for more frequent and effective project-status reporting (such as on a quarterly basis, with projects categorized by policy and/or technology area). With a four-administrator model, it is more difficult to classify and summarize projects across the whole EPIC portfolio. The Annual Reports, the primary way that the CPUC and stakeholders monitor project status, consists of four different reports, posted to four different websites and distributed to different listservs, without any categorization of projects (beyond by investment period and investment area), such as by policy or technology area.

This process is not effective and impedes the ability of stakeholders and the public to fully engage with the Program. Providing key project information on a more frequent basis is consistent with the peer RD&D programs we reviewed. We recommend that:

- ***4a) The administrators share information while projects are in progress with the CPUC and the public on a more frequent basis***, such as quarterly.
- ***The administrators collaborate in categorizing and summarizing projects***, as previously recommended (2b), (such as by technology type and/or policy area) so that interested parties can more easily obtain pertinent information on a given topic area. See Appendix D for an example of a quarterly status report that we developed that provides a foundation for such a report.
- ***4b) The administrators collaborate and jointly convene a quarterly workshop to share results about project status and lessons to-date on a topical basis***, with engagement from stakeholders on topics that are of interest. Such workshops should be publicized in advance along with the topic or topics to be covered. All EPIC projects that fall under the announced topic should be discussed and organized topically. This process will ensure that: 1) information about EPIC projects is conveyed to the appropriate audiences, and 2) stakeholders can better anticipate the types of information that will be shared at EPIC workshops and thus be better prepared to participate in discussions about future research needs and EPIC investment areas.

11.4.2 Benefits Quantification

The third key research question related to the assessment of EPIC projects that we sought to address is:

> *Are processes in place to assess project viability over time and disseminate project results to stakeholders?*

The CEC has an effective, structured and transparent process in place for tracking project benefits.

The IOUs are not effectively tracking and reporting on benefits metrics.

We identified a need for the administrators to coordinate on compiling and jointly reporting on project benefits.

The CEC's process for tracking project benefits consists of three project benefits questionnaires that grantees are required to complete. These processes are consistent with other peer RD&D programs. Though the CEC's projects are not very far along, the first set of questionnaires that were prepared when projects were initiated appear to be sufficiently and reasonably well documented quantitatively and/or qualitatively.

The IOUs track and report on project results and provide some information related to project benefit metrics in their project closeout reports, as required by the CPUC. However, there is room for improvement with respect to measuring project success and reporting on the metrics. They may need to conduct additional data and information gathering in order to estimate and report project benefits, which is a consistent practice among other peer RD&D programs. We recommend that:

- ***4c) The IOUs develop more detailed processes to quantify benefits*** associated with their projects, including what types of data would be necessary and how they will collect these data, as well as a reporting structure and process that would document and report those benefits to all relevant stakeholders. The IOUs should include a plan to collect and report on project benefits metrics in their project scopes of work, and analyze and report on benefits in their project closeout reports and follow-up reports as necessary (since some benefits may take more time after project completion before they can be quantified).

We have identified a need for the administrators to coordinate on compiling and reporting on project benefits. Such reporting should be shared with the CPUC, key stakeholders and the general public to widely publicize the Program's collective benefits, consistent with peer RD&D program practices. Unlike EPIC, peer RD&D programs have a single administrator, making it much easier to produce a single report publicizing program benefits. It is more challenging for EPIC to categorize and summarize project benefits across the four administrators. We recommend that:

- ***4d) The administrators develop a process to jointly report on EPIC's short-, mid- and long-term project benefits*** across the portfolio on a routine basis (e.g., annually) to the CPUC, relevant stakeholders and the general public.

11.4.3 Results Dissemination

The CEC has a robust process in place to disseminate project results and track knowledge gained.

PG&E has disseminated project results widely, while SCE has not. (SDG&E had not yet completed projects at the time of our research.)

The four-administrator model for EPIC may create some barriers and limitations to information dissemination since there is no program-wide communications mechanism or central repository of project information.

The CEC's robust results dissemination processes are consistent with peer RD&D programs. However, since it is premature to determine whether the CEC's project dissemination tracking processes are effective at achieving their mid- and long-term objectives, we recommend that:

- ***4e) The CEC's project benefits quantification processes be reviewed*** again once more projects are completed.

The IOUs document the results of their dissemination plans in their project closeout reports by identifying presentations they have made or plan to make. SDG&E had not yet submitted any closeout reports at the time of our assessment, but PG&E appeared to identify several external conferences to share results, whereas SCE reported far fewer information sharing plans. These results are consistent with analysis we conducted on information dissemination by IOU, with SCE sharing information about projects much less frequently compared to PG&E and SDG&E. SCE should make additional efforts to disseminate information about its EPIC projects to ensure project results are widely shared. We recommend that:

- ***4f) SCE share its project results more widely*** with interested stakeholders, including delivering presentations at conferences and workshops.
- ***4g) SDG&E's project closeout reports be reviewed*** once projects are completed to ensure results are being widely disseminated.

While the administrators do collaborate on EPIC symposia, outreach is conducted separately even though there is possible overlap in stakeholder interest across technologies investigated by the administrators. Similarly, while the CEC Media Office is an additional source by which the public learns about CEC projects, the Office does not disseminate any information about IOU projects. Each administrator uses its own website and listserv(s) to distribute information. Given these inefficiencies of the four-administrator model, we recommend that:

- ***4h) The administrators jointly develop a single EPIC website and listserv to post and distribute project information*** (including quarterly project status reports, project closeout reports and any additional documents on project benefits and knowledge gains) for both the CEC and IOU projects. Included on this website would be a single, downloadable Excel spreadsheet that contains key information for all EPIC projects. This would ensure that stakeholders have an easy way to obtain all relevant information about EPIC projects that support their particular areas of interest. More stakeholders might engage with the Program if it is easier for them to receive and organize all relevant information about the performance of individual projects as well as the entire EPIC portfolio.

11.4.4 Project Networks

The administrators have been effective even at this early stage of the Program's implementation in developing networks and disseminating knowledge.

The CEC engages with more organizations than the IOUs, with much more focus on public organizations, corroborating previous findings in this report about the much narrower focus of IOU projects and the lack of transparency of IOU projects compared to the CEC.

Our analysis of knowledge dissemination activities and the relational networks of each of the sampled interview projects suggests that projects are developing broad networks of stakeholders and other market actors. The wide range of entities that is already engaged in projects suggests that the projects are well positioned to lead to wide dissemination of knowledge once projects are completed.

On average, the CEC engages with 18 organizations per project during implementation, while IOUs engage with 7. The type of organizations with which the CEC and IOUs engage also differs to a great extent. Ninety percent of organizations that the IOUs engage are private compared to 36 percent for CEC TD&D projects. The IOUs' networks consist mainly of manufacturers, private companies and other utilities, with very few government/policy-making organizations included. The CEC engages more often with its project networks as compared to the IOUs, which may be due to having fewer formal relationships with external organizations (20 percent formal agreements in place for the IOUs versus 57 percent for the CEC).

- We have no recommendation on whether the IOUs should engage a higher percentage of public agencies in line with the CEC's approach, since the program rules regarding the dissemination of information do not distinguish between public versus private organizations.

11.5 Project Impacts and Policy Alignment

The key research questions related to project impacts and how they align with policy that we sought to address are:

> *Are ongoing projects showing reasonable indicators of success? Looking beyond project- and administrator-specific considerations, what impacts does the Program overall have in a wider context?*

Overall, the EPIC portfolio appears to be on track, thus far, in meeting its short-, mid- and long-terms objectives. Collectively, EPIC is both broad and deep, and administrators take steps to integrate projects into the broader innovation and policy landscape. To that extent, projects appear to be consistent with the Program's objectives and core values.

The Program as a whole is not consistent with other peer RD&D programs, which have a much greater focus on support for commercialization. However, we note that EPIC

reflects the diversity of projects encouraged by CPUC Decisions, which contain a more broadly defined set of objectives.

We reiterate the need to prioritize the principles, policies and strategic objectives and operationalize what it means for a portfolio to be optimized.

Overall, when viewed as a portfolio, EPIC's Applied R&D projects show some progress with respect to knowledge and awareness among potential users, follow-on research and development, technology demonstrations, potential private investment, patents and early adoption. In general, the TD&D portfolio also appears to be on track, thus far, in meeting its short-, mid- and long-terms objectives.

EPIC's Market Facilitation projects are clearly consistent with the goal of addressing non-technical barriers with projects aimed at enhancing permitting and market and technical analysis predominating, thus far. We found that projects generally are on track to achieve their research objectives and expected benefits. Many also reported that these same benefits could be achieved if these projects were replicated in other states and jurisdictions. We did note that there is a disconnect between the Market Facilitation projects and the Applied R&D and TD&D projects that are upstream from them. This disconnect is primarily due to the fact that all three program areas were launched more or less at the same time, making it extremely difficult to develop projects that are aimed to meet the needs of Applied R&D and TD&D projects. The CEC has recognized this gap and reported that it is committed to working more closely with those responsible for the upstream projects to better meet their needs.

We observed that that the EPIC portfolio of projects is highly diverse, which is consistent with CPUC Decisions, which contain a broadly defined set of objectives. We characterized this diversity in terms of the types of technologies and studies and their commercialization status. We found that the diversity of projects with respect to technologies and commercialization in the EPIC portfolio adequately addresses EPIC's multiple policy goals. However, whether each administrator is expending the right level of effort to address each of these policy goals, delivering project results quickly enough and bringing important innovations to market or the public domain cannot be determined until these policies are prioritized. It is also clear that portfolio optimization is an on-going process that must respond to changing priorities and budgets in a rapidly changing technological and environmental landscape.

We recommend that:

- ***5a) The CPUC consider using our characterization of the EPIC portfolio in terms of the types of technologies and studies and their commercialization status*** as baselines against which to compare future iterations of EPIC.

- ***5b) The CPUC regularly evaluate EPIC*** to confirm that the CEC is ensuring the Market Facilitation projects are effectively connected to and serving the needs of the Applied R&D and TD&D projects.

We identified future opportunities for more coordination at the project level between the CEC and the IOUs, with the IOUs considering demonstration projects that could build on CEC Applied R&D projects, once those are further along. Given the lack of extensive coordination between the IOUs and the CEC at the project level, such opportunities may not happen unless a more formal process is introduced. We recommend that:

- ***5c) EPIC administrators establish a process to ensure that once Applied R&D projects are completed by the CEC, the results are considered and potential TD&D projects are identified***. Such a process would ensure that projects that have evaded the Technological Valley of Death do not subsequently fall into the Commercialization Valley of Death. Such a view is consistent with the underlying theory that supports the three phases of the administrator's innovation pipeline.

11.6 Overarching Coordination and Collaboration

Our evaluation has identified a critical need for improving administrative coordination and stakeholder engagement that the administrators are not currently addressing due to limitations associated with the administrative model and their reliance on minimum project reporting procedures. **We have identified a need to explicitly supplement the existing administrative structure by convening an independent body that provides coordination and facilitation support to the administrators and compiles and helps disseminate information.** Such efforts would increase transparency and stakeholder engagement and ensure the Program is most effectively directing EPIC funds toward energy innovation that meets the highest priority state policy goals, as identified by the CPUC. These efforts would also address the deficiencies we outlined in the previous two sets of findings. We recommend that:

- ***6a) The CPUC and/or the administrators fund and convene an independent body to coordinate, facilitate and lend technical expertise.*** The responsibilities of such a body could include:
  - Supporting administrator and CPUC efforts to categorize projects by technology and/or policy areas, in order to facilitate easier access of EPIC project information for interested stakeholders;
  - Convening and engaging stakeholders earlier in the investment planning process;
  - Supporting administrators in collecting data regarding key performance metrics in a consistent manner.

- Supporting administrator and CPUC efforts to track and prioritize policy goals and funding criteria, and periodically revisiting priorities as policy goals change and EPIC matures;
- Supporting administrator and CPUC efforts to ensure that those priorities are effectively addressed in the administrators' Investment Plans;
- Supporting administrator and CPUC efforts to review Investment Plans and project research plans to ensure there is no unnecessary duplication (particularly for the IOUs' TD&D projects);
- Engaging stakeholders and ensuring any input that would lead to greater ratepayer and state policy benefits is considered by the administrators in their Investment Plans;
- Reviewing administrator quarterly status reports, such as by policy and/or technology areas, engaging relevant stakeholders in projects of interest, and helping to identify issues or concerns;
- Planning and facilitating a quarterly meeting devoted to a particular topic of interest to stakeholders, including publicizing the meetings to stakeholders and addressing their needs;
- Coordinating an effort to develop a centralized EPIC website and listserv, helping to identify interested parties and ensuring that those parties are linked to relevant information on projects and topic areas of interest;
- Reviewing project research plans and ensuring consistency with the Investment Plans, and supporting the engagement of relevant stakeholders in reviewing research plans;
- Identifying interested stakeholders and appropriate forums for administrators to more broadly disseminate their results; and
- Facilitating coordination at the project planning level between the CEC and IOUs once the CEC's Applied R&D projects are further along.

11.7 On-Going Program Evaluation

We have identified the need for on-going assessment of the program and project benefits.

The various planning documents and CPUC Decisions combined with the comments from EPIC project teams support the conclusion that due diligence is being done to identify projects that, absent EPIC funding, would not move forward or move forward more slowly. Again, this is a necessary but not sufficient condition for establishing a causal connection between EPIC-funding activities and any measureable changes in metrics associated with the mid- and long-term outcomes. The probability that these outcomes will eventually be achieved will increase substantially only through the combination of successfully designed and implemented projects and the diffusion of these technologies and tools over time in their targeted markets. While projects appear to be on a good trajectory to disseminate knowledge, it is too early in the program life to determine the full extent of more concrete knowledge benefits such as patents, journal articles and existence of follow-on research. It is also premature at this time to assess if these activities will be sufficient to encourage further research and technology adoption after the EPIC projects are completed. A more complete case for attribution must be built on an on-going, theory-driven evaluation that, based on the preponderance of the evidence, will assess the extent to which these mid- and long-term outcomes have been achieved and the extent to which EPIC is responsible for any of these achievements. We therefore recommend that:

- ***7a) Using the theory-driven framework developed for this evaluation, monitor and report key performance metrics on an on-going basis and conduct a comprehensive evaluation every three to four years. All of these evaluation activities should be conducted by an independent evaluator in close collaboration with the four administrators to avoid any duplication of efforts and to ensure that the results will be useful to all stakeholders (e.g., the CPUC, state legislators, and the four administrators and other stakeholders).*** While this evaluation report documents what is working and what could be improved, the Program is still very young and should undergo ongoing independent assessment to ensure it remains on track and addresses the issues we have noted. Moreover, most projects have yet to be completed, and independent review is needed in the future to assess project benefits as the Program matures. Conducting independent program evaluations is consistent with the best practice of peer RD&D programs.
- ***7b) The administrators create a single, centralized database containing all relevant information on active and completed EPIC projects along with monitoring and quarterly reporting of key performance metrics,*** in order to support the on-going evaluation of the Program.

We also have identified a need to better characterize the Program to support future assessment efforts.

Our initial understanding of EPIC was based on the Triennial Investment Plans and other CPUC documents. However, through our interviews, document reviews and analysis of the EPIC portfolio, we now understand that the Program is far more complex. This theme of greater complexity is woven throughout this report. Below, we highlight the key areas of complexity.

EPIC projects do not follow a linear process. EPIC is not characterized by a linear progression from Applied R&D projects to TD&D projects and on to Market Facilitation projects, as we expected based on our review of the CEC's Investment Plans. The best practices literature noted that the technology innovation process is not linear; it requires program stakeholders, including administrators, implementers and other partners to be adept at identifying and capitalizing on opportunities as they arise. For example, Chiavari and Tam note that feedback from the market and technology users during commercialization and diffusion phases can influence additional RD&D and promote continuous innovation.[84] The literature also indicated that monitoring of early-phase products or pilots can help inform program design and implementation.[85] Mazzucato also notes that:

> "The causation that occurs in the steps taken from basic science to large-scale R&D, to applications, and finally to diffusing innovations is not linear. Rather, innovation networks are full of feedback loops existing between markets and technology, applications and science. In the linear model of innovation, the R&D system is seen as the main source of innovation, reinforcing economists' use of R&D stats to understand growth. In this more non-linear view, the roles of education, training, design, quality control and effective demand are just as important." [86]

We understand why the linear model remains so appealing.

> "Although the linear model does not represent the reality and complexity of the innovation process, it has been particularly influential and remains widely used because it offers a(n) (over)simplified description of the innovation process and allows the spokesmen for the economic and scientific community to communicate their thoughts to the general public and policy makers in an understandable (though flawed) way." [87]

While the administrators fully appreciate the complexity of the EPIC Program, they should develop logic models (building on the ones we developed) and associated performance metrics that better reflect a shared understanding of this complexity among themselves, the CPUC, and key stakeholders. Such logic models can provide an effective framework for identifying the underlying assumptions and theories as well as the potential performance metrics that can better test these assumptions and theories and track progress towards the short-, mid- and long-term outcomes. This framework can also assist all stakeholders in interpreting the large amount of program performance data that has been and will continue to be collected throughout the life of the program. In collaboration with the CPUC and their independent evaluators, the administrators should also develop a

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[84] Joana Chiavari and Cecilia Tam, *Good Practice Policy Framework for Energy Technology Research, Development and Demonstration (RD&D)*. International Energy Agency, 2011. https://www.iea.org/publications/freepublications/publication/good_practice_policy.pdf
[85] Bhavya Lal, Nayanee Gupta, and Christopher L. Weber, "Innovation Pipeline Management: Lessons Learned from the Federal Government and the Private Sector" (Washington, DC: IDA Science & Technology Policy Institute, 2012). https://www.ida.org/idamedia/Corporate/Files/Publications/STPIPubs/2014/D-5367.ashx; Chiavari and Tam, *Good Practice Policy Framework*.
[86] Mariana Mazzucato, *The Entrepreneurial State* (New York: Public Affairs, 2015), 43.
[87] D. Edgerton, "The Liner Model Did Not Exist," in K. Grandin, N. Worms and S. Widmalm (eds). *The Science Industry Nexus: History, Policy, Implications* (New York: Science History Publication, 2004).

more condensed set of metrics that the administrators could track and report annually to provide more timely feedback on high priority areas.

As an example of this nonlinearity, we noted previously in this section that there is a disconnect between the Market Facilitation projects and the Applied R&D and TD&D projects that are upstream from them. In the future, one would expect that the Market Facilitation Commission Agreement Managers (CAMs) will better assess the needs of the Applied R&D and TD&D CAMs as well as the IOU TD&D project managers, conduct relevant research to meet these needs and provide feedback that might trigger changes in the emphasis or direction of the project-level research and strategies for commercialization or wider adoption in the public domain of EPIC innovations. Such needs assessments and feedback loops need to be recognized and their effectiveness tested periodically.

The sources of proposed Applied R&D and TD&D projects are diverse. The CEC's Triennial Investment Plan stated that once Applied R&D projects are completed, they continue through the pipeline as a TD&D project and, once finished, their market-related research questions are then addressed through Market Facilitation research projects. In fact, TD&D project proposals come from many sources including internal staff, EPRI and manufacturers, as well as public and private R&D laboratories. None of the TD&D projects thus far have originated in the EPIC Applied R&D portfolio. This is not surprising since none of the Applied R&D projects were completed at the time of our research. Over time, more and more TD&D projects are expected to originate in the Applied R&D portfolio. The question of the expected proportion of EPIC TD&D projects that should originate in the EPIC Applied R&D portfolio should be addressed by the CPUC.

The types of projects are diverse. The Triennial Investment Plan stated that two of EPIC's primary objectives are to avoid the Technological Valley of Death (for Applied R&D projects) and/or the Commercialization Valley of Death (for TD&D projects), implying that the primary objective of every EPIC project is commercialization. As indicated in Section 10.5.1, about 60 percent of the Applied R&D projects do not have commercialization as an objective, while about 95 percent of the CEC TD&D projects and 4 percent of the IOU TD&D projects have commercialization as an objective. Even within these two general categories of *intend to commercialize* and *do not intend to commercialize,* projects are diverse, with some involving a combination of commercially available technologies applied to an emerging problem while others are developing products such as forecasting software that are intended for the public domain.

Given this, we recommend that ***the CPUC work with the administrators with the support of the recommended coordination body (if created) to***:

- ***7c) Modify (and continually update as needed) the characterization of the Program to more accurately reflect its complexity.***

- ***7d) Modify (and continually update as needed) the EPIC program theory and logic models to better reflect the more complex character of the Program.***
- ***7e) Revisit the key performance metrics that should be tracked and the frequency with which they should be tracked and reported.***

12 Appendix A: CPUC Decision Detail

1. CPUC Decision 13-11-025 Attachment 4 (List of Potential Evaluation Areas)

List of Proposed Metrics and Potential Areas of Measurement (as applicable to a specific project or investment area in applied research, technology demonstration, and market facilitation)

1. Potential energy and cost savings

   a. Number and total nameplate capacity of distributed generation facilities

   b. Total electricity deliveries from grid-connected distributed generation facilities

   c. Avoided procurement and generation costs

   d. Number and percentage of customers on time variant or dynamic pricing tariffs

   e. Peak load reduction (MW) from summer and winter programs

   f. Avoided customer energy use (kWh saved)

   g. Percentage of demand response enabled by automated demand response technology (e.g. Auto DR)

   h. Customer bill savings (dollars saved)

   i. Nameplate capacity (MW) of grid-connected energy storage

2. Job creation

   a. Hours worked in California and money spent in California for each project

3. Economic benefits.

   a. Maintain / Reduce operations and maintenance costs

   b. Maintain / Reduce capital costs

   c. Reduction in electrical losses in the transmission and distribution system

   d. Number of operations of various existing equipment types (such as voltage regulation) before and after adoption of a new smart grid component, as an indicator of possible equipment life extensions from reduced wear and tear

e. Non-energy economic benefits

f. Improvements in system operation efficiencies stemming from increased utility dispatchability of customer demand side management

g. Co-benefits and co-products (e.g. feed, soil amendment, lithium extraction)

h. Energy Security (reduced energy and energy-related material imports)

4. Environmental benefits

   a. GHG emissions reductions (MMTCO2e)

   b. Criteria air pollution emission reductions

   c. Water savings

   d. Water quality improvement

   e. Waste reductions

   f. Habitat area disturbance reductions

   g. Wildlife fatality reductions (electrocutions, collisions)

5. Safety, Power Quality, and Reliability (Equipment, Electricity System)

   a. Outage number, frequency and duration reductions

   b. Electric system power flow congestion reduction

   c. Forecast accuracy improvement

   d. Public safety improvement and hazard exposure reduction

   e. Utility worker safety improvement and hazard exposure reduction

   f. Reduced flicker and other power quality differences

   h. Reduction in system harmonics

   i. Increase in the number of nodes in the power system at monitoring points

6. Other Metrics (to be developed based on specific projects through ongoing administrator coordination and development of competitive solicitations)

7. Identification of barriers or issues resolved that prevented widespread deployment of technology or strategy

    a. Description of the issues, project(s), and the results or outcomes

    b. Increased use of cost-effective digital information and control technology to improve reliability, security, and efficiency of the electric grid (PU Code § 8360)

    c. Dynamic optimization of grid operations and resources, including appropriate consideration for asset management and utilization of related grid operations and resources, with cost-effective full cyber security (PU Code § 8360)

    d. Deployment and integration of cost-effective distributed resources and generation, including renewable resources (PU Code § 8360)

    e. Development and incorporation of cost-effective demand response, demand-side resources, and energy-efficient resources (PU Code § 8360)

    f. Deployment of cost-effective smart technologies, including real time, automated, interactive technologies that optimize the physical operation of appliances and consumer devices for metering, communications concerning grid operations and status, and distribution automation (PU Code § 8360)

    g. Integration of cost-effective smart appliances and consumer devices (PU Code § 8360)

    h. Deployment and integration of cost-effective advanced electricity storage and peak-shaving technologies, including plug-in electric and hybrid electric vehicles, and thermal-storage air-conditioning (PU Code § 8360)

    j. Provide consumers with timely information and control options (PU Code § 8360)

    k. Develop standards for communication and interoperability of appliances and equipment connected to the electric grid, including the infrastructure serving the grid (PU Code § 8360)

    l. Identification and lowering of unreasonable or unnecessary barriers to adoption of smart grid technologies, practices, and services (PU Code § 8360)

8. Effectiveness of information dissemination

a. Web-based surveys of people viewing materials or participating in program reviews

b. Number of reports and fact sheets published online

c. Number of times reports are cited in scientific journals and trade publications for selected projects

d. Number of information sharing forums held

e. Stakeholders attendance at workshops

f. Technology transfer

9. Adoption of EPIC technology, strategy, and research data/results by others

a. Description/documentation of projects that progress deployment, such as Commission approval of utility proposals for widespread deployment or technologies included in adopted building standards

b. Number of technologies eligible to participate in utility energy efficiency, demand response or distributed energy resource rebate programs

c. EPIC project results referenced in regulatory proceedings and policy reports

d. Successful project outcomes ready for use in California IOU grid (Path to market)

e. Technologies available for sale in the market place (when known)

10. Reduced ratepayer project costs through external funding or contributions for EPIC-funded research on technologies or strategies

a. Description or documentation of funding or contributions committed by others

b. Co-funding provided for solicitations

c. Dollar value of funding or contributions committed by others

2. CPUC Decision 12-05-037 Statutory Guidance

Public Utility Code 740.1 Statutory Guidance

The commission shall consider the following guidelines in evaluating the research, development, and demonstration projects proposed by electrical and gas corporations:

(a) Projects should offer a reasonable probability of providing benefits to ratepayers.

(b) Expenditures on projects which have a low probability for success should be minimized.

(c) Projects should be consistent with the corporation's resource plan.

(d) Projects should not unnecessarily duplicate research currently, previously, or imminently undertaken by other electrical or gas corporations or research organizations.

(e) Each project should also support one or more of the following objectives:

1. Environmental improvement.
2. Public and employee safety.
3. Conservation by efficient resource use or by reducing or shifting system load.
4. Development of new resources and processes, particularly renewables resources and processes which further supply technologies.
5. Improve operating efficiency and reliability or otherwise reduce operating costs.

Public Utility Code 8360 Statutory Guidance

It is the policy of the state to modernize the state's electrical transmission and distribution system to maintain safe, reliable, efficient, and secure electrical service, with infrastructure that can meet future growth in demand and achieve all of the following, which together characterize a smart grid:

(a) Increased use of cost-effective digital information and control technology to improve reliability, security, and efficiency of the electric grid.

(b) Dynamic optimization of grid operations and resources, including appropriate consideration for asset management and utilization of related grid operations and resources, with cost-effective full cyber security.

(c) Deployment and integration of cost-effective distributed resources and generation, including renewable resources.

(d) Development and incorporation of cost-effective demand response, demand-side resources, and energy-efficient resources.

(e) Deployment of cost-effective smart technologies, including real time, automated, interactive technologies that optimize the physical operation of appliances and consumer devices for metering, communications concerning grid operations and status, and distribution automation.

(f) Integration of cost-effective smart appliances and consumer devices.

(g) Deployment and integration of cost-effective advanced electricity storage and peak-shaving technologies, including plug-in electric and hybrid electric vehicles, and thermal-storage air-conditioning.

(h) Provide consumers with timely information and control options.

(i) Develop standards for communication and interoperability of appliances and equipment connected to the electric grid, including the infrastructure serving the grid.

(j) Identification and lowering of unreasonable or unnecessary barriers to adoption of smart grid technologies, practices, and services.

13 Appendix B: Logic Models

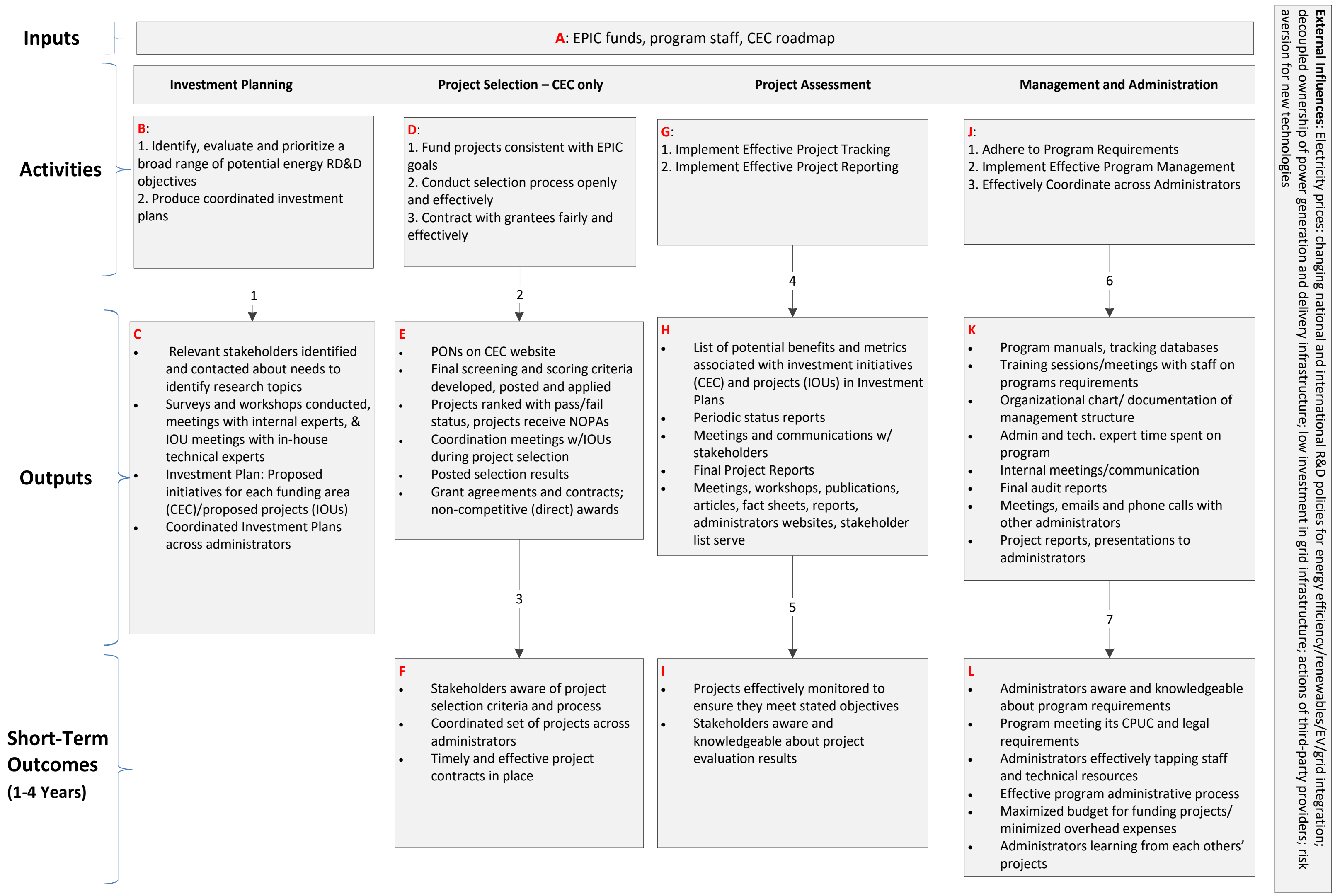
This section presents the more detailed and complex Administration, Applied R&D, TD&D and Market Facilitation logic models that guided our identification of multiple performance metrics that informed our data collection plan.

13.1 Administration Logic Model

Numerous administrative activities support the Program's Applied R&D, TD&D and Market Facilitation investment areas. Comprehensive program administration by the CEC and the IOUs is required to select and fund strategic research projects, monitor and report on project progress and outcomes to a variety of audiences, and meet program legal requirements. Administrative activities are the "oil in the machine" that allows the Program to start, operate and conclude effectively each program cycle.

The following logic model diagram (Figure 26) provides a visual representation of the Program's key administrative activities, expected outputs and outcomes.

Figure 26: Administration Logic Model



Inputs A: EPIC program funding and administrator staff resources are the two key inputs to ensure that projects are solicited, selected fairly, monitored and implemented according to plans/contracts, and that they provide useful results (which get disseminated). In addition, CEC roadmaps provide strategic direction to the Program, as well as guidelines that administrators must follow.

Activities B (Investment Planning): Under the broad category of Investment Planning are two sub-categories of activities: prioritizing a range of R&D objectives and producing coordinated Investment Plans. These initial activities are critical to ensure that each administrator, and the Program as a whole, has a firm set of research and project objectives in mind prior to soliciting specific proposals.

Outputs C: Investment planning activities lead to a range of short-term outputs, including public solicitations for current and important research topics, workshops and surveys to gather stakeholder and expert input, and ultimately strategic and coordinated Investment Plans to guide the next cycle of project selection and funding.

Activities D (Project Selection): Under the broad category of Project Selection are three subcategories of activities: conducting transparent selection processes, funding projects that are expected to meet program goals, and executing contracts with selected grantees. These activities are critical to ensure that the strategic program objectives and current research needs are translated into actual projects. Note that these activities only occur for the CEC; the IOUs select projects to fund during the earlier investment planning stage.

Outputs E: The project selection process should yield several short-term outputs, including issuance of multiple Public Opportunity Notices (PONs), the development and posting of transparent selection criteria, administrator meetings to rank and select projects, posting of the final grantees, and contracts/funding awarded to grantees.

Outcomes F: As the Project Selection process unfolds, stakeholders become more aware and knowledgeable of the process and expectations for selected projects, and can potentially submit higher quality bids going forward. At the conclusion of the process, there should be a coordinated set of selected projects across administrators, as well as contracts in place to initiate those projects.

Activities G (Project Assessment): The broad activity of Project Assessment requires effective project tracking and reporting. At a high level, these activities are critical to ensure that projects move forward (and implementation barriers are addressed), stakeholders are informed of project status, and that project results are disseminated in a wide range of formats.

Outputs H: During the Project Assessment phase, multiple outputs are produced by the program administrators, including periodic status reports, communications with stakeholders, and final project results in a variety of formats (e.g., formal reports, websites, workshops, publications, list serves, etc.).

Outcomes I: As a result of the Project Assessment activities, stakeholders remain informed about the status of specific projects, the projects are effectively monitored to ensure that they meet the contracted research objectives, and a wide range of stakeholders have access to the final project results.

Activities J (Management and Administration): A last set of administrative activities is broadly categorized as Management and Administration. As opposed to the other kinds of activities that require more interaction with the general public, project grantees and research stakeholders, this group of activities is more internally focused. Key sub-activities include implementing effective project/grantee management, coordination with other administrators, and adhering to program requirements.

Outputs K: Management and Administration activities result in a broad set of short-term outputs, including staff allocation and training, program manuals, project monitoring, project tracking databases, internal audit reports, communications with other EPIC administrators, and internal project reporting.

Outcomes L: As a result of ongoing management and administration activities, program staffs become well-versed about program requirements, staff resources and program budgets are used effectively, program administrators are informed about each others' projects, and the Program meets its CPUC and legal requirements.

13.2 Applied R&D Logic Model

In the *2012-2014 EPIC Investment Plan* (EPIC 1), the CEC provided $158.70 million for Applied R&D funding for development of new technologies, methods and approaches from early bench scaleup to pilot scale prototype demonstration. For the *2015-2017 EPIC Investment Plan* (EPIC 2), the CEC provided $151.63 million to support the same activities. The funding areas include energy efficiency and demand response (DR), clean generation, smart grid enabling clean energy and cross-cutting projects. Each strategic objective outlines a set of initiatives focused on a particular area of proposed research (Table 60).

Table 60: Proposed Strategic Objectives for the Applied Research and Development Program Area

Funding Area, by Strategic Objective	
Energy Efficiency and Demand Response	
S1 Strategic Objective: Improve Energy Efficiency Technologies and Strategies in California's Building, Industrial, Agriculture, and Water Sectors.	
S2 Strategic Objective: Enable Cost-Effective Demand Response for California IOU Electricity Customers.	
Clean Generation	
S3 Strategic Objective: Develop Innovative Solutions to Increase the Market Penetration of Distributed Renewable and Advanced Generation.	
S4 Strategic Objective: Improve Power Plant Performance, Reduce Cost, and Accelerate Market Acceptance of Existing and Emerging Utility-Scale Renewable Energy Generation Systems.	
S5 Strategic Objective: Reduce the Environmental and Public Health Impacts of Electricity Generation and Make the Electricity System Less Vulnerable to Climate Impacts.	
Smart Grid Enabling Clean Energy	
S6 Strategic Objective: Advance the Use of Smart Inverters as a Tool to Manage Areas with High Penetrations of PV.	
S7 Strategic Objective: Develop Advanced Distribution Modeling Tools for the Future Smart Grid.	
S8 Strategic Objective: Advance Customer Systems to Coordinate with Utility Communication Systems.	
S9 Strategic Objective: Advance Electric Vehicle Infrastructure to Provide Electricity System Benefits.	
Cross-Cutting	
S10 Strategic Objective: Advance the Early Development of Breakthrough Energy Concepts.	
S11 Strategic Objective: Provide Federal Cost Share for Applied Research Awards.	
Applied Research and Development Program Area Total	**$151.63 million**

Source: California Energy Commission

While the key barrier that the Applied R&D program area addresses is the Technological Valley of Death (or TVD, described later), there are many other barriers such as legal and regulatory, the higher cost of new technologies, performance uncertainty, split incentives, risk avoidance, information-search costs, and a wide variety of technical barriers. This means that the number and types of barriers addressed varies to some extent by project.

Details regarding interrelated program activities engaged in by CEC staff and grantees and how they combine to produce the hypothesized outputs, short-term outcomes, mid-term outcomes and long-term outcomes[88] are provided in Figure 27. Each input, activity, output and outcome in the logic model is assigned a letter and each link is assigned a number. These letters and numbers are for ease of reference and do not indicate a sequence of activities.

Through a review of key documents and an in-depth discussion with CEC staff, we developed an initial understanding of the set of inputs and activities that would lead to certain outputs and outcomes. In addition, literature in the following areas was reviewed: diffusion of innovation, communication through organizational and interpersonal networks, organization decision-making, engineering research methods and software development methods, and evaluations of similar programs. Theories that were found to be especially relevant are discussed below, with the theory discussion broken out by the key program activities presented in the logic model diagram.

The discussion below is organized by program activities and their causal links to outputs, short-term, and mid-term/long-term outcomes. In this way, the reader can focus on specific program intervention activities and whether comparative program findings and/or theory literature provide support for the program theory or suggest concerns that might need to be tested in evaluation or addressed in future program refinement activities.

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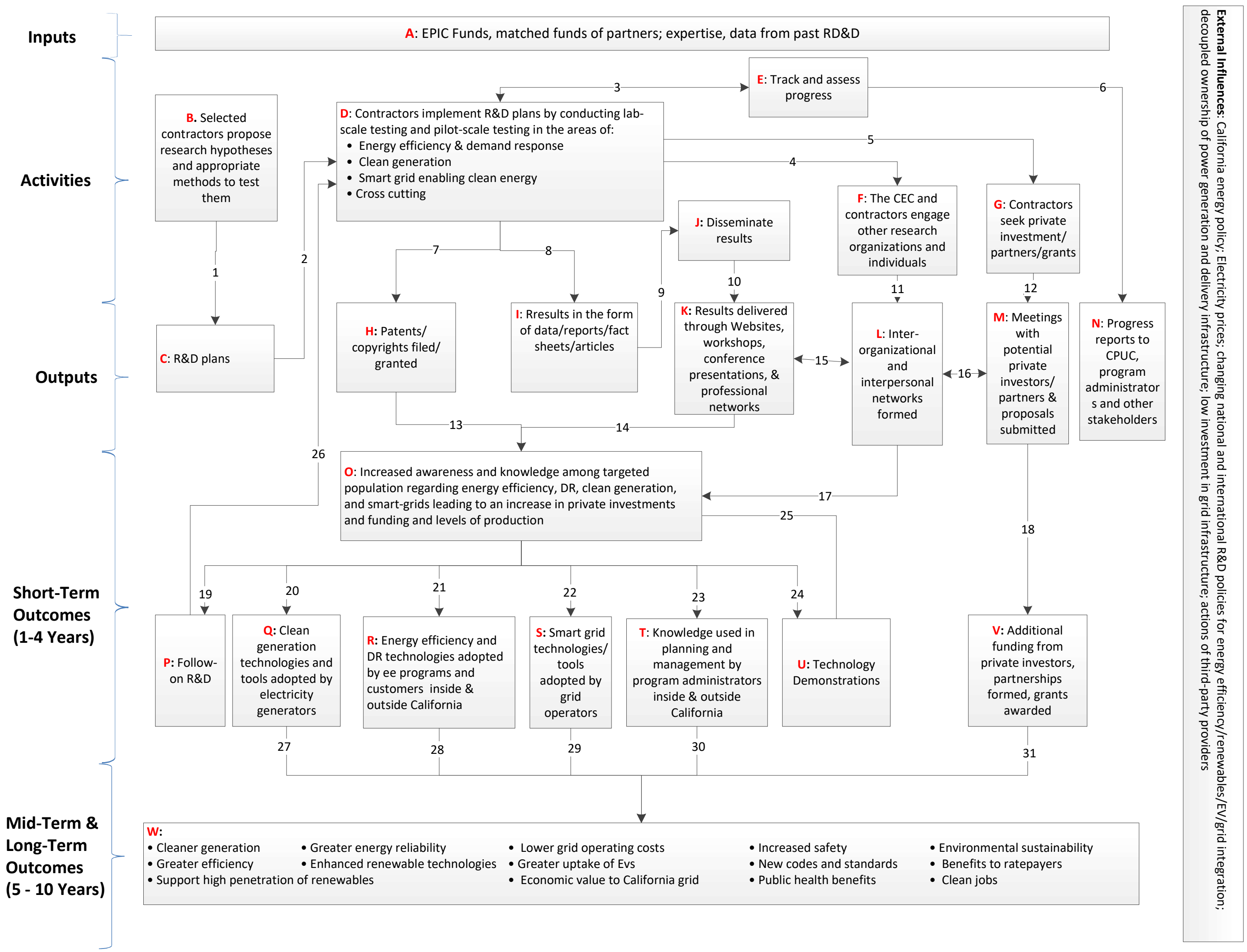
[88] Note that we have not distinguished in the model between mid- and long-term outcomes, since it is difficult to determine which desired outcomes would happen at specific intervals of time. Once the Program has matured, it may be possible to distinguish between mid- and long-term outcomes and indicate associated time horizons (e.g., 5-10 years, 10 years +).

Figure 27: Applied R&D Logic Model



Inputs A: Capital and expertise are the two key inputs into any EPIC Applied R&D project. These come in the form of EPIC funds as well as the matched funds from partners. Expertise provided by the CEC, IOUs, and other interested stakeholders are also essential for these funds to be prudently spent. These experts will also rely on any past research to guide their decisions.

Activities B: The first activity is that contractors are selected by EPIC administrators. In general, it involves reviewing and then selecting proposals for projects in energy efficiency and demand response, clean generation, and smart grid enabling, as well as cross-cutting projects. Proposals are evaluated on a number of administrative and technical criteria, which includes 1) technical merit and need, 2) technical approach, 3) impacts and benefits to California IOU ratepayers, 4) team qualifications, capabilities and resources, 5) budget and cost-effectiveness, 6) funds spent in California and 7) the ratio of direct labor and fringe benefit rates to loaded labor rates. More details regarding this activity are presented in the Administration logic model in Section 13.1.

The awarding of grants to winning bidders is crucial to the mission of Applied R&D, which is to address gaps in the funding necessary to help innovative energy technologies and approaches bridge the TVD.[89] The TVD occurs early in the development of a technology, as breakthrough research and technological concepts aim to achieve commercial proof-of-concept. At this stage, innovators and entrepreneurs conducting basic and applied research need further capital to undergo a process of developing, testing and refining their technologies in order to prove to private funders that these technologies will be viable in markets beyond initial success in the laboratory. However, investors are typically reluctant to fund such early-stage research and product development, largely due to the high technical, market and management execution related risks and long development horizons associated with as-yet-unproven technological concepts. As a result, many entrepreneurial start-up firms and research laboratories fail to accumulate the necessary capital to see their innovative research concepts translated into commercial products and ventures.

This early-stage TVD, while endemic to the development of most innovative technologies, is particularly acute in the energy sector. In this sector, the process of developing technologies is both capital- and time-intensive, and new innovations must quickly compete with well-entrenched and commoditized conventional energy technologies. The early stage expenses necessary for nascent advanced energy technologies to demonstrate market validity, including prototyping and laboratory costs, are significantly higher than for many other sectors. In the "garage culture" of Internet startups, for example, it takes

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[89] J. Jenkins and S. Mansur, "Bridging the Clean Energy Valleys of Death: Helping American Entrepreneurs Meet the Nation's Energy Innovation Imperative." Breakthrough Institute, 2011. http://thebreakthrough.org/blog/Valleys_of_Death.pdf

comparatively little capital or time to advance an innovative research idea or product concept into a provable business plan. In contrast, bringing innovative energy research to its pre-deployment phase requires significant capital and as much as 10 to 15 years.

Venture capitalists usually expect a shorter time frame for exit from an investment (often just three to five years), and the long investment payoff periods typical to new energy technologies only serve to further discourage investors. Alternatively, angel investors, who tolerate high-risk projects, often provide funding for startups in exchange for ownership equity. However, these entities only provide financing on the order of $1–2 million, not nearly enough to bring these capital-intensive projects across the TVD.

Outputs C: Once bidders are selected, they prepare a final research plan in close collaboration with the appropriate subject matter experts at the CEC. This plan should incorporate best research practices which are a necessary condition for a successful project.

Activity D: The research plan is then well managed and faithfully implemented by the project team. However, we recognize that deviations from the original plan will by necessity sometimes occur.

Activity E: Each project is tracked to assess its progress. As the interim results become available, it is possible that grantees will need to make mid-course corrections in the research design and methods to keep the project on track. Interim results might also indicate that the technology/tool is infeasible and, in close collaboration with CEC staff, conclude that the project should be terminated.

Output N: These progress reports are also delivered to the CPUC, the program administrators and other stakeholders.

Activity F: This activity is concerned with building an essential part of the results-dissemination infrastructure, i.e., a network of organizations and individuals with which to share research results to decrease the uncertainty of new technologies/tools and move them closer to commercialization and deployment.

Activity G: Contractors seek private investment, partners and grants. Grantees are encouraged to identify other sources of funding to help defray the costs to IOU ratepayers and share the inherent risks associated with emerging technologies/tools. They might meet with venture capitalists to present their technology/tool and its clear path to profitability. They could also seek organizations and individuals with whom to partner in order to share the risk or seek public and private grants.

Output M: Meetings are held with potential private investors and partners, and grant proposals are submitted.

Outputs H and I: The results in the form of databases, fact sheets and articles are produced and, in some cases, patents and copyrights are granted.

Activity J: Any new knowledge must be effectively disseminated if it is to change behavior and advance the new technologies, methods and approaches. To disseminate this new knowledge, the CEC, CPUC, and IOUs rely on a variety of paths to reach their target audiences including websites, workshop presentations and conference presentations. While journal articles and other professional publications reach their subscribers, the CEC, CPUC, and IOUs attempt to broaden their reach by making them available on the websites and at workshops and conferences.

Output K: Results are posted on the CEC, CPUC, and IOU websites, workshops are held for interested parties, and presentations are made at professional conferences and delivered to a variety of organizations and individuals that comprise their professional network.

Output L: Another way to reach the various target audiences is through a network of individuals and organizations with which to share research results in order to decrease the uncertainty and cost of new technologies/tools and move them closer to commercialization and deployment. While networks can form naturally, the CEC and the IOUs have intentionally sought out other individuals and organizations that have expressed an interest in EPIC (Activity F). That these individuals and organizations have a shared interest is important: "A fundamental principle of human communication is that the exchange of ideas occurs most frequently between individuals and organizations who are alike, or homophilous. Homophily is the degree to which a pair of individuals who communicate are similar."[90]

As a result of Activity F, complex inter-organizational and interpersonal networks are formed. The nature of each network depends on the interests of each member. For example, those interested in efficient technologies might belong to one network with sub-groups formed around a particular end use such as lighting or HVAC. Other networks might form among those interested in public policy surrounding energy innovations such as the CPUC, CEC and IOUs. Interactions among network members can vary with respect to frequency, reciprocity, connectedness,[91] and the types of information and resources shared.[92]

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[90] Everett M. Rogers, *Diffusion of innovations* (New York: The Free Press, 2003), 305.
[91] Connectedness refers to the extent to which the actors are able to connect to each other through the network. If there is no path from one actor to the other actor, then the two actors are disconnected.
[92] Martin Kilduff and Wenpin Tsai, *Social Networks and Organizations* (Los Angeles: SAGE Publications, 2009).

There could be multiple networks: ones established by the CEC, ones established by the grantees, and ones established by the IOUs. There could also be some considerable overlap in network membership. The efficacy of building and maintaining such dissemination networks as a way of communicating important information is highlighted in the diffusion of innovation literature.[93] When cooperation is high among members of a network with similar interests, one can think of the network communications as an exercise in group problem solving.

Outcome O: The Outputs H, I, K and L combine to increase awareness and knowledge among targeted population regarding energy efficiency, demand response, clean generation and smart grids. This, in turn, leads to a reduction in key barriers to the commercialization and adoption of these new technologies and tools.

Short-Term Outcomes P, Q, R, S, T, U and V: Changes in behavior follow from Outcome O including 1) the conduct of additional research (follow-on R&D), 2) the adoption of clean generation technologies and tools by electricity providers, 3) the adoption of energy efficiency and demand response technologies by energy efficiency and demand response programs, 4) the adoption of smart grid technologies and tools by grid operators, 5) the use of new knowledge in planning and management by program administrators, and 6) the formation of partnerships and the obtaining of additional grants and funding from private investors. It is also possible that some completed R&D projects could be selected for demonstration in a lab or at customer sites.

Mid-Term & Long-Term Outcomes W: As a result of the short-term outcomes, over time, the adoption and use of these technologies, methods and approaches will increase in the targeted populations, eventually leading to a broad set of mid-term and long-term large-scale outcomes such as cleaner electricity generation, greater energy reliability and increased safety.

External Influences: There are many external factors that can also influence the Applied R&D program area at all levels and time frames. These factors include:

- California energy policy
- Electricity prices
- Changing national and international R&D policies for energy efficiency/renewables/EV/grid integration
- Decoupled ownership of power generation and delivery infrastructure
- Low investment in grid infrastructure

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[93] Rogers, *Diffusion of Innovations*; Jesse H. Ausubel and H. Dale Langford, *Technological Trajectories and the Human Environment* (Washington DC: National Academy Press, 1997).

- Actions of third-party providers
- Risk aversion for new technologies

13.3 TD&D Logic Model

In the *2012-2014 EPIC Investment Plan* (EPIC 1), the CEC provided $129.9 million to test new technologies in conditions that approximate real-world applications. In the *2015-2017 EPIC Investment Plan* (EPIC 2), the CEC provided $145.02 million to support the same activities. The EPIC 2 funding areas vary slightly from the EPIC 1 funding areas (see Table 61 and Table 62). While EPIC 1 addresses grid reliability (S14), EPIC 2 is focused specifically on three areas of improving grid reliability (S14, S15 and S16). In addition, while EPIC 1 addresses clean energy generation (S13), EPIC 2 focuses specifically on Biomass-to-Energy Conversion Systems (S13). Because relatively few EPIC 2 projects have launched, this evaluation will focus primarily on EPIC 1 projects.

Table 61: EPIC 1 Proposed Funding Allocation for the Technology Demonstration and Deployment Program Area by Strategic Objective

Funding Area
S12 Strategic Objective: Demonstrate and Evaluate the Technical and Economic Performance of Emerging Energy Efficiency and Demand-Side Management Technologies and Strategies
S13 Strategic Objective: Demonstrate and Evaluate Emerging Clean Energy Generation Technologies and Deployment Strategies
S14 Strategic Objective: Demonstrate the Reliable Integration of Energy Efficient Demand-side Resources, Distributed Clean Energy Generation, and Smart Grid Components to Enable Energy-Smart Community Development
S15 Strategic Objective: Provide Cost Share for Federal Awards

Table 62: EPIC 2 Proposed Funding Allocation for the Technology Demonstration and Deployment Program Area by Strategic Objective

Funding Area
S12 Strategic Objective: Overcome Barriers to Emerging Energy Efficiency and Demand-Side Management Solutions Through Demonstrations in New and Existing Buildings
S13 Strategic Objective: Demonstrate and Evaluate Biomass-to-Energy Conversion Systems, Enabling Tools, and Deployment Strategies
S14 Strategic Objective: Take Microgrids to the Next Level: Maximize the Value to Customers
S15 Strategic Objective: Demonstrate Advanced Energy Storage Interconnection Systems to Lower Costs, Facilitate Market and Improve Grid Reliability
S16 Strategic Objective: Expand Smart Charging and Vehicle-to-Grid Power Transfer for Electric Vehicles
S17 Strategic Objective: Provide Federal Cost Share for Technology Demonstration and Deployment Awards

Source: California Energy Commission

While the key barrier that the TD&D program area addresses is the Commercialization Valley of Death (or CVD, described later), there are many other barriers such as legal and regulatory, the higher cost of new technologies, performance uncertainty, split incentives, risk avoidance, information-search costs and a wide variety of technical barriers. This means that the number and types of barriers addressed varies to some extent by project.

Details regarding interrelated program activities engaged in by CEC staff and grantees and how they combine to produce the hypothesized outputs, short-term outcomes, mid-term outcomes and long-term outcomes[94] are provided in the logic model. Each input, activity, output and outcome in the logic model is assigned a letter and each link is assigned a number. These letters and numbers are for ease of reference and do not indicate a sequence of activities. Finally, the potential performance indicators for each activity in this logic model are presented.

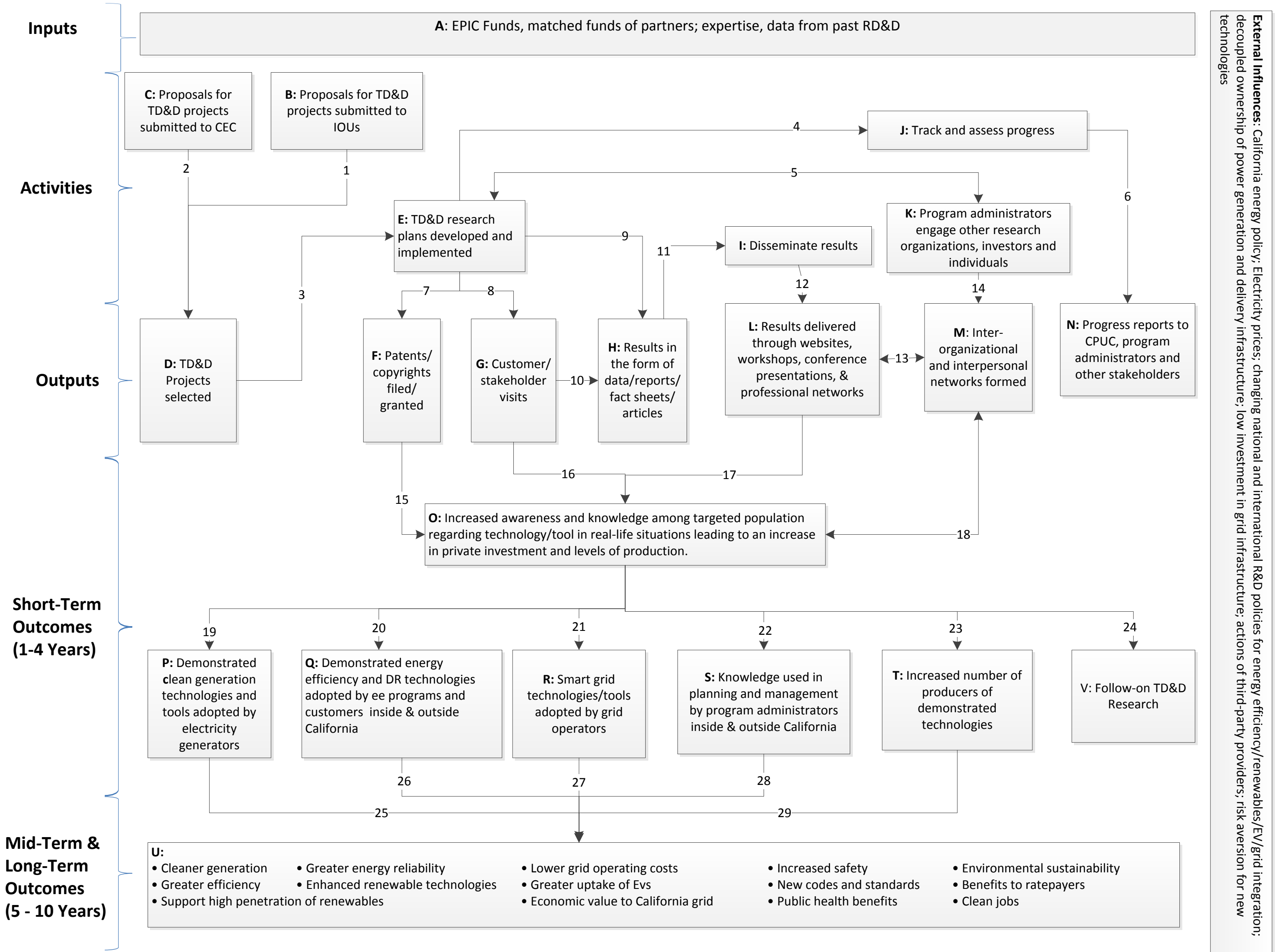
Through a review of key documents and an in-depth discussion with CEC staff, we developed an initial understanding of the set of inputs and activities that would lead to certain outputs and outcomes. In addition, literature in the following areas was reviewed: diffusion of innovation, communication through organizational and interpersonal networks, organization decision-making, engineering research methods and software

[94] Note that we have not distinguished in the model between mid- and long-term outcomes, since it is difficult to determine which desired outcomes would happen at specific intervals of time. Once the Program has matured, it may be possible to distinguish between mid- and long-term outcomes and indicate associated time horizons (e.g., 5-10 years, 10 years +).

development methods, and evaluations of similar programs. Theories that were found to be especially relevant are discussed below, with the theory discussion broken out by the key program activities presented in the logic model diagram.

The discussion below is organized by program activities and their causal links to outputs and short-term and mid-term/long-term outcomes. In this way, the reader can focus on specific program intervention activities and whether comparative program findings and/or theory literature provide support for the program theory or suggest concerns that might need to be tested in evaluation or addressed in future program refinement activities.

Figure 28: TD&D Logic Model



Inputs A: Capital and expertise are the two key inputs into any EPIC TD&D project. These come in the form of EPIC funds as well as the matched funds from partners. Expertise provided by the CEC, IOUs, and other interested stakeholders are also essential for these funds to be spent prudently. These experts will also rely on any past research to guide their decisions.

Activities B and C: Once technologies have been successfully tested in bench-scale systems and meet pre-defined performance targets, the technologies must be fully demonstrated and deployed in actual commercial applications to document the benefits and savings in real-world conditions. Demonstrations and large-scale deployments are necessary in real-world conditions to independently document technical feasibility; validate energy, water and cost savings, and environmental benefits; resolve regulatory barriers; and determine overall life-cycle economics. Without an independent assessment of technical and economic viability, these technologies and strategies lack a solid value proposition to potential customers and often do not make it past the CVD, which exists between the pilot/demonstration and commercialization phases of the technological development cycle and aligns with a gap between the traditional role of venture capital and the later stage investments of project finance and debt/equity investors.[95]

Demonstrations of multiple, integrated demand-side management technologies are required to document the synergies, overall economics and other benefits of combining technologies that would result in the greatest ratepayer benefits. These demonstrations are especially necessary to establish the right mix of technologies for particular applications, document technical and economic feasibility, and minimize risk to building owners/operators. Key features of a demonstration include that it is open to the public or to an interest group, that many viewers are encouraged to visit, and that it may highlight a systems approach rather than an individual measure.

Public funding for demonstrations to bridge the CVD is essential. The private sector does not typically conduct applied research and is risk-averse regarding new, unproven technologies, often lacking the resources to analyze and evaluate various technologies. Frequently, new technologies are developed in academic communities that do not have the funding for large-scale demonstrations. Typically, the private sector only offers funding after a successful field demonstration.

[95] Jenkins, J., and Mansur, S. 2011. "Bridging the Clean Energy Valleys of Death: Helping American Entrepreneurs Meet the Nation's Energy Innovation Imperative." Breakthrough Institute. http://thebreakthrough.org/blog/Valleys_of_Death.pdf

The importance of demonstration sites in reducing uncertainty among key stakeholders was highlighted in the diffusion of innovations literature.[96] Rogers and Shoemaker[97] also provides us with a list of five factors of the product or service that influence the rate of diffusion. These five factors are the following:

1. *Relative advantage*: The perceived relative advantage compared to the previous product/service, including economic, social prestige, convenience and satisfaction.
2. *Compatibility*: The degree to which the product/service is perceived to be consistent with existing values, past experiences and needs.
3. *Complexity*: The degree of difficulty of understanding the product/service—the more difficult it is, the longer it takes for acceptance/adoption.
4. *Trialability*: The degree to which the new product can be tried on an "installment plan" basis.
5. *Observability*: The degree to which the product can be observed in use fulfilling similar needs for others.

While the TD&D program area attempts to address all five of the attributes through the development of technology demonstrations, relative advantage and observability have been found to be most important.[98] However, they go on to point out that, while customers can be invited to buildings where a given technology has been installed, it remains difficult to observe reduced energy use and the complexity of new innovations. The TD&D program area attempts to overcome this problem by monitoring each technology in a laboratory or field setting to verify its energy and demand savings and providing very detailed project descriptions that provide information beyond what can be seen.

The CEC and the three IOUs consider proposals for TD&D projects from a variety of sources.

Output D: The TD&D projects are selected that have the greatest potential energy and non-energy benefits and have the highest risk of falling into the CVD.

Output E: A final demonstration project research plan is developed by the CEC grantees and the IOU project managers in close collaboration with the appropriate subject matter experts. This plan should incorporate best research practices which are a necessary condition for a successful project. The demonstration site is then launched, and the

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[96] Rogers, *Diffusion of innovations*.
[97] Everett M. Rogers with F. Floyd Shoemaker, *Communication of innovations: A cross-cultural approach* (New York: Free Press, 1971), 137-157.
[98] John H. Reed and Nicholas P. Hall, "Methods for measuring market transformation." Proceedings of the International Energy Evaluation Conference, 1997, 177-184.

research plan is faithfully implemented by the project team. However, we recognize that deviations from the original plan will by necessity sometimes occur.

Output F: At some point during and/or after the completion of a given project, patents might be filed and granted. In addition, the results of some projects might be copyrighted or licensed.

Output G: Customers and other stakeholders, including potential investors, visit the customer site or laboratory where the technology is being demonstrated.

Outputs H: The results in the form of final reports, databases, fact sheets, journal articles and trade magazine articles are produced.

Activity I: Any new knowledge must be effectively disseminated if it is to change behavior and advance the new technologies, methods and approaches. To disseminate this new knowledge, the CEC, CPUC and the IOUs rely on a variety of paths to reach their target audiences including websites, workshop presentations and conference presentations. While the journal articles and other professional publications reach their subscribers, the CEC, CPUC and IOUs attempt to broaden their reach by making them available on their websites and at workshops and conferences.

Output L: Results are posted on the CEC, CPUC and IOU websites, workshops are held for interested parties, and presentations are made at professional conferences and delivered to a variety of organizations and individuals that comprise their professional network.

Activity J: Each project is tracked to assess its progress. As the interim results become available, it is possible that grantees will need to make mid-course corrections in the research design and methods to keep the project on track. Interim results might also indicate that the technology/tool is infeasible and, in close collaboration with CEC staff, conclude that the demonstration project should be terminated.

Output N: These progress reports are also delivered to the CPUC, the program administrators and other stakeholders.

Activity K: This activity is concerned with building an essential part of the results-dissemination and collaboration infrastructure, i.e., a network of potential investors, technology manufacturers, research organizations and individuals with whom to share ideas, resources and research results to decrease the uncertainty of new technologies/tools and move them closer to commercialization and deployment.

Output M: Another way to reach the various target audiences is through a network of potential investors, technology manufacturers, research organizations, and individuals with whom to share ideas, resources and research results in order to decrease the uncertainty and cost of new technologies/tools and move them closer to commercialization and deployment. While networks can form naturally, the CEC and the IOUs have intentionally sought out other individuals and organizations that have expressed an interest in EPIC. That these individuals and organizations have a shared interest is important: "A fundamental principle of human communication is that the exchange of ideas occurs most frequently between individuals and organizations who are alike, or homophilous. Homophily is the degree to which a pair of individuals who communicate are similar."[99]

As a result of Output M, complex interorganizational and interpersonal networks are formed. The nature of each network depends on the interests of each member. For example, those interested in efficient technologies might belong to one network with sub-groups formed around a particular end use such as lighting or HVAC. Other networks might form among those interested in public policy surrounding energy innovations such as the CPUC, the CEC and the IOUs. Interactions among network members can vary with respect to frequency, reciprocity, connectedness[100] and the types information and resources shared.[101] Of course, private investors are a key audience for every demonstration since additional capital is needed to increase level of production.

There could be multiple networks, ones established by the CEC, ones established by the grantees, and ones established by the IOUs. There could also be some considerable overlap in network membership. The efficacy of building and maintaining such dissemination networks as a way of communicating important information is highlighted in the diffusion of innovation literature.[102] When cooperation is high among members of a network with similar interests, one can think of the network communications as an exercise in group problem solving.

Outcome O: The Outputs I, J, K, O and Q combine to increase awareness and knowledge among targeted populations regarding real technologies/tools in real life situations and a subsequent reduction in key market barriers. This in turn leads to an increase in private sector investments and levels of production.

Short-Term Outcomes P, Q, R, S, T and V: Changes in behavior follow from Outcome O including: 1) the adoption of clean generation technologies and tools by electricity providers, 2) the adoption of energy efficiency and DR technologies by energy efficiency and DR programs, 3) the adoption of smart grid technologies and tools by grid operators, 4) the use of new knowledge in planning and management by program administrators, 5)

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[99] Rogers, *Diffusion of innovations*, 305.
[100] Connectedness refers to the extent to which the actors are able to connect to each other through the network. If there is no path from one actor to the other actor, then the two actors are disconnected.
[101] Kilduff and Tsai, *Social Networks and Innovations*.
[102] Rogers, *Diffusion of innovations*; Ausubel and Langford, *Technological Trajectories*.

an increase in the number of producers of demonstrated technologies, and 6) follow-on TD&D research.

Mid-Term & Long-Term Outcomes U: As a result of the short-term outcomes, over time, the adoption and use of these technologies, methods and approaches will increase in the targeted populations, leading eventually to a broad set of mid-term and long-term large-scale outcomes such as cleaner electricity generation, greater energy reliability and increased safety.

External Influences: There is a wide variety of external factors that can also influence the TD&D area at all levels and time frames. These factors include:

- California energy policy;
- Electricity prices;
- Changing national and international R&D policies for energy efficiency/renewables/EV/grid integration;
- Decoupled ownership of power generation and delivery infrastructure;
- Low investment in grid infrastructure;
- Actions of third-party providers; and
- Risk aversion for new technologies.

The research designs should attempt to control for these external factors so that any impacts of the TD&D program area can be observed.

13.4 Market Facilitation Logic Model

For the 2015-2017 EPIC Investment Plan, the CEC has provided $53.27 million for Market Facilitation funding which encompasses a range of activities that include program tracking, market research, education and outreach, regulatory assistance and streamlining, and workforce development to support clean energy technology and strategy deployment.

The key barrier that the Market Facilitation program area addresses is the "Commercialization Valley of Death." As Jenkins and Mansur observe in their monograph, *A Clean Energy Deployment Administration,* "many energy technologies fall prey to this Commercialization Valley of Death [CVD], having exhausted the (comparatively) small investments of venture capitalists yet remaining too risky to be attractive to traditional debt or equity finance." The CVD also includes a variety of non-technical and structural barriers embedded in the existing market environment. These barriers to accelerating the commercial viability of high-priority technologies and strategies may generally be classified as follows:

1. Supply-side barriers that impede entrepreneurs from successfully bringing their innovations to market;
2. Demand-side barriers that inhibit customers from purchasing and adopting clean energy technology innovations;
3. Regulatory barriers that block or delay the market implementation of the innovations; and
4. Information barriers that hinder complete knowledge and rational decisions with respect to clean energy technologies.

The strategic objectives for Market Facilitation guide the development of initiatives and activities that address such non-technical and structural barriers. Accordingly, Market Facilitation funding areas include activities associated with fostering commercialization, facilitating procurement, enhancing permitting, and conducting market and technical analysis. Each strategic objective has a set of associated initiatives/activities (Table 63).

Table 63: Strategic Objectives for the Market Facilitation Program Area

Funding Area, by Strategic Objective
Foster the Development of the Most Promising Energy Technologies into Successful Businesses.
S1 Facilitate a Commercialization Assistance Network to Foster Successful Clean Energy Entrepreneurship.
S2 Integrate Market Insight into the Selection and Management of EPIC Funded Technologies and Strategies.
S3 Provide Support for Entrepreneurs to Test, Verify, and Certify their Innovations.
Facilitate Inclusion of Emerging Clean Energy Technologies into Large-Scale Procurement Processes
S4 Develop Tools and Strategies to Encourage Large-Scale Purchasers to Adopt Emerging Energy Technologies.
S5 Facilitate Innovative Procurement Strategies to Reduce Costs for Clean Energy Technologies.
Accelerate the Deployment of Energy Technologies in IOU Territories Through Innovative Local Planning and Permitting Approaches
S6 Develop Innovative Approaches to Integrate Utility and Local Government Planning for Emerging Technology Deployment.
S7 Develop Innovative Strategies to Streamline the Permitting Process for Zero Net Energy Buildings.

Funding Area, by Strategic Objective	
Inform Investments and Decision-Making Through Market and Technical Analysis	
S8 Conduct Analyses on Different Technology Options and Strategies for the Electricity System.	
S9 Develop a Clearinghouse for Advanced Energy Technologies, Strategies and Tools.	
S10 Measure and Verify the Ratepayer Benefits of EPIC-funded Innovations	
Applied Research and Development Program Area Total	**$53.27 million**

Source: California Energy Commission

Details regarding interrelated program activities engaged in by CEC staff and grantees and how they combine to produce the hypothesized outputs, short-term outcomes, mid-term outcomes and long-term outcomes[103] are provided in the logic model. Each input, set of activities, set of outputs and set of outcomes in the logic model is assigned a letter and each link is assigned a number. These letters and numbers are for ease of reference and do not indicate a sequence of activities. Finally, the potential performance indicators for each activity in this logic model are presented.

Through a review of key documents and an in-depth discussion with CEC staff, we developed an initial understanding of the set of inputs and activities that would lead to certain outputs and outcomes. In addition, literature in the following areas was reviewed: diffusion of innovation, communication through organizational and interpersonal networks, organization decision-making, engineering research methods and software development methods, and evaluations of similar programs. Theories that were found to be especially relevant are discussed below, with the theory discussion broken out by the key program activities presented in the logic model diagram.

The discussion below is organized by program activities and their causal links to outputs and short-term and mid-term/long-term outcomes. In this way, the reader can focus on specific program intervention activities and whether comparative program findings and/or theory literature provide support for the program theory or suggest concerns that might need to be tested in evaluation or addressed in future program refinement activities.

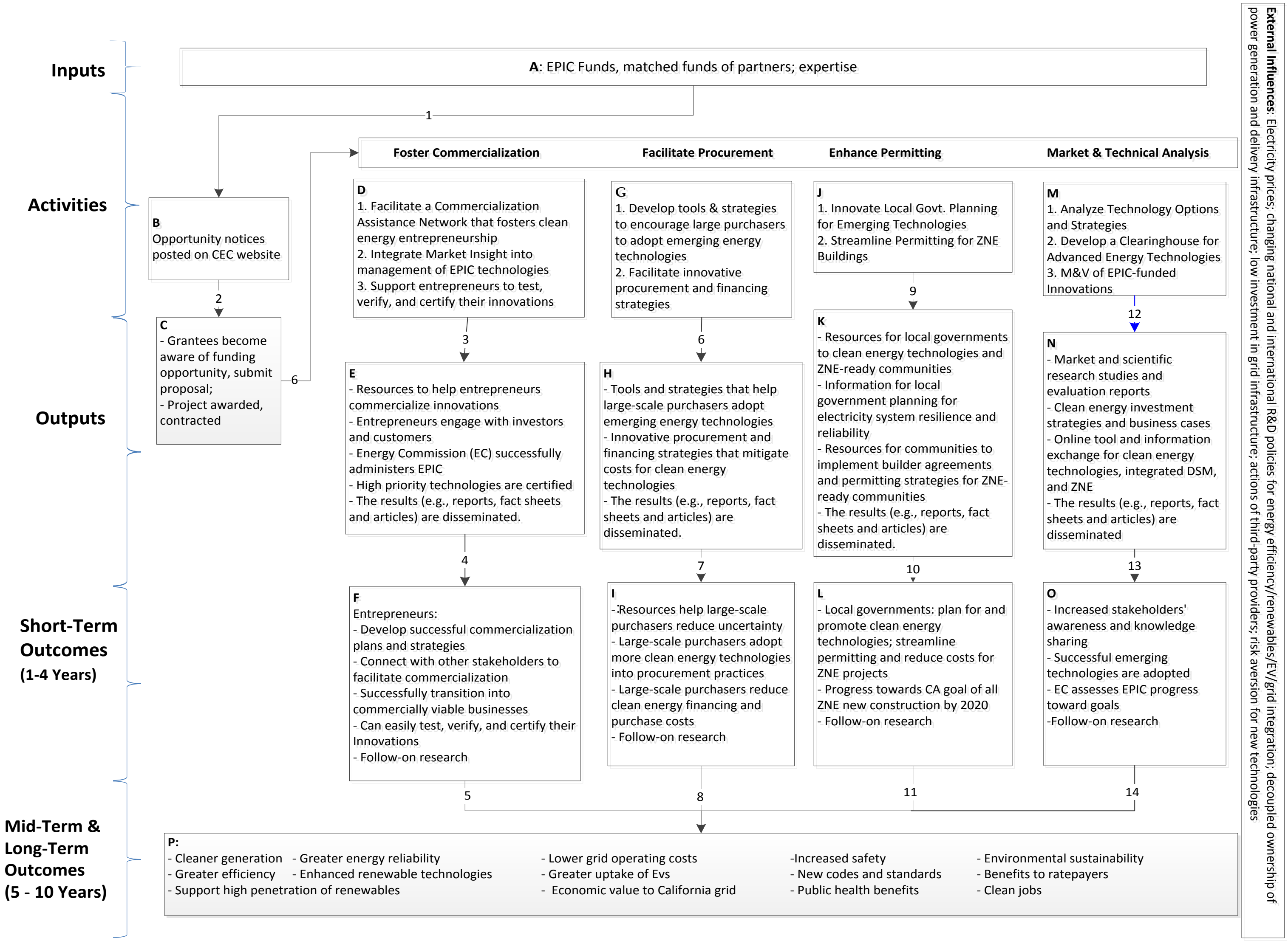
[103] Note that we have not distinguished in the model between mid- and long-term outcomes, since it is difficult to determine which desired outcomes would happen at specific intervals of time. Once the Program has matured, it may be possible to distinguish between mid- and long-term outcomes and indicate associated time horizons (e.g., 5-10 years, 10 years +).

Input A: Capital and expertise are the two key inputs into any EPIC Market Facilitation project. These come in the form of EPIC funds as well as the matched funds from partners. Expertise provided by the CEC, IOUs, and other interested stakeholders are also essential for these funds to be prudently spent. These experts will also rely on any past research to guide their decisions.

Activity B: Opportunity notices posted on CEC website.

Activities C: Grantees become aware of funding opportunity and submit proposal; projects are awarded and contracts signed.

Figure 29: Market Facilitation Logic Model



13.4.1 Foster Commercialization

Activities D: The activities to foster commercialization include: 1) Facilitate a Commercialization Assistance Network that fosters clean energy entrepreneurship, 2) Integrate market insight into management of EPIC technologies, and 3) Support entrepreneurs to test, verify, and certify their innovations. In their monograph, *A Clean Energy Deployment Administration,* Jenkins and Mansur also note that, "The Commercialization Valley of Death represents an institutional barrier, as no particular set of private actors or institutions is well equipped or willing to bear the risks or invest the capital on their own to help an energy technology cross the bridge between development and deployment." A critical element of this barrier is that investors need assurance of the technical viability and marketability of the innovations. The activities to foster commercialization are intended to address this barrier by helping entrepreneurs make business connections, gain market knowledge, and certify their technologies.

Outputs E: The activities to foster commercialization will result in resources that will help entrepreneurs commercialize innovations such as business networks, information and commercialization tools, market research, and access to testing and certification. Results such as final reports, fact sheets and articles are published and disseminated to target audiences.

Short-Term Outcomes F: The resulting outcomes will be that entrepreneurs use the information and commercialization tools and market research to develop effective commercialization plans and strategies, leverage the business networks to connect with other stakeholders, and access testing and certification to certify their clean energy technologies. All of these will serve to streamline the path of entrepreneurs to the successful commercialization of their innovations.

13.4.2 Facilitate Procurement

Activities G: The activities to facilitate procurement include: 1) Develop tools and strategies to encourage large purchasers to adopt emerging energy technologies, and 2) Facilitate innovative procurement and financing strategies. In his book, *Crossing the Chasm*, Geoffrey Moore posits that a key approach to bridging the CVD is to cultivate "champions" among early adopters.[104] In the context of the EPIC Market Facilitation initiatives, large procurers such as military bases, government facilities, the University of California and building developers are targeted as these prospective champions and early adopters. Adoption of the technologies by such large customers can help create the early market pull that provides entrepreneurs with the volume of sales needed to scale up production and establish a foothold in the market.

[104] Geoffrey A. Moore, *Crossing the Chasm* (New York: Harper Business Essentials, 2014).

Outputs H: The activities to facilitate procurement will result in tools and strategies that reduce risks associated with purchasing decisions for clean energy—thereby increasing incorporation of emerging energy technologies into large-scale purchasers' procurement strategies—and reduce the costs for large-scale purchasing of clean energy technologies through collaborative purchasing arrangements and innovative financing mechanisms. Results such as final reports, fact sheets and articles are published and disseminated to target audiences.

Short-Term Outcomes I: The resulting outcomes will be that large-scale purchasers will have resources that reduce the technical and financial risks of adopting new clean energy technologies, increase the incorporation of the technologies into their procurement practices, and adopt more clean energy technologies.

13.4.3 Enhance Permitting

Activities J: The activities to enhance permitting include: 1) Helping local governments make innovations and changes to their information and planning for emerging clean energy technologies, and 2) Helping local governments streamline their permitting processes for Zero Net Energy (ZNE) buildings and communities. The environment for distributed energy resources and emerging clean energy technologies is undergoing significant changes. Energy end-users are increasingly taking advantage of opportunities to become ZNE users and energy providers. Inadequate funding also has slowed the response of local governments to improve preparedness for extreme and manmade emergency events. Local government regulations, permitting and land use requirements may be challenged in trying to keep up with these changes. Accordingly, these activities are aimed at aiding local governments by providing needed information and tools and helping streamline their regulations and processes to facilitate the timely deployment of applicable technologies. Results such as final reports, fact sheets and articles are published and disseminated to target audiences.

Outputs K: The activities to enhance permitting will result in the development of resources for local governments to upgrade regulations for clean energy technologies and ZNE-ready communities, information to help local government planning for resilience and reliability of electricity systems, and resources for communities to implement builder agreements and permitting strategies for ZNE-ready communities.

Short-Term Outcomes L: The resulting outcomes will be that local governments plan for and promote clean energy technologies, streamline permitting and reduce costs for implementation of ZNE projects. This, in turn, will further progress towards achievement of the goal of 100 percent ZNE new construction in California by 2020.

13.4.4 Conduct Market and Technical Analysis

Activities M: The market and technical analysis activities include: 1) Analyses of technology options and strategies, 2) Development of a clearinghouse for advanced energy technologies, and 3) Measurement and verification of EPIC-funded innovations. The clean energy market is in a state of flux and rapid change. In such an environment, the barriers to adoption of clean energy technologies may not be readily obvious. Additionally, the California clean energy goals set by the recent SB 350 has intensified the need for implementation of clean energy technologies, further underscoring the importance of ensuring the optimal allocation of EPIC funds in technologies that provide the greatest ratepayer benefits. All of these trends make it essential to conduct research on gap analyses, scenario assessments and other decision-making tools. Accordingly, these activities are aimed at supporting market and technical analyses to provide guidance on available technology options and ensuring that EPIC funding is achieving program goals.

Outputs N: The market and technical analysis activities will result in the production of market and scientific research studies and evaluation reports, clean energy investment strategies and business cases, and an online tool and information exchange for clean energy technologies, integrated DSM, and ZNE. Results such as final reports, fact sheets and articles are published and disseminated to target audiences.

Short-Term Outcomes O: The resulting outcomes will be that stakeholders have higher awareness of clean energy technologies and there is greater knowledge sharing and successful adoption of the technologies; the CPUC will also make a credible assessment of progress towards EPIC goals.

13.4.5 Mid-Term & Long-Term Outcomes P

As a result of the short-term outcomes, over time, the adoption and use of these technologies, methods and approaches will increase in the targeted populations leading eventually to a broad set of mid-term and long-term large-scale outcomes such as cleaner electricity generation, greater energy reliability and increased safety.

13.4.6 External Influences

There is a wide variety of external factors that can also influence the Market Facilitation program area at all levels and time frames. These factors include:

- California energy policy;
- Electricity prices;
- Changing national and international R&D policies for energy efficiency/renewables/EV/grid integration;
- Decoupled ownership of power generation and delivery infrastructure;
- Low investment in grid infrastructure;

- Actions of third-party providers; and
- Risk aversion for new technologies.

The research designs should attempt to control for these external factors so that any Program impacts may be observed.

13.5 Selected References for Appendix B

Atkinson, Rob, Netra Chhetri, Joshua Freed, Isabel Galiana, Christopher Green, Steven Hayward, Jesse Jenkins, Elizabeth Malone, Ted Nordhaus, Roger Pielke Jr., Gwyn Prins, Steve Rayner, Daniel Sarewitz, and Michael Shellenberger. "Climate Pragmatism." The Hartwell Group, July 2011.

Ausubel, Jesse H. and H. Dale Langford. *Technological Trajectories and the Human Environment*. Washington D. C.: National Academy Press, 1997.

California Energy Commission. *The Electric Program Investment Charge: Proposed 2012-2014 Triennial Investment Plan*, Staff Report. Publication Number CEC-500-2012-082-CMF, 2012.

California Energy Commission. *The Electric Program Investment Charge: Proposed 2015-2017 Triennial Investment Plan*. California Energy Commission. Publication Number: CEC-500- 2014-038-CMF, 2014.

Jenkins, J., and S. Mansur. *A Clean Energy Deployment Administration: Unlocking Advanced Energy Innovation and Commercialization*. Breakthrough Institute, 2011. http://thebreakthrough.org/blog/CEDA.pdf

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Kilduff, Martin and Wenpin Tsai. *Social Networks and Organizations*. Los Angeles, California: SAGE Publication, 2009.

Moore, Geoffrey A. *Crossing the Chasm*. New York, NY: Harper Business Essentials, 2014.

Reed, John H. and Nicholas P. Hall. "Methods for measuring market transformation." Proceedings of the International Energy Evaluation Conference, August 1997, 177-184.

Rogers, Everett M. *Diffusion of innovations*. New York: The Free Press, 2003.

Rogers, Everett M., with F. Floyd Shoemaker. *Communication of innovations: A cross-cultural approach*. New York: Free Press, 1971.

14 Appendix C: Best Practices Assessment Results Memorandum

This section presents the findings from two research tasks associated with the Best Practices Assessment: a literature review and in-depth interviews. These results were developed and delivered to the CPUC as an interim memo before the evaluation analyses were completed and this report was drafted.

14.1 Literature Review

This section summarizes findings from a literature review of reports and documents relevant to the planning, design, and implementation of innovative energy research, development, and demonstration (RD&D) programs. The team reviewed a total of 38 resources, including reports and white papers, evaluation reports, and webpages. This review will help inform the evaluation of the EPIC program by identifying effective practices summarized in the literature.

14.1.1 Introduction

This review compiles the key learnings from reports and analyses of programs that are designed to increase coordinated investment in new and emerging energy solutions. In particular, this review focuses on key topics of relevance to the EPIC program.

Objectives

The objective of this best practices review is to identify effective practices that have been used to support RD&D programs. This research will help the EPIC program identify improvement opportunities by developing lessons learned and comparing the performance of the EPIC projects to other RD&D programs.

Methodology

To accomplish the objectives of this effort, the Evergreen team conducted a literature review to identify best practices and lessons learned regarding the planning, design, implementation, and evaluation of RD&D programs. In doing so, we identified a selection of programs similar to the EPIC program and reviewed publicly-available evaluation reports and other documents about these programs. These peer programs include:

- Department of Energy’s Small Business Innovation Research Program (SBIR)
- Department of Energy’s Small Business Technology Transfer Program (STTR)
- Department of Energy’s Advanced Research Projects Agency-Energy Program (ARPA-E)
- Department of Energy’s Clean Energy Manufacturing Initiative (CEMI)
- New Mexico Small Business Assistance (NMSBA) Program

- NYSERDA Technology and Market Development Program
- Washington State Clean Energy Fund
- Connecticut Green Bank

In general, program-related documents draw on publically-available reports, evaluations, and other resources related to the peer programs listed above. We primarily tried to cite practices supported by evaluation results, but some programs either did not have publically-available evaluation reports or the reports did not cover the topics of interest for this review. Overall, we documented the evidence as it was available, and plan to further corroborate this information through follow up interviews with program stakeholders. In addition to reviewing reports and documents from these peer programs, we reviewed existing best practices literature that addressed the issues related to the design and implementation of RD&D programs in general (see 14.1.4 for a full listing of programs and related documents). The team plans to take into consideration these various sources to determine the extent to which a particular practice is effective and relevant to the EPIC program.

The team employed a systematic approach to this review, documenting whether a set of elements relevant to the evaluation was present in each document. The research dimensions covered a range of topics, including best practices related to investment planning, implementation, program management and tracking; technology transfer mechanisms; market development mechanisms; and key findings from program- or project-level research/evaluation efforts. See below for the full list of research dimensions.

14.1.2 Summary of Findings

We have distilled the findings from the literature review to correspond with the five research categories that the EPIC evaluation will cover: 1) Investment Planning, 2) Project Selection, 3) Project Assessment, 4) Program Management and Administration, and 5) Contextualized Considerations. Table 64 below presents a general overview of how the reports that we reviewed align with the research dimensions. Overall, documents reviewed for the peer programs offered some background information on factors related to investment planning, and, to some extent, implementation. There was not as much specific information related to topics related to project management, technology transfer mechanisms, or market development mechanisms. The best practices literature covered many of the topics of interest, but in varying levels of detail.

Table 64: Best Practices Reports and Related Dimensions

	Programs								Best Practices Literature									
Research Dimension	DOE SBIR[1]	DOE STTR[1]	DOE APRA-E	CEMI	NMSBA	NYSERDA TMD[1]	WA State Clean Energy Fund	CT Green Bank	Chiavari & Tam, 2011	Hughes et al., 2011	IEA, 2010	Jenkins & Mansur, 2011	Lal, Gupta, & Weber, 2012	Murphy & Edwards, 2003	Townsend & Smith, 2016	USDOT, 2011	Wessner, 2013	WHCC, 2013
	● = supporting documents cover topic in-depth ○ = supporting documents mentioned topic, but do not provide the level of detail relevant to this review																	
Investment Planning (internal and external inputs—stakeholders, experts, etc.)																		
Federal/state/local energy context	●	●	●	●	●	●	●	●			●						○	
Setting goals and priorities	○	○	○	○	○	○	○		●						○			
Market assessment/identification of gaps and opportunities	●	●									●		●					
Plan development processes													○					
Implementation																		
Project identification and selection processes	●	●	●	○	○								○					
Organizational structure (internal and external coordination)	○	○	○	○	○				○				○		○		○	○
Contracting processes																		
Intellectual Property Identification and Protection																		
Market barriers	○	○		○					○		●	●						
Project Management, Tracking, and Reporting																		
During implementation (metrics tracked, reporting frequency, other mechanisms)	○	○	○		○	○		○	○	●								○
After implementation (metrics tracked, reporting frequency, dissemination of results, other mechanisms)	○	○							○	●								

	Programs								Best Practices Literature									
Research Dimension	DOE SBIR[1]	DOE STTR[1]	DOE APRA-E	CEMI	NMSBA	NYSERDA TMD[1]	WA State Clean Energy Fund	CT Green Bank	Chiavari & Tam, 2011	Hughes et al., 2011	IEA, 2010	Jenkins & Mansur, 2011	Lal, Gupta, & Weber, 2012	Murphy & Edwards, 2003	Townsend & Smith, 2016	USDOT, 2011	Wessner, 2013	WHCC, 2013
	● = supporting documents cover topic in-depth ○ = supporting documents mentioned topic, but do not provide the level of detail relevant to this review																	
Technology Transfer Mechanisms																		
Licensing (license agreements, start-ups)										○						●		
Cooperative R&D (CRADAs and Cooperative Research Agreements, government-industry partnership programs)										●	●	○		●	○	●	○	
Technical Assistance (user agreements, work for others, commercial test agreements)										○						●		
Information Dissemination and Exchanges (formal and informal)	○	○								●				●		●		
Other technology transfer mechanisms (consortia, research parks, innovation hubs, advisory committees)										●	○	○		●	○	●		
Market Development Mechanisms																		
Market-readiness facilitation (regulatory environment adjustments, testing and certification, entrepreneur network facilitation)	○	○									●	○	○		○		○	○
Customer/market demand stimulation														○				
Other market development												●						

	Programs								Best Practices Literature									
Research Dimension	DOE SBIR[1]	DOE STTR[1]	DOE APRA-E	CEMI	NMSBA	NYSERDA TMD[1]	WA State Clean Energy Fund	CT Green Bank	Chiavari & Tam, 2011	Hughes et al., 2011	IEA, 2010	Jenkins & Mansur, 2011	Lal, Gupta, & Weber, 2012	Murphy & Edwards, 2003	Townsend & Smith, 2016	USDOT, 2011	Wessner, 2013	WHCC, 2013
	● = supporting documents cover topic in-depth ○ = supporting documents mentioned topic, but do not provide the level of detail relevant to this review																	
mechanisms																		
Program- or Project-Level Research/Evaluation																		
Research questions	●	●				●		●										
Methodology	●	●				○		●										
Conclusions	●	●						●										
Recommendations/Lessons Learned	●	●						○	●									
Outcomes (quantitative and qualitative metrics)	●	●						○										

[1] Documents for these programs include at least one program evaluation report which covers topics of interest for this review.

Investment Planning

- ***All of the peer programs noted close alignment between program investments and relevant energy policy environment and frameworks.*** Typically, the federal, state, or local policy environment has a direct bearing on how RD&D programs operate, including how these program prioritize financial and other resource investments. All of the programs included in this review appear to make a strong, connection with overarching policy directives, most of which are energy-focused. For example, the goals and objectives of the DOE-funded SBIR program and its sister program, STTR, clearly reference the Department's mission. As the 2008 evaluation of the SBIR program states, "The SBIR program is structured to support all four mission objectives of DoE [sic] in a manner that parallels the overall allocation of R&D funding to non-weapons programs." (Wessner, 2008). The Connecticut Green Bank similarly recognizes that its goals are tightly aligned with the state's energy policy. The 2015 and 2016 Comprehensive Plan outlines the Bank's mission and goals and states further, "These goals support the implementation of Connecticut's clean energy policies be they statutory (i.e., Public Act 11-80, Public Act 13-298), planning (i.e., Comprehensive Energy Strategy, Integrated Resources Plan), or regulatory in nature."
- ***The best practices literature indicates that programs should additionally allow flexibility for individual projects to build on and enhance public—private partnerships.*** These partnerships may include funding, but other resources such as technical expertise and equipment are also highly valued. All of the RD&D programs in this review rely to some extent on public sector funding, but documents reviewed for these programs did not always indicate the extent to which public-private partnerships exist.
- ***The program reports and best practices literature did not cover in great detail the processes used to conduct market assessments, identify gaps and opportunities, or develop investment plans.*** This may be an area to explore further through the in-depth interviews.

Project Selection

- ***Rigorous selection criteria, strong alignment with overall goals and objectives, and a peer review process appear to be fairly common among RD&D programs.*** The documents for the eight programs featured in this review varied in the amount of information regarding project identification and selection processes. The documents from the DOE-funded programs – SBIR, STTR, and ARPA-E – were most likely to provide detail regarding selection processes. These programs all appear to use rigorous selection criteria that are strongly aligned with their overall goals and objectives. In addition, the use of external peer reviewers for these programs ensures that individuals with relevant expertise help inform awards, which may help bolster the programs' credibility.

- ***Of the programs reviewed, the SBIR and STTR programs seem to have the most transparent process for grantees; information regarding the type of grants, eligibility, deadlines, etc. were featured more prominently on the programs' joint website.*** The stated aim of these programs to engage traditionally underrepresented segments of the small business sector (e.g., women- and minority-owned businesses) may factor into the more pronounced display of this information.

Project Assessment

- ***The best practices literature recognized the importance of identifying metrics and systems for tracking progress***. Examples of key project metrics include patents, copyrights, trademarks, and scientific publications. Across a program or portfolio, broader metrics related to economic impact (e.g., return on investment, increase in revenue, or amount of leveraged funding or financing) or qualitative metrics associated with technical assistance (improve operations, marketplace competitiveness, or improved expertise) are tracked or assessed.
- ***The best practices literature on RD&D programs does not offer a lot of detail or guidance related to how systems are implemented, how frequently metrics are monitored or reported, and how internal systems help inform planning, design, and implementation.*** These issues will be investigated further through in-depth interviews with program stakeholders.

Program Management and Administration

- ***The peer program reports as well as the best practices literature reveal that effective RD&D programs have a core internal staff that oversees design and implementation; the program administration team facilitates relationships with investors, government agencies, small and large companies, and other organizations.***
- Staff are also responsible for ensuring that the program's overall goals and objectives are reflected in the portfolio of projects.
- According to the literature (program documents and best practices), program staff and other institutional supports play an important role in facilitating technology transfer and market development mechanisms.
    - Successful **technology transfer mechanisms** include protocols and processes that directly address barriers to commercialization. Examples of useful resources include templates for licensing and other agreements such as software usage

agreements, material transfer agreements, standardized CRADA (cooperative research and development agreement) templates or master CRADAs that allow for single negotiation for several projects are (Hughes et al., 2011; US DOT, 2011).

- In order to implement and share these tools, programs and related institutions provide support or foster information and knowledge sharing. For example, universities or other research institutions may have offices to help researchers navigate the technology development and commercialization processes. Another mechanism is through federal agencies which may fund or partner with private firms to facilitate information sharing via research consortia, innovation hubs, or advisory committees. These opportunities help bring together researcher and funders to unite the relevant technical expertise and financial resources.
- Effective **market development mechanisms** address barriers that occur as a product or pilot program is scaled up. Larger scale funding from federal entities or private investors helps address financial barriers that researchers and entrepreneurs face as they make this transition. Additional policy solutions such as incentives, subsidies, and tax provisions help ease financial impediments to market-readiness (Jenkins & Mansur, 2011; Wessner 2013). Other supports and resources such as entrepreneurial business development programs and online directories for investors seeking clean energy investment opportunities exist to facilitate networks among private funders, clean energy companies, and research institutions (WHCC, 2013; Murphy & Edwards, 2003).

Contextualized Considerations

Aside from specific issues discussed above, there were other contextual considerations referenced in the literature.

- ***The best practices literature noted that the technology innovation process is not linear; it requires program stakeholders, including administrators, implementers, and other partners to be adept at identifying and capitalizing on opportunities.*** A few sources noted that opportunities for feedback loops occur at key junctures, such as the transitions from basic research to applied research, applied research to development, or development to commercialization. For example, Chiavari & Tam (2011) note that feedback from the market and technology users during commercialization and diffusion phases can influence additional RD&D and promote continuous innovation. The literature also indicated that monitoring of early-phase products or pilots can help inform program design and implementation (Lal et al., 2012; Chiavari & Tam, 2011).

- ***Research and evaluation of RD&D programs is an important element for program success, but only a few programs have publically-available evaluation reports, which limits information and knowledge sharing in this field.*** Program-level research and evaluation helps identify targeted areas of improvement and also establish credibility and build the case for program investments. In addition, while the findings may be specific to a particular program, they serve as a valuable contribution to the field as a whole.

14.1.3 Conclusions, Lessons Learned, and Recommendations

The primary findings from this review of programs and best practices point to several key takeaways regarding the design and implementation of RD&D programs:

- Program investment areas and priorities should be closely aligned with energy policy environment.
- Project selection criteria must be rigorous and reflect overall program goals and objectives. Transparent application and selection processes for grantees is a positive asset for RD&D programs.
- Public-private partnerships are vital to addressing financial and other barriers to commercialization.
    - While financial investments from both the public and private sectors are important, RD&D programs also benefit from sharing of other resources such as technical expertise and equipment.
    - Successful RD&D programs provide researchers and funders with the tools and support to navigate the commercialization process. Formal mechanisms might include systems for sharing license agreements, business coaching for researchers, and networking opportunities for researchers and funders.
- Technology innovation typically starts with basic research and ends with a commercialized product, but the process is not linear, which requires program stakeholders such as administrators, implementers, and partners to be adept at identifying and responding to opportunities for continuous improvement.
- Program- and project-level evaluation is important for identifying areas of improvement and for establishing credibility and justifying program investments. Such evaluation can be carried out by program staff to support internal monitoring and reporting or by a third-party external evaluator.

14.1.4 Appendix A: Programs and Documents Included in the Review

This appendix provides brief descriptions of the programs, reports, and resources included in the review of best practices.

Programs

We identified and reviewed websites and publicly-available reports for the following programs.

DOE Small Business Innovation Research Program (SBIR)

Website: http://science.energy.gov/sbir/

Description: The SBIR Program awards Federal Research/Research and Development (R/R&D) grants to small businesses through various federal agencies, including the Department of Energy (DOE). According to the original charter, SBIR and STTR (described below) have four program goals: 1) stimulate technological innovation; 2) use small business to meet Federal R/R&D needs; 3) foster and encourage participation in innovation and entrepreneurship by socially and economically disadvantaged persons; and 4) increase private sector commercialization of innovations derived from Federal R/R&D.[105] With a strong emphasis on commercialization, small businesses that receive awards through the SBIR and STTR programs maintain the rights to any technology developed and are encouraged to commercialize the technology. The SBIR and STTR programs offers participation in three phases. Phase I awards grants to fund up to $225,000 over 9 months for feasibility studies. Phase II grants, which are up to $1,500,000 over two years, support more extensive R&D to develop the scientific and technical merit. Only Phase I awardees may compete for Phase II funding. Phase III is the period during which Phase II innovation moves from the laboratory into the marketplace with non-SBIR/STTR funding. Small businesses are expected to acquire additional funds from private investors, the capital markets, or from the agency that made the initial award.

Related Evaluation Reports and Documents:

Wessner, Charles W., Editor, Committee for Capitalizing on Science, Technology, and Innovation, National Research Council. 2008. "An Assessment of the SBIR Program." http://www.nap.edu/catalog/11989.html.

Wessner, Charles W., Editor, Committee for Capitalizing on Science, Technology, and Innovation, National Research Council. 2008. "An Assessment of the SBIR Program at the Department of Energy." http://www.nap.edu/catalog/12052.html.

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[105] From http://science.energy.gov/sbir/about/.

SBA Office of Investment & Innovation. October 2015. "SBA Office of Investment & Innovation SBIR-STTR Presentation." https://www.sbir.gov/sites/default/files/SBA_SBIR-STTR_Overview_October_2015.pptx.

Oliver, Manny. August 2016. "DOE's Small Business Innovation Research (SBIR) and Small Business Technology Transfer (STTR) Programs. Webinar slides. http://science.energy.gov/~/media/sbir/pdf/docs/2017/FY17_Phase_I_Release_1_FOA_Webinar.pdf.

DOE Small Business Technology Transfer Program (STTR)

Website: http://science.energy.gov/sbir/

Description: Like the SBIR program, STTR is administered by the DOE's Office of Investments and Innovation. As a sister-program of SBIR, the STTR program adheres to the same goals and grant structure. While SBIR is focused on having small businesses engage in federal R/R&D, STTR facilitates R&D cooperation between small businesses and research institutions. As a result, there are two key differences between the two programs: First, with an SBIR award, the principal investigator (PI) must be primarily employed by the small business concern (SBC) while the PI of an STTR project can be employed by either the SBC or research institution. Second, with an STTR, using a research partner with a Phase I and Phase II award is required, and the minimum level-of-effort expended by the SBC must not be less than 40% in both Phase I and Phase II. With an SBIR, the SBC is not required to partner with a research institution; however, if using a research partner, the minimum level-of-effort expended by the SBC must not be less than 60%.

Related Evaluation Reports and Documents:

National Academies of Sciences, Engineering, and Medicine. 2016. "STTR: An Assessment of the Small Business Technology Transfer Program." https://www.nap.edu/catalog/21826/sttr-an-assessment-of-the-small-business-technology-transfer-program.

See related SBIR/STTR references above.

DOE Advanced Research Projects Agency-Energy Program (ARPA-E)

Website: https://arpa-e.energy.gov/

Description: The ARPA-E focuses on advancing energy technologies designed to reduce the dependence on energy imports; reduce energy related emissions; improve energy efficiency across all sectors of the economy; and ensure that the US remains competitive in developing and deploying transformational technologies. The program provides funding for technologies that are too early for private sector investment but have the potential to lead to new ways to generate, store, and use energy. Project staff also receive direct training and critical business information as part of the Agency's Technology-to-Market program. This support equips projects with a clear understanding of market needs to guide technical development and help projects succeed in the marketplace.

Related Evaluation Reports and Documents:

Advanced Research Projects Agency-Energy Program (ARPA-E). "October 2013. ARPA-E Strategic Vision 2013." https://arpa-e.energy.gov/sites/default/files/ARPA-E_Strategic_Vision_Report_101713.pdf.

Advanced Research Projects Agency-Energy Program (ARPA-E). 2016. "ARPA-E: The First Seven Years, A Sampling of Project Outcomes." https://arpa-e.energy.gov/sites/default/files/documents/files/Volume%201_ARPA-E_ImpactSheetCompilation_FINAL.pdf.

Advanced Research Projects Agency – Energy. July 2015. "Advanced Research Projects Agency – Energy Annual Report for FY2014." https://arpa-e.energy.gov/sites/default/files/FY14%20Annual%20Report%207_27_0.pdf.

Clean Energy Manufacturing Initiative (CEMI)

Website: http://energy.gov/eere/cemi/clean-energy-manufacturing-initiative

Description: The Clean Energy Manufacturing Initiative (CEMI) is a DOE-wide endeavor designed to enhance U.S. manufacturing competitiveness while advancing the nation's energy goals, boosting the economy, and contributing to energy security. CEMI engages in activities that focus on innovation and breaking down market barriers, including technology research and development; new innovation models; competitiveness analysis; stakeholder engagement; and energy productivity technical assistance.

Related Evaluation Reports and Documents:

U.S. Department of Energy. 2016. "The Clean Energy Manufacturing Initiative: Strengthening American Manufacturing and Clean Energy Innovation." http://energy.gov/sites/prod/files/2016/10/f33/CEMI%20Publication-WebR.pdf.

Executive Office of the President National Science and Technology. February 2012. "A National Plan for Advanced Manufacturing." https://www.whitehouse.gov/sites/default/files/microsites/ostp/iam_advancedmanufacturing_strategicplan_2012.pdf.

Executive Office of the President National Science and Technology Council Advanced Manufacturing National Program Office. January 2013. "National Network for Manufacturing Innovation: A Preliminary Design." http://energy.gov/sites/prod/files/2013/11/f4/nstc_jan2013.pdf.

New Mexico Small Business Assistance (NMSBA) Program

Website: http://www.nmsbaprogram.org/

Description: The NMSBA Program fosters collaboration between New Mexico small businesses and the Los Alamos and Sandia national laboratories. Small businesses can receive assistance from lab scientists or engineers for projects that require testing, design consultation and access to equipment or facilities that are not available in the private sector. The NMSBA Program offers three types of projects: individual, leveraged, and contract. Individual projects involve a single small business tackling a problem with national laboratory expertise. Requests for individual projects are accepted year-round until funding is exhausted. Leveraged projects include multiple small businesses with shared technical challenges. Proposals for leveraged projects are reviewed twice and awards range from $20,000 to $100,000 per laboratory. Contract projects allow small businesses to contract for services typically not available in the private sector at a considerably reduced cost (such as courses on renewable energy development).

Related Evaluation Reports and Documents:

New Mexico Small Business Assistance (NMSBA). 2015. "2015 Annual Report for the New Mexico Small Business Assistance (NMSBA) Program." http://www.nmsbaprogram.org/userfiles/2016NMSBAperspectivesFY15_Final_lowres.pdf.

NYSERDA Technology and Market Development Program

Website: http://www.nyserda.ny.gov/All-Programs

Description: The mission of the T&MD Program is to "test, develop, and introduce new technologies, strategies, and practices that build the statewide market infrastructure to reliably deliver clean energy to New Yorkers." The specific objectives include: moving new and under-used technologies and services into the marketplace to help achieve the goals for the Energy Efficiency Portfolio Standard (EEPS) and Renewable Portfolio Standard (RPS) Programs goals; validating emerging energy efficiency, renewable, and smart grid technologies/strategies and accelerate market readiness; stimulating technology and business innovation to provide more clean energy options and lower cost solutions, while growing the state's clean energy economy; and spurring actions and investments to achieve results distinct from incentive-based programs. T&MD portfolio is designed to support these objectives by funding nine initiatives in a range of areas, including power supply and delivery, building systems, and clean energy infrastructure.

Related Evaluation Reports and Documents:

New York State Energy Research and Development Authority. June 2016. "NYSERDA Technology and Market Development Program Semiannual Report through June 30, 2016, Final Report." https://www.nyserda.ny.gov/-/media/Files/Publications/PPSER/NYSERDA/tmd-report-2016jun.pdf
Ridge, Richard and Helen Kim. "Value-Cost Assessment of New York Energy $martsm Research and Development Program." Prepared for the New York State Energy Research and Development Authority, August 2005.

Washington State Clean Energy Fund

Website: http://www.commerce.wa.gov/growing-the-economy/energy/clean-energy-fund/

Description: The Washington State Clean Energy Fund invests in clean energy development by supporting the ". . . development, demonstration, and deployment of clean energy technologies that save energy and reduce energy costs, reduce harmful air emission, or otherwise increase energy independence for the state." The fund provides funding for a range of projects, including grants to electric utilities for smart grid projects, grants to leverage support for research and development, financing opportunities for renewable energy manufacturing, and grants to nonprofit lenders that provide capital to residential and commercial consumers who install renewable energy systems and make other energy-efficient upgrades.

Related Evaluation Reports and Documents:

Weed, Rogers, Washington State Department of Commerce. December 2011. "2012 Washington State Energy Strategy." http://www.commerce.wa.gov/wp-content/uploads/2016/06/energy-state-strategy-2012.pdf.

Washington State Department of Commerce. August 2016. "Clean Energy Fund Update." http://www.commerce.wa.gov/wp-content/uploads/2016/08/Energy-Fund-Update-Aug-2016.docx.

State of Washington, Office of the Governor. 2014. "Executive Order 14-04 WA: Carbon Pollution Reduction and Clean Energy Action." http://www.governor.wa.gov/sites/default/files/exe_order/eo_14-04.pdf.

Connecticut Green Bank

Website: http://www.ctgreenbank.com/

Description: The Connecticut Green Bank furthers the adoption of clean and renewable energy solutions by making financing available to homeowners, businesses, municipalities, and capital providers. The focus of the Green Bank is to attract and deploy capital to fill the investment gap needed to support the successful implementation of the state's clean energy policy goals. To make clean energy more affordable and accessible to consumers, the Green Bank is structured to address four consumer sectors: residential (single and multifamily properties), commercial and industrial, institutional (state, municipal, universities, schools, and hospitals) and infrastructure (grid-tied projects as well as statutorily required programs such as the Residential Solar Investment Program and the Anaerobic Digester Pilot Program).

Related Evaluation Reports and Documents:

Connecticut Green Bank. October 2015. "Connecticut Green Bank Comprehensive Plan: Fiscal Years 2015 and 2016." http://www.ctgreenbank.com/wp-content/uploads/2015/11/CGB_FY15_and_FY16_Comprehensive_Plan.pdf.

Cadmus Group. September 2016. "Moving Forward with Green Energy: Market Potential Assessment for Alternative Fuel Vehicles in Connecticut." http://www.ctgreenbank.com/wp-content/uploads/2016/09/CTGreenBank-Market-Potential-Assessment-Alternative-Fuel-Vehicles-090816-FF.pdf.

Cadmus Group. March 2016. "Cost-Effectiveness Assessment of the Residential Solar Investment Program." http://www.ctgreenbank.com/wp-content/uploads/2016/03/RSIP_Evaluation_II_Final_Report_and_cvr_ltr1.pdf.

Cadmus Group. January 2015. "Residential Solar Investment Program Evaluation." http://www.ctgreenbank.com/wp-content/uploads/2016/03/RSIP_Evaluation_I_Final_Report_and_cvr_ltr.pdf.

Best Practices Literature

We reviewed the following sources to identify effective RD&D practices previously identified in the literature.

Chiavari, Joana and Cecilia Tam. 2011. "Good Practices Policy Framework for Energy Technology Research. Development and Demonstration (RD&D)." Prepared for the International Energy Agency. https://www.iea.org/publications/freepublications/publication/good_practice_policy.pdf.

Hughes, Mary Elizabeth, et al. June 2011. "Technology Transfer and Commercialization Landscape of the Federal Laboratories." https://www.ida.org/idamedia/Corporate/Files/Publications/STPIPubs/ida-nsp-4728.ashx.

International Energy Agency. 2010. *"Global Gaps in Clean Energy RD&D: Update and Recommendations for International Collaboration."* https://www.iea.org/publications/freepublications/publication/global_gaps.pdf.

Jenkins, Jesse and Sara Mansur. November 2011. "Bridging the Clean Energy Valleys of Death: Helping American Entrepreneurs Meet the Nation's Energy Innovation Imperative." http://thebreakthrough.org/blog/Valleys_of_Death.pdf.

Lal, Bhavya, Gupta, Nayanee and Christopher L. Weber. January 2012. "Innovation Pipeline Management: Lessons Learned from the Federal Government and the Private Sector." https://www.ida.org/idamedia/Corporate/Files/Publications/STPIPubs/2014/D-5367.ashx.

Murphy, L. M. and P. L. Edwards. 2003. "Bridging the Valley of Death: Transitioning from Public to Private Sector Financing." http://www.nrel.gov/docs/gen/fy03/34036.pdf

Ruegg, Rosalie and Irwin Feller, 2003, *A Toolkit for Evaluating Public R&D Investment: Models, Methods, and Findings from ATP's First Decade*. Prepared for the Economic Assessment Office, Advanced Technology Program, National Institute of Standards and Technology, Gaithersburg, MD.

Townsend, Brad and Erin Smith. March 2016. "U.S. Energy R&D Architecture: Discreet Roles of Major Innovation Institutions." http://cdn.bipartisanpolicy.org/wp-content/uploads/2016/03/BPC-AEIC-Energy-RD-Architecture.pdf.

U.S. Department of Transportation, Research and Innovative Technology Administration. March 2011. "Key Findings and Recommendations for Technology Transfer at the ITS JPO." http://ntl.bts.gov/lib/42000/42100/42107/FHWA-JPO-11-085__Key_Findings___Recommendations_for_Tech_Transfer_at_ITS_JPO__PDF_508.pdf

Wessner, Charles. 2008. "Best Practices in State and Regional Innovation Initiatives: Competing in the 21st Century." https://www.nap.edu/download/18364.

Wessner, Charles. 2003. "Government-Industry Partnerships for the Development of New Technologies." Washington, D.C.: The National Academic Press." https://pdfs.semanticscholar.org/4546/9283a7c5b782a9d736d242dd5c5338050bfa.pdf

White House Conference Center. 2013: "Lab-to-Market Inter-Agency Summit: Recommendations from the National Expert Panel." https://www.aau.edu/WorkArea/DownloadAsset.aspx?id=14535.

14.2 In-Depth Interviews

This section summarizes findings from interviews conducted with seven administrators involved in the design and implementation of energy research, development, and demonstration (RD&D) programs. The team conducted these interviews as part of the best practices review, which seeks to identify key learnings from programs designed to increase coordinated investment in new and emerging energy solutions.

14.2.1 Introduction

Objectives

The objective of the best practices review is to identify effective practices that have been used to support RD&D programs. The team initially conducted a literature review to summarize the best practices and lessons learned regarding the planning, design, and implementation, of RD&D programs. This literature review identified a selection of programs similar to the EPIC program, and compiled findings from publicly-available evaluation reports and other documents about these peer programs. While the literature provided valuable insights, the team identified specific areas to investigate further through in-depth interviews with individuals involved in the administration of these programs. This memo summarizes the findings from those interviews.

Methodology

The initial literature review identified several programs similar to the EPIC program. Through the in-depth interviews and further review of program documents, the team determined that four of the seven programs initially identified were very similar to the EPIC program in terms of their objectives and mission. These primary peer programs include:

- Department of Energy's Small Business Innovation Research Program (SBIR)
- Department of Energy's Small Business Technology Transfer Program (STTR)
- Department of Energy's Advanced Research Projects Agency-Energy Program (ARPA-E)
- NYSERDA's Technology and Market Development (T&MD) Program

The literature review also identified three other peer programs that, upon closer investigation, were revealed to be not as similar. Although these three programs support innovative R&D efforts, they do not have an explicit goal related to commercialization, which is a key feature of the EPIC program. These secondary peer programs include:

- New Mexico Small Business Assistance (NMSBA) Program
- Washington State Clean Energy Fund
- Connecticut Green Bank

The interviews covered a range of topics, including program background, project selection processes, program administration and management, program tracking and reporting, support for commercialization, knowledge dissemination and technology transfer, and general program challenges and successes.

14.2.2 Summary of Findings

This memo builds on the initial literature review of best practices and focuses on the following areas that were identified for further investigation:

- Processes used to conduct market assessments, identify gaps and opportunities, and determine program or portfolio-level investment priorities.
- More detail on how program administrators coordinate with implementation agencies and other partnering organizations.
- Information on how program and project-level systems are used to monitor and evaluate program performance, including insights on the frequency of data collection and reporting as well as how related findings inform planning, design, and implementation.
- How RD&D programs adapt and respond to rapidly changing technologies and markets.

We have grouped the key findings from these interviews in the five research categories that the overall EPIC evaluation will cover: 1) Program Management and Administration, 2) Policy Alignment, 3) Investment Planning, 4) Project Selection, and Project Assessment. Table 65 below summarizes the broad categories of effective practices that were referenced during interviews with the peer programs.

Table 65: Program Comparison of Effective Practices

Effective Program Practices	Primary Peer Programs: SBIR	Primary Peer Programs: STTR	Primary Peer Programs: ARPA-E	Primary Peer Programs: NYSERDA T&MD	Secondary Peer Programs: WA CEF	Secondary Peer Programs: NMSBA	Secondary Peer Programs: CT Green Bank
Program Management and Administration							
Core internal staff that coordinates with internal and external stakeholders	✓	✓	✓	✓	✓	✓	✓
Require match funding	✓*	✓*	✓	✓	✓		NA
Offer support and resources to promote commercialization activities	✓**	✓**	✓	✓	NA	NA	NA
Explicit requirement for project-based knowledge or technology plan	✓	✓		✓	NA	NA	NA
Policy Alignment							
Explicit alignment with federal or state policy goals	✓	✓	✓	✓	✓	✓	✓
Investment Planning							
Directly engage external stakeholders in determining investment priorities	✓	✓	✓	✓			
Offer focused funding opportunity	✓	✓			✓	✓	NA
Offer focused ***and*** open funding opportunity			✓	✓			NA
Project Selection							
Transparent review criteria and selection process	✓	✓	✓	✓	✓	✓	NA
Utilize external reviewers	✓	✓	✓	✓	✓	✓	NA
Requirement for applicants to indicate initial interest prior to submitting a full proposal (e.g., concept paper, letter of intent)	✓	✓	✓	✓			NA
Project Assessment							
Formally track metrics program-wide	✓	✓	✓	✓		✓	✓
Require regular progress reports	✓	✓	✓	✓	✓	✓	✓
Use third-party evaluation to assess program impact	✓	✓	✓	✓			✓

* SBIR and STTR do not mandate match funding, the programs do encourage it for projects that fall under their Phase II funding, which has an increased emphasis on commercialization.
** SBIR and STTR do not directly offer commercialization supports, but grantees may access the Commercialization Accelerator Program, which provides assistance to all federal programs.

Program Management and Administration

- ***The interviewees from all of the peer programs all spoke about the depth of knowledge and expertise of the program administrators, consultants, and other stakeholders that contribute to the program's implementation.*** Each of the RD&D programs employs staff with a strong technical expertise. Because these programs support new and emerging technologies, the programs also rely on other experts both within and outside of their respective agencies who may have specialized knowledge of certain technologies or concepts. For example, when developing a funding opportunity, the program administrators will convene industry experts to help inform the initiative (see Investment Planning below for more detail). Interviewees also spoke about coordinating with other state or federal agencies and industry groups to stay current on topics affecting their work.
- ***Three of the seven peer programs, including two primary peer programs, require projects to obtain match funding; while they do not directly assist with finding the match funding, to the extent that they can, they try to help address any barriers the project team may face.*** Washington State's Clean Energy Fund requires a 50% cost-share, NYSERDA's T&MD Program requires 25% or 50% cost-share depending on the size of the project, and ARPA-E's cost-share varies by specific funding opportunity. While SBIR and STTR do not mandate match funding, it is encouraged for projects that fall under their Phase II funding, where the programs place increased emphasis on commercialization.
- ***Contracting times vary substantially across the different peer programs***. Among all of the peer programs, one of the secondary peer programs has the shortest turnaround of one week. On the other end of the spectrum, a primary peer program takes roughly three to six months on average. Another primary peer program reportedly takes six weeks but allows the project team to begin working on the project at-risk up to 90 days before the contract is finalized.
- ***Two of the four primary peer programs offer support and resources to promote commercialization activities.*** ARPA-E's Tech-to-Market Team provides direct business-related technical support and assistance to grantees. In addition to providing guidance on the project team's Technology-to-Market Plan, the Tech-to-Market advisors assist projects in a variety of ways, including helping them to conduct market assessments, identify potential investors, and develop and deliver a business pitch. The ARPA-E program also holds an Annual Energy Summit that convenes individuals and organizations from industry, academia, and government and provides an opportunity for project managers to meet with potential partners, collaborators, or investors.

  Projects funded through NYSERDA's T&MD can also access commercialization-related resources available through the Entrepreneurs-in-Residence (EIR) Program, which is very much like ARPA-E's Tech-to-Market Team. In addition, NYSERDA funds six business incubators across the state and supports a Proof-of-Concept Center where businesses can access existing intellectual property (IP) and work on commercializing it.

- ***All four of the primary peer programs have structures in place to help projects identifying and capitalizing on opportunities to change course, when needed, to maximize the projects' success.*** Because the technology innovation process is not linear, it often requires program administrators, grantees, and others involved in the RD&D process to be adept at recognizing critical opportunities to maximize. The SBIR program allows projects to be able to reallocate up to 10% of their budget without prior approval. Because ARPA-E and NYSERDA's T&MD Program both have an explicit focus on commercialization, advisors for their respective programs actively work with project teams to identify appropriate pivots, and may help facilitate these course corrections.

Policy Alignment

- ***Interviewees from all seven peer programs indicated that their initiatives are explicitly aligned with federal or state local policy goals.*** For example, as the primary author for the New York State Energy Plan, NYSERDA played a key role in defining energy policy goals and objectives. As a result, the T&MD Program is closely coordinated with the Energy Plan recommendations and helps contribute to the state's energy goals. While the SBIR and STTR programs do not establish the technology areas that they fund, the program administrators work closely with the relevant R&D program offices at DOE. These program offices typically develop their research priority areas, often driven by roadmaps or other investment planning mechanisms, that are aligned with their mission. SBIR and STTR programs help facilitate RD&D in these priority areas by stimulating technology innovation among small businesses.

  While the ARPA-E program is mission driven, it is the only peer program that intentionally is not bound by policy roadmaps and other similar directives. As a result, the program takes into consideration such documents, but specifically seeks to fund the "disruptive technologies and solutions" that may not necessarily be identified in these investment planning mechanisms. As the Strategic Vision for ARPA-E states, the program is designed to advance "high-potential, high-impact energy technologies that are too early for private sector or other DOE applied research and development investment."[106]

- ***When asked about potential reductions in federal funding and support for energy-related RD&D, and what EPIC could do to address those gaps, interviewees offered***

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[106] Advanced Research Projects Agency-Energy Program (ARPA-E). "October 2013. ARPA-E Strategic Vision 2013." https://arpa-e.energy.gov/sites/default/files/ARPA-E_Strategic_Vision_Report_101713.pdf.

a range of responses but few concrete strategies. One interviewee stated that the EPIC program should closely monitor federal funding for RD&D programs and allocate funding in areas that are negatively affected by budget or policy changes, but did not specify technology areas to target. Two interviewees suggested that private investment might help fill the financial gap should the federal government reduce RD&D funding, but did not recommend specific ways to do so. Two interviewees also indicated that with the recent change in the administration, it was too soon to predict what implications that would have on Congress' funding decisions.

Investment Planning

- ***All seven of the peer programs are informed in some way by external stakeholders; interviewees from the four primary peer programs noted that they have formal mechanisms to solicit input to identify and develop funding opportunities.*** As noted above, the peer programs are directly influenced by policy directives, which involves engagement with a variety of external stakeholders including federal and state government agencies, legislators and legislative committees, businesses, and other interest groups. The primary peer programs also formally engage external stakeholders in identifying investment areas. The DOE convenes planning workshops and other meetings that help inform funding priorities for individual research offices. These investment areas support research funding, and a portion is allocated to small business initiatives like SBIR and STTR. The ARPA-E program uses a different approach. ARPA-E rotating Program Directors have a considerable degree of autonomy in defining funding opportunities. ARPA-E's use of rotating Program Directors helps the program bring in fresh ideas based on their prior experience and expertise. Also, because they have a three-year tenure with ARPA-E, they typically are working within a relatively short timeframe and are attempting to make a significant impact during their time with the program. These staff conceptualize focused technical funding opportunities, which are informed by meetings with external stakeholders. The Program Director takes the lead on soliciting input from external stakeholders as well as other Program Directors and leadership staff within the program, and ultimately has a great degree of ownership in developing funding opportunities and selecting projects. Staff from NYSERDA's T&MD Program worked with an external consulting firm to determine the program's investment priority areas.
- ***Six of the seven peer programs offer focused and clearly-defined funding opportunities; two of the four primary peer programs – ARPA-E and NYSERDA's T&MD Program additionally offer an open funding opportunity to encourage ideas that not covered in focused program areas.*** In general, the focused funding opportunities are developed by program staff and are designed to address the mission and goals of the program. These opportunities offer funding to specific

technology areas such as battery storage, building efficiency, grid modernization, etc. To foster innovative approaches and solutions, both ARPA-E and NYSERDA's T&MD Program also offer funding beyond the traditional focused opportunity. ARPA-E's Innovative Development in Energy-Related Applied Science (IDEAS), accepts, on a rolling basis, proposals for single-phase projects of up to 12 months and $500,000 of funding. NYSERDA similarly offers funding through The Advanced Clean Energy Exploratory Research Program (ACE Program); proposals are accepted on a rolling basis, and project funding and timelines vary.

Project Selection

- ***All six of the peer programs that offer grants, or, in the case of SBIR and STTR, cooperative agreements, provide transparent information about RD&D funding opportunities, proposal review criteria, and the selection process.***[107] Each of these programs include information about funding opportunities on their website. In general, the funding announcements describe technology-related parameters, funding amount and duration, due date, and award date. SBIR, STTR, and ARPA-E also have webinar archives that provide background on the program and eligibility as well as information on how applications are reviewed and selected for funding.
- ***All four of the primary peer programs require applicants to provide a preliminary research description prior to developing and submitting a full proposal.*** SBIR and STTR require a letter of intent while ARPA-E and NYSERDA'S T&MD Program expect a concept paper. While the specific requirements are different for each program, this preliminary description serves a few purposes. It allows program administrators to get a sense of the technology areas that are likely to be addressed in response to a particular solicitation, which helps them determine the types of external reviewers that will be needed for proposal review. It also allows the applicant to describe their proposed research with relatively modest commitment in terms of time and resources. Based on a review of the preliminary description, the programs provide applicants with a notice of encouragement or discouragement to submit a full proposal.

Project Assessment

- ***Six of the seven peer programs use formal metrics to track project performance.*** Although the metrics of the peer programs vary based on their stated focus and technology, the interviewees generally reported that they do track such indicators and do so on a regular basis. Among the primary peer programs, common project-based metrics include patents, copyrights, and publications. Metrics tracked across program portfolios typically include indicators such as progress toward commercialization, sales revenues, and leveraged funding.

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[107] The Connecticut Green Bank provides financing for commercially-available clean energy technologies.

- ***All seven of the peer programs stated that projects are required to report regularly on their progress.*** For example, projects funded through NYSERDA's T&MD Program provided monthly or quarterly performance reports, which the assigned Project Manager uses to track progress on milestones identified in the Statement of Work. Many T&MD projects also receive support through the Entrepreneurs-in-Residence (EIR) program, a resource available to companies engaged in commercialization activities (described above under Program Management and Administration). Through these interactions, the main points of contact between the EIR program and the project often develop close relationships, and the EIR advisor is often privy to project status updates on an ongoing basis. Interviewees representing other peer programs similarly reported regular interaction between program administrators and grantees through written reports (monthly, quarterly, or annual), on-site visits, or phone calls.
- ***Five of the seven peer programs, including all four of the primary peer programs, use an external evaluator to assess the program's performance.*** In addition to internal tracking reporting mechanisms, interviewees from the primary peer programs stated that they have used third-party evaluations aggregate, assess, and report on program-wide outcomes. The National Academies of Sciences recently published assessments of the SBIR and STTR programs.[108,109] NYSERDA also has a separate evaluation group, which works with a third-party to evaluate the T&MD Program's effectiveness.[110] ARPA-E recently completed an independent evaluation, which is forthcoming. Interviewees generally indicated that these external efforts help provide objective insights regarding the program's performance are useful for reporting to external program stakeholders.

14.2.3 Conclusions

The findings from these interviews fill important gaps and supplement information previously identified in the team's literature review.

- The interviewees confirmed findings from the literature regarding the importance of a core internal program staff that the coordinates with both internal and external stakeholders in the design and implementation of the RD&D program.

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[108] National Academies of Sciences, Engineering, and Medicine. 2016. *STTR: An Assessment of the Small Business Technology Transfer Program.* Washington, DC: The National Academies Press. https://www.nap.edu/catalog/21826/sttr-an-assessment-of-the-small-business-technology-transfer-program.

[109] National Academies of Sciences, Engineering, and Medicine. 2016. *SBIR/STTR at the Department of Energy*. Washington, DC: The National Academies Press. https://www.nap.edu/catalog/23406/sbirsttr-at-the-department-of-energy.

[110] New York State Energy Research and Development Authority. June 2016. "NYSERDA Technology and Market Development Program Semiannual Report through June 30, 2016, Final Report." https://www.nyserda.ny.gov/-/media/Files/Publications/PPSER/NYSERDA/tmd-report-2016jun.pdf.

- Interviewees provided greater detail on formal mechanisms used to identify investment priorities. The various approaches indicate that EPIC's current methods are consistent with its peer programs.
- EPIC generally is consistent with the peer programs with regard to transparency about funding opportunities, proposal review criteria, and the overall selection process.
- Peer programs use formal metrics to regularly track projects' performance. These metrics are specific to the program's stated focus, but common metrics include patents, copyrights, publications, progress towards commercialization, and leveraged funding.

15 Appendix D: Example of Project Tracking Recommendation

To address unmet needs and missed opportunities in sharing relevant project-specific updates and information in a timely and effective manner, we suggest that the administrators collaborate to develop an electronic, searchable database that provides relevant project updates on a quarterly basis. Initially, this database could be a simple workbook sent to the CPUC, but there are opportunities to make it more widely available by publishing it via the Internet.

Key attributes of this database should be:

- Search or sort capability by policy or technology area so users tracking a particular topic can get an overview of EPIC activity and future outcomes in that topic area;
- Ease of administering so the assembly and updating of the database relies on readily available existing information that can be easily compiled;
- Descriptive value so a reader can understand the general scope and scale of each project (as defined by a brief project description, list of organizations involved, and budget information); and
- Tracking value so a reader can follow the status of the project and any interim results that can be shared or outputs that are being made public.

We have developed an illustrative example of how such a database could be structured and the information it could contain. Figure 30 shows how projects related to energy storage could be grouped and the kind of content it could provide. Some of the example data is based on real information taken from existing Annual Reports or project data, while other information is made up for illustrative purposes only. We show the latter in blue text.

We note that our illustrative example is based on existing information about projects or information that could easily be obtained consistently in project updates that administrators already track (e.g., either internally by the IOUs, or by grantees to the CEC). Specifically, we suggest that:

- Searchable fields include the EPIC Triennial Investment Plan, the administrator, and one or two pre-existing tracking variables that identify the technology or policy area that the project is intended to help inform or advance (columns B and C in our illustrative example);
- Static descriptive information about the project, including its name, date of award, date of expected completion, the value chain to which it is assigned (generation,

transmission, etc.), EPIC and matching funds budgeted; and grantees, vendors, and partners involved in the project;

- Current project information, such as funds expended, activities to date, and any updates to the project description; and
- References to outputs and outcomes that have already been delivered and are ready to be made public.

This last point requires a bit more explanation. The intent of including outputs and outcomes that can be made public is to facilitate information sharing with stakeholders who are tracking a particular topic area in near-real time. We anticipate the inclusion of references to papers, publications and presentations that have been given or are anticipated in which project information and results are being made public anyway. At the study team's discretion, hypotheses and interim results could be included too, but those would need to be clearly identified as such. We do not anticipate any proprietary information that is not intended to be made public to be included in these reports.

The vast majority of the information in this illustrative list of project updates is already available to administrators, and much of it is reported in current Annual Reports. Project outputs and outcomes would be new additions, but we believe that information such as presentations given and publications created can be easily gathered as part of the project updates required of grantees.

Figure 30: Quarterly Report by Project Area

A. Investment Program Period	B. Technology / Policy Area	C. Sub-Technology / Policy Area	D. Program Administrator	E. Project Name**	F. Project Type	G. A Brief Description of the Project	H. Date of the Award	I. Expected Date of Project Completion	J. Assignment to Value Chain	K. EPIC Funds Committed ($)	L. Matching Funds Committed ($)	M. Funds Expended to Date: Contract/Grant Amount ($)	N.Partners (Primary Grantee or Vendor: Subcontractors)	O. Update
2012-2014 Triennial Investment Plan	CSP	Grid Scale Storage	CEC	EPC-14-003 Low-Cost Thermal Energy Storage for Dispatchable CSP	Applied Research and Development	The purpose of this project is the development and demonstration of a cost-optimal, robust, and low-cost thermal energy storage (TES) fluid, elemental sulfur. Use of sulfur as a TES fluid will enable overall low system costs, long lifetime, and scalability for a wide range of concentrating solar power (CSP) applications and temperatures.	1/15/15	3/15/18	Generation	$1,497,024	$300,000	$188,054	Listed as Southern California Gas Company in annual report, but should be UCLA	A project kickoff meeting was held in April 2015 and technical progress is underway. The project team has conducted heat transfer modeling and simulation as well as laboratory-scale material compatibility experiments that will feed into on-sun testing in 2017.
2012-2014 Triennial Investment Plan	Grid-Scale storage	Market Identification & Market Pairing	PG&E	PG&E #1.01: Energy Storage for Market Operations	Technology Demonstration and Deployment/ Renewables/DER Resource Integration	Develop and deploy technology to enable fully automated resource response to CAISO market awards. Report financial performance from participation in CAISO markets Report comparison of actual performance vs. hypothetical performance quoted in industry reports. Comply with regulatory requirements and establish a framework/recommendations for accounting standards applicable to energy storage.	9/19/13	9/19/16	Distribution; Grid Operation/Market Design	$2,030,000	n/a	$1,833,110	DC Systems, Power Settlements, Trimark	After completing the process flow and software components of the project, the project partners attempted to market the products commercially in the CAISO markets. Currently, market demand appears to be low although the administrators and other project partners will continue to gauge market response going forward if plans for commercialization appear viable.

Illustration for Quarterly Reports by Project Area (Columns A – O)

P. Activities to date	Q. Outputs to date	R. Outputs to watch for	S. Short-Term Outcomes: Working hypotheses, learnings, and results	T. Mid-Term & Long-Term Outcomes: Anticipated project impact on energy technology and commercialization
Laboratory testing of elemental sulfur's relevant properties and storage container have been completed.	Project presentation at December 2015 EPIC Symposium and four presentations at ASME Power and Energy Conference in June 2016. Available from Kevin Uy at CEC (kevin.uy@energy.ca.gov).	Laboratory results will be documented in a laboratory demonstration report and available from Kevin Uy at CEC in March 2017. Grantee is submitting a manuscript to the referred journal Photovoltaics of the Future. If acccepted, anticipated publication in Summer 2018 edition. Project report with detailed lab and field results planned for March 2018 and will be available at epic.cec.ca.gov.	Analysis of elemental properties of sulfur in storage setting and storage container in laboratory have shown feasibility of safe sulfur-based thermal energy storage. Results so far suggest that performance metric of storage costs of below $15/kWh and levelized cost of solar power below $0.06/kwh will be achievable. Actual field results will be available by March 2018.	Grantee is working with a newly formed firm Element Sixteen Technologies, Incoporated, to further development and commercialization of sulfur-based thermal energy storage. CEC is coordinating with CPUC, IOUs, and US DOE on an energy storage roadmap, which includes thermal energy storage.
Demonstrated the use of PG&E's Vaca-Dixon and Yerba Buena Sodium Sulfur (NAS) Battery Energy Storare Systems (BESSs) to provide energy and ancillary services in CAISO markets as the first battery storage resources in California to participate in the market. Developed and deployed a scalable technology platform to automate the response of current and furture PG&E battery storage resources to CAISO market awards vis Automated Dispatch System (ADS). Developed optimization models and workflow processes for efficient bidding of battery resources into the CAISO market,	Completed a final report in September 2016, summarizing project objectives, technical results and lessons learned through EPIC project. Presented at the 2015 EPIC Symposium as well as several other industry conferences during the course of the project.	Project completed, no future outputs anticipated. However, project results have led to the development of new flexible ramping product in CAISO market	Based on market participation analysis, current market dynamics do not favor long-duration batteries given that most significant revenues in the market are from frequeny regulation - a power rather than an energy product - project administrators concluded a 30-minute BESS might be ablet o provide the same FR capabilities as a 7-hour system with less capital investment.	Due to the achievement of the project, administrator will continue to maintain the Automated Disipatch System as a platform to automate the response of current and future batter storage resources to CAISO market awards. Administrator also plants to provide a new flexible ramping product that CAISO plans to introduce in late 2016.

Illustration for Quarterly Reports by Project Area (Columns P - T)

16 Appendix E: Supplemental Information on EPIC Project Performance

This Appendix provides more details regarding the progress that each of the three program areas has made with respect to its expected outputs and outcomes, which was summarized in Section 10.5. These results are based primarily on 90 in-depth interviews with members of EPIC project teams (CEC administrators, CEC Commission Agreement Managers (CAMs), CEC grantees, IOU project managers, and, in some cases, IOU vendors) associated with 54 sampled projects.

16.1 Applied Research and Development Projects

In this section, we present results to date with respect to the outputs and outcomes depicted in the Applied R&D logic model in Appendix B. These results are based on the analysis of a random sample of nine Applied R&D projects from a population of 121. We reviewed project details and conducted in-depth interviews with CAMs and grantees to develop a deep understanding of these nine sampled projects. Note that all of these projects are administered by the CEC, since the IOUs are authorized to work only on TD&D projects.

Because none of the sampled projects were (at the time of the interviews) complete, we expected to observe some *outputs* but no measureable impacts with respect to any short-term, mid-term or long-term *outcomes*. However, we were able to examine indicators as to whether the projects are on a path to achieving these desired outcomes if the Applied R&D proves successful. Such leading indicators include:

- Knowledge creation and knowledge utilization;
- Private and public investment (especially for technologies intended to be commercialized);
- Follow-on research and development (if needed);
- Technology demonstrations (for technology-based projects); and
- Technology or tool adoption.

We discuss the degree to which existing Applied R&D projects show progress by these indicators below. In order to connect the reader to the overarching framework provided by the Applied R&D logic model, we have included, in parentheses next to each heading, the letters associated with the output and outcome boxes in the Applied R&D logic model in Appendix B.

16.1.1 Knowledge Creation and Knowledge Utilization (Logic Model Boxes H, I, N, T)

Knowledge Creation

Project teams were asked to assess how successful they have been thus far in achieving their technical performance targets. For these eight active projects, three of the eight respondents indicated that they have been somewhat to extremely successful in achieving their technical performance targets. Others said that it was too early to judge.

Another question is whether these active projects are likely to verify the targeted benefits. Applied R&D projects targeted a range of benefits. We reviewed benefit questionnaires from seven of nine Applied R&D projects. Table 66 below summarizes the project benefits targeted by the following general benefit areas:

- **Potential Energy and Cost Savings** – for example, CEC project 14-030 developed, demonstrated and evaluated scenarios that identify the most promising opportunities for waste biomass distributed generation. Expected energy and cost savings benefits of this project include an increase in distributed generation which can be used to meet local system needs and lower costs by reducing the need for transmission infrastructure investment and protecting ratepayers from changes in fossil fuel prices. CEC project 15-021 will leverage mobile design practices, hardware components and energy management software to evaluate the energy consumption of residential and commercial plug-load devices. Expected energy and cost savings benefits of this project are lower customer electric bills, and individual ratepayer savings will make a significant contribution to California's statutory energy goals.
- **Job Creation** – CEC project 14-025 developed, demonstrated and evaluated a photovoltaic solar system with air driven trackers for research purposes. It is predicted that this project will add approximately 860 jobs per gigawatt.
- **Economic Benefits** – CEC project 14-030 developed, demonstrated and evaluated scenarios that identify the most promising opportunities for waste biomass distributed generation. An expected benefit of this project is a reduction in electrical losses in the transmission and distribution system, and with integrated use of waste biomass for distributed generation applications, providing the potential to produce approximately 4.2 terawatt-hours of renewable electricity per year. CEC project 15-021 will leverage mobile design practices, hardware components and energy management software to evaluate the energy consumption of residential and commercial plug-load devices. Potential economic benefits of this project are, at the macro level, long-term, deep savings across a broad array of plug load devices.
- **Environmental Benefits** - for example, CEC project 14-040 will develop, test and demonstrate Self-Tracking Concentrator Photovoltaic systems. Expected environmental benefits of this project are GHG emission reductions from increased

solar power generation resulting from new low-cost PV panel technology. CEC project 14-030, which developed, demonstrated and evaluated scenarios that identify opportunities for waste biomass distributed generation, will provide potentially significant environmental benefits. Expected environmental benefits for this project are substitute energy sources worth significant savings in avoided grid electricity and natural gas heating. This will result in avoided fossil fuel GHG emissions of approximately 2.5 million metric tons of carbon dioxide per year.

- **Safety, Power, Quality, and Reliability (Equipment, Electric System)** – for example, CEC project 14-040 will develop, test and demonstrate Self-Tracking Concentrator Photovoltaic Systems. This is expected to provide greater reliability of the equipment and electric system through increasing the use of distributed solar generation, which will help improve reliability by reducing the sensitivity to outages. CEC project 14-025, which developed, demonstrated and evaluated a photovoltaic solar system with air driven trackers for research purposes, will also have an impact on the reliability of the electric system and equipment. The expected benefit of this project is to increase the flexibility of the system by capturing the sun in the late afternoon to soften the net peak load, which now occurs in the evening.

Table 66: Summary of Sampled Project Projected Benefits

Benefit	# with Quantified Benefits	# with Qualitative Benefits	Total with Benefits	Sample Size
Potential Energy & Cost Savings	2	3	5	7
Job Creation	1	0	1	7
Economic Benefits	2	3	5	7
Environmental Benefits	4	1	5	7
Safety, Power, Quality and Reliability (Equipment, Electric System)	1	1	2	7

We also asked grantees how successful they have been, thus far, in validating the expected benefits from these Applied R&D projects that might eventually lead to longer-term benefits once the technology/tool is more broadly deployed. For these eight active projects, three of the eight respondents indicated that they have thus far been somewhat to extremely successful in validating their targeted benefits. Other said that it was too early to judge.

Other more concrete indicators of knowledge creation are the creation of progress reports, final reports, databases, fact sheets, refereed journal articles and trade journal articles. The CEC closely monitors their projects on a monthly or quarterly basis, with a few even getting weekly progress reports (discussed in more detail in Section 9). There is also a general consensus among the CAMs that these reports are very or extremely useful. The use of these on-going reviews that allow for mid-course corrections are essential for EPIC's success and are considered best practice. In addition, two fact sheets have been produced, but no articles in refereed journals or trade journals have been published, and no software tools or databases have been created. However, given that all projects are still active, it is premature to expect any more such outputs.

Knowledge Utilization

While it is important to create knowledge both during and at the conclusion of a project, it is equally important for these results to be used. Knowledge gained during a project is used to assess whether the project is on schedule and on budget and whether the technology is working as expected. Any adjustments are triggered by consultation from technical advisory committee (TAC) and policy advisory committee (PAC) members, critical project reviews and discussions between the administrators and the CEC grantees and IOU project managers. One question focused on the extent to which project teams, as a result of knowledge gained thus far from their projects, have deviated from their original CEC-approved research plan. Only two of the project teams reported that they had experienced any deviations and they were all relatively minor. As a result, none of the projects have been re-scoped thus far.

Market Actor Awareness

One of the earliest indicators of progress toward future market adoption is a perceived need, awareness and appreciation of the value of new technology or tools by those market actors who would use them. We asked grantees how much they thought that potential buyers or users in the market understand the added value of the technology or tool they are developing.

Three of the four projects teams[111] developing technologies they intend to commercialize indicated that their target audience has some level of understanding of their technology or tool so far and the value that it may provide to them,[112] while one reported that it was too early to make that assessment. We did not ask this question of project teams working on technologies or tools that were not anticipated to be commercialized.

This range of market understanding reflects the various stages of development of the technologies and the degree to which they vary from existing approaches to achieve the desired outcome. In some cases, the value of the technology is the key output from the EPIC project. In these studies, the Applied R&D project is seeking to quantify the cost-

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[111] References to project teams refer to CEC staff overseeing projects and grantees and principal investigators leading them. We had conducted separate interviews with both and were informed by their collective responses.

[112] Two of these projects teams characterized their target audience as having a significant level of understanding, while one said there was a low level of understanding of the technology and its value.

effectiveness of a particular technology or solution to determine whether (or prove that) it is an improvement over current alternatives.

Of the project teams that do plan to commercialize their technology/tool, three out of the four believe that buyers and users in the broader market will have a high level of interest in purchasing the end product regardless of their current understanding of the technology or tool.

Patents/Copyrights

Two of the eights projects have filed a combined total of three patent applications since the launch of these EPIC projects, although no patents have yet been granted. The broad objective of obtaining these patents is to further the development of utility scale renewable energy generation technologies as well as developing new technologies, tools and strategies to lower the cost of distributed generation.

No project results have been copyrighted or licensed across all eight Applied R&D projects; however, one project team stated that it is too early in the project to have produced such results.

16.1.2 Private and Public Investment (Logic Model Box V)

The willingness of investors to provide additional funding for the development of a new technology or tool is another indicator of progress toward future market adoption for technologies or tools that will be commercialized for profit. For technologies or tools that will be in the public domain or that have only indirect impacts on technology adoption, such funding may come from public sources instead. To explore the degree to which additional investment was being pursued and provided, we asked grantees whether they had sought or secured additional funding from public or private investors since the start of the EPIC project. We also examined matching funds as evidence of external support and interest.

Table 67 below shows that the total budget of the eight sampled Applied R&D projects is $8.9 million with $2.4 million of that budget being spent through 2016. Six of the eight projects also include match funding totaling $8.9 million with those funds coming from various private or public sources. Of the six projects with match funding (another indicator of external support for Applied R&D projects), one project accounts for 68 percent of the total match funding amount.

Table 67: Private and Additional Public Investment for Sampled Applied R&D Projects

Total Project Budget w/out Match Funds	Total Match Funds	Total Project $ Spent (through 2016)	# Projects with Match Funds	Seeking Federal and/or State Funding	Seeking Private Investor Funding
$8.9 million	$8.9 million	$2.4 million	6	4	2

*Project total does not include the ninth sampled project that we excluded from this section because it had not yet started by the time of our project interviews.

Extent of Future Private or Public Investment – Actual and Anticipated

Out of the eight sampled projects, four are seeking additional funding from various federal and state sources such as the National Science Foundation, Department of Energy (DOE) and Joint Bioenergy Institute. Two out of the four that are seeking additional investments have also looked for private partners to invest from either U.S. venture capital or other domestic private companies. One of the two project teams seeking private investments has been granted funds, whereas the other is still pursuing their options.

Because the sampled projects are in the early stages, no project teams have had any interaction with the CEC Market Facilitation program area thus far. However, it was noted by one project team that although no interaction has occurred, they believe the Market Facilitation program area will be helpful in overcoming non-technical barriers and accelerating the commercial viability of their technology when they enter that stage in their project.

Partnerships Formed

The addition of project partners is also indicative of external interest and can be a source of private investment of funds (or intellectual capital). Thus far, two project teams have added a combined eight project partners with each having either a formal written or informal agreement. None of the project partners provide additional funding; however, seven are essential in the role of providing their services and expertise in leading discussions regarding the development of the technology or a relevant new Institute of Electrical and Electronics Engineers (IEEE) standard. One partner had been working with the team informally before the start of this EPIC project, and the partnership became formal during the project. Typically, the project partners meet on an ad hoc basis, depending on the need at that time of the project.

Finally, we note that all four project teams that have a technology or tool that they plan to commercialize currently believe that it will be commercially viable, in that it will compete effectively in the market and make a profit. However, due to the early stages of these projects, it is not expected for any of these technologies to become commercially viable for another one to three years. In most cases, the EPIC research will indicate whether their belief that it is viable or cost-effective seems justified.

16.1.3 Follow-on Applied R&D (Logic Model Box P)

For some technologies or tools, another indicator of progress toward future market adoption is their continued development with additional research and development. We asked both CEC administrators and grantees if they planned to conduct additional applied R&D for their technology or tool based on the results of the project.

Four of the eight project teams indicated that they do plan to conduct additional research for their technology or tool depending on final results. Based on the current stages of the existing research and interim results of our sampled projects, the technologies and tools that are being developed seem to be on track with the original research objectives, suggesting that additional research and development may be worthwhile.

Anticipated Future Research and Development via EPIC

Of the teams that anticipate pursuing follow-on applied R&D, two of the four project teams plan to seek additional funding from EPIC.

Anticipated Future Research via Other Funding

In addition (or in place of additional EPIC funding), some project teams anticipate future research funded from other sources. One team hoping for future EPIC funding plans to seek funding from the DOE as well. Another team indicated that they might take some of their findings and bring them to their start-up company to continue their research, while seeking additional funding from non-dilutive investors (i.e., financing that does not require the sale of company shares, and hence does not cause dilution of the existing shareholders).

Finally, one of the four project teams planning to conduct follow-on research stated that it was too early in the project to provide any details on potential next steps.

16.1.4 Technology Demonstrations (Logic Model Box U)

According to the program logic model, technology demonstrations would follow the completion of Applied R&D efforts. Given that all sampled Applied R&D projects were still in progress, it is still too early to know the extent to which the current set of projects will lead to technology demonstrations.

While our review of the on-going projects and project team assessment of their progress suggests that the technologies and tools being developed seem to be on track with the original research objectives, the CAMs have only general ideas of what they want to see out of any potential technology demonstrations. Clear next steps are not apparent at this time.

16.1.5 Technology Adoption (Logic Model Boxes Q, R, S, and T)

While the Applied R&D logic model indicates that the adoption of technologies and tools is expected to follow project completion, it is generally too early to assess the likelihood of eventual adoption. However, we note that one grantee is reportedly already offering the technology being studied in its Applied R&D project in the marketplace and is in the process of its first open market installation in California. That technology is a PV-oriented innovation that has received both EPIC and DOE funding and is transitioning to commercial availability even as the EPIC project is still being completed. The other seven project teams all appeared to anticipate the eventual adoption of their respective technologies.

16.2 Technology Demonstration and Deployment Projects

In this section, for the Technology Demonstration and Deployment (TD&D) projects designed and implemented by the CEC and the three IOUs, we present results to date with respect to the outputs and outcomes depicted in the TD&D logic model in Appendix B. These results are based on the analysis of a random sample of 38 TD&D projects, stratified by administrator (17 active CEC projects, 12 active IOU projects and 9 completed IOU projects). For the CEC projects, we conducted in-depth interviews with the CAMs and grantees. For the IOU projects, we conducted in-depth interviews with the project managers and, when necessary, the vendors. These in-depth interviews allowed us to address a broader range of issues in greater detail.

Below, we present the results for the various outputs and outcomes, as depicted in the TD&D logic model, for the 38 sampled TD&D projects.[113] In presenting these results, there are two things to keep in mind. First, since only nine projects have been completed at the time of data collection, many of the observations are based on the informed judgment of project teams regarding the likely eventual success of their projects. Answers to questions for active projects should therefore be considered early indicators of project performance. Second, a sample size of 38 is a relatively large sample fraction, but when some questions are contingent on earlier responses and then broken out by different variables such as by administrator and/or by active versus complete, the sample sizes within each cell become quite small, making any generalizations to the larger populations less tenable. In order to connect the reader to the overarching framework provided by the TD&D logic model, we have included, in parentheses next to each heading, the letters associated with the output and outcome boxes in the TD&D logic model in Appendix B.

[113] At the time the TD&D sample was drawn in October of 2016, there were only nine completed projects. The number of completed projects has grown to 18 by the time this evaluation report was prepared in July of 2017.

16.2.1 Knowledge Creation and Knowledge Utilization (Logic Model Boxes F, H, N and S)

From the TD&D logic model, it is clear that the key output of any project is knowledge and that this knowledge should be used in some way to advance innovative technologies leading eventually to commercialization of new products or wider adoption of new products in the public domain. Over time, it is the combination of all of these projects that is expected to increase the probability of achieving the mid- and long-term EPIC outcomes. Respondents associated with completed projects were of course more confident about any knowledge they created and its usefulness, while respondents associated with active projects could only assess their progress to date, which at least provides us with a leading indicator of success.

Knowledge Creation

The most basic question is whether, for completed projects, any new knowledge had been created. For both completed and active projects, there was a consensus that knowledge has been created and that this knowledge has given them greater confidence in the performance of their technologies and tools. One way TD&D projects can increase adoptions is to install the technology at a site where potential adopters can visit the site, see it in operation and assess its applicability to their own situation. In general, respondents felt that visitors to TD&D sites were, as a result, more confident in the performance of the technology and more likely to adopt it.

Project teams were also asked to assess how successful they have been in achieving their technical performance targets. For the completed IOU projects, nearly all indicated that they had been very successful. For the active CEC and IOU projects, nearly all indicated that, thus far, they have been very or extremely successful in meeting their technical performance targets.

Another question is whether, if completed, they have validated or, if still active, are likely to validate their targeted benefits. To address this question, we reviewed benefits questionnaires from 14 of 38 TD&D projects. Table 68 below summarizes the project benefits targeted by the following general benefit areas:

- **Potential Energy and Cost Savings** – for example, CEC project 15-053 developed, demonstrated and evaluated energy retrofit packages to help the CPUC reach residential Zero Net Energy (ZNE) goals. Expected benefits of this project are significant savings in energy, money, resources, and operation and maintenance costs that will accrue to ratepayers. CEC project 14-031, which is utilizing gas turbines to convert dirty, low heating value fuels into heat, also anticipates potential energy and cost savings. Expected benefits of this project are significant savings in yearly electricity costs, reuse of resources, and reductions of nitrogen oxide emissions.

- **Job Creation –** CEC project 14-081 is demonstrating a software tool that links ground water extraction with smart meter data to provide growers with automated information on energy and water consumption. It is predicted that this project will add approximately 28 jobs in the state of California, with those jobs lasting anywhere between 15 and 50 years.
- **Economic Benefits –** for example, CEC project 14-085 demonstrates how a combination of PV generation and an energy management system could reduce the community's average daily power and peak energy demand. Expected benefits of this project are reductions in electricity charges while reducing carbon dioxide emissions and other GHG emissions associated with power products. CEC project 15-042, which is developing and evaluating a cost-competitive ZNE community, also anticipates economic benefits. Expected economic benefits coming from this project involve the construction of 50 ZNE new homes in a disadvantaged community, favorable media attention leading to an increase in awareness and knowledge of ZNE homes and an increase in property values in the community.
- **Environmental Benefits –** CEC project 15-079 is demonstrating a pre-commercial flow battery storage control system at a Regional Wastewater Treatment Plant located in a disadvantaged community. Expected benefits of this project are a significant decrease in grid power consumption and GHG emissions. CEC project 14-050 is developing, demonstrating and evaluating microgrids to assist emergency response facilities by providing three hours a day of power for critical loads during a utility power outage. This project is expected to produce environmental benefits by decreasing air emissions relative to the currently used diesel back-up power.
- **Safety, Power, Quality, and Reliability (Equipment, Electric System)** – CEC project 15-042 is developing and evaluating a cost-competitive ZNE community. Expected benefits of the project will directly improve grid reliability by reducing peak demand through efficiency and renewable generation in the 50 homes constructed in the community. CEC project 14-060, which is demonstrating a utility-owned microgrid in a community commonly impacted by severe thunderstorms and rugged terrain, also expects electric system reliability benefits. It is expected that the microgrid will allow quicker restoration of services to customers in order to sustain critical infrastructure during grid outages.

Table 68: TD&D Project Benefits Tracked

Benefit	# with Quantified Benefits	# with Qualitative Benefits	Total with Benefits	Sample Size
Potential Energy & Cost Savings	8	3	11	14
Job Creation	1	0	1	14
Economic Benefits	4	7	11	14
Environmental Benefits	6	2	8	14
Safety, Power, Quality and Reliability (Equipment, Electric System)	3	3	6	14

For the IOU completed projects, nearly all project teams indicated that they were somewhat to very successful in validating these expected benefits, with only one project team indicating that they have not been at all successful. For active IOU projects, project teams indicated that they have, thus far, been very successful in validating their expected benefits. For the CEC active projects, nearly half of the project teams said that they have thus far been very or extremely successful in validating their benefits. For the remaining half, project teams indicated that it was too early to judge. Only two CEC project teams felt that they have been not at all or a little successful thus far. In general, completed projects and active projects thus far have been successful with some CEC project teams indicating that it is too early to tell. In general, projects have either validated their expected benefits or are on track to verifying them.

Other more concrete indicators of knowledge creation are the production of progress reports, final reports, databases, fact sheets, refereed journal articles, and trade journal articles. Both the CEC and IOU closely monitor their projects on a monthly or quarterly basis, with a few even getting weekly progress reports (discussed in more detail in Section 9). There is also a general consensus among the CAMs and IOU project managers that these reports are very or extremely useful. Furthermore, none of the projects have been re-scoped even with such careful oversight, which is one indication that the research plans finalized at the beginning of each project were very well designed and are being faithfully implemented. This use of these on-going reviews allows for mid-course corrections that are essential for the success of EPIC. The use of such feedback is considered best practice.

In addition, five of the 15 CEC grantees indicated that thus far they had published articles in refereed journals (four more are in progress), three had created fact sheets, and two had published articles in trade journals, but no software tools or databases have been created. Thus far, the IOUs have published two articles in refereed journals and three articles in trade journals, and have created four fact sheets, three databases and three software tools.

We emphasize that it is premature to expect a large number of such outputs, and more are expected as these TD&D projects evolve.

Results in the form of final reports, articles, fact sheets and databases are posted on the CEC, CPUC and IOU websites, presented at workshops for interested parties, presented at professional conferences, and delivered to a variety of organizations and individuals that comprise their professional network. These dissemination-of-knowledge activities are described in more detail in the network analysis in Section 9.

Knowledge Utilization

While it is important to create knowledge both during and at the conclusion of a project, it is equally important for these results to be used. Knowledge gained during a project is used to assess whether the project is on schedule and on budget and whether the technology is working as expected. The adjustments are triggered by consultation from TAC and PAC members, critical project reviews and discussions between the administrators and the CEC grantees and IOU project managers. For IOU projects, this assessment is conducted by the project managers. Two questions focused on the extent to which project teams, as a result of knowledge gained thus far from their projects, have deviated from their original research plans and, as a result, re-scoped their projects. For the CEC, there were only a few minor deviations and thus no reason to re-scope any of their projects. For the IOUs, only one experienced a serious deviation based on interim feedback resulting in its cancellation. These results suggest that knowledge gained during the implementation of projects is being considered by project teams, resulting in some minor adjustments and only one case of project cancellation. Such on-going feedback is essential for EPIC's success..

Finally, for six of the nine completed IOU projects, respondents indicated that they are aware of other organizations or individuals, apart from their EPIC project team, who are planning to use the findings or outputs from this project. Such use by others is one indicator of the value of the IOU research.

Development of Patents and Copyright Material

In the application of TD&D activities, project scoping is normally directed toward products and materials that have already been developed and are ready for integration within a viable demonstration platform. Therefore, it is generally accepted that any patent or copyright activities in product development would have taken place previous to project scoping. For thoroughness of analysis, the sampled project interviews with CEC grantees included questions to determine if TD&D project activities had led to any further developments of patents, licenses and copyrights. While no such activity was identified, it should be noted that many of these projects were in mid-cycle development, and it was determined that any such activity, if they were to occur, would likely take place near the end of project completion and prior to technology dissemination activities.

16.2.2 Private Investment (Logic Model Boxes M and O)

Commercial Viability

As mentioned in Section 10, many technologies, absent public funding, fall into the CVD since the private sector does not typically conduct applied research and is risk-averse regarding new, unproven technologies, often lacking the resources to analyze and evaluate various technologies. We asked respondents who were planning to commercialize their technology whether, absent EPIC funding, they thought that this technology would have fallen into the CVD. Of course, accelerating a promising technology to market is still an important contribution. Of the relatively few IOU projects for which the goal was commercialization, many indicated that it would have fallen into the CVD, but a few also noted that, while their technology would not have fallen into the CVD, EPIC funding had basically helped them to accelerate its development in a more comprehensive manner and also allowed them to take on more of the risk in some of these projects than they typically would. Again, accelerating a promising technology to market and sharing the risk are still important contributions. Only two indicated that the technology would not have fallen into the CVD. Finally, many volunteered that private funding was not available.

To successfully commercialize a product or, if not to commercialize it, ensure the broader adoption of a product in the public domain, one must have an understanding of the extent to which the potential buyers or users in the broader market understand the added value of the product and, once the product is commercially available, how willing they might be to purchase or use the product. While markets are dynamic and willingness to pay is difficult to predict, having some understanding of these two issues is an indication that one is at least tracking these two issues and, as a result, has a greater chance of succeeding in the market. The vast majority of the IOU project teams showed some level of understanding of their respective markets, comprised mostly of other utilities. Because all of the CEC projects are still active, fewer of the CEC project teams were able to answer this question, and more felt that it is too soon to tell. However, those who were able to answer also displayed some level of understanding of their respective markets.

As noted earlier, as one of the conditions for funding, grantees had to justify their projects based on market forecasts/penetration estimates, and justify why EPIC funds are needed, i.e., what would happen to the project if EPIC funds were not provided. They also were asked to identify the market barriers to adoption. As EPIC projects evolve, additional market intelligence and support can be provided by the Market Facilitation program area. However, there is a disconnect between the Market Facilitation projects and TD&D projects (as well as the Applied R&D projects) that are upstream from them. The CAMs for Market Facilitation projects rarely mentioned these upstream CAMs and the IOU project managers as potential users of their research and, not surprisingly, the CAMs and project managers of these upstream projects are mostly unaware of the commercialization resources available through the Market Facilitation program area. This disconnect is primarily due to the fact that all three program areas were launched more or less at the same time, making it extremely difficult to develop projects that are aimed to meet the needs of TD&D (and Applied R&D) projects. The CEC recognizes this gap and reports that it is committed to working more closely with those responsible for the upstream projects to better meet their needs. This disconnect and a recommendation to address it are discussed in Section 11.

Another question focused on the extent to which project teams, as a result of knowledge gained thus far from their projects, have deviated from their original strategy to commercialize this technology/tool and from their original assessment of market interests. Nearly all of the IOU project teams and more than half of the CEC project teams indicated that, based on what they have learned thus far, they had not changed their original strategy, with the remaining CEC project teams indicating that it was too early to tell. Nearly all of the CEC and IOU projects indicated that they have also not deviated from their original assessment of market interests. This might mean that their original understanding of the path to commercialization and the needs of the various users in this market was reasonably sound. Of course, it could also mean that they have not yet learned enough to challenge their original thinking, something that is certainly possible given the disconnect between the Market Facilitation projects and the Applied R&D and TD&D projects that are upstream from them. Again, this disconnect and a recommendation to address it are presented in Section 11.

Assistance in Commercialization

There are a number of resources available to assist in the commercialization of a technology including firms that specialize in providing such support. We asked CEC grantees whether they have hired any outside firms to assist in the commercialization of their technology. Thus far, none of the respondents said that they have hired any firms. Another question is whether the CAMs have assisted the grantees in finding such firms. Of the nine respondents, only two said that they have provided any assistance while three suggested that it was soon. Such low levels of use of outside firms could indicate that they do not see the need for such firms or they do not understand fully the services offered by such firms.

Another potential source of assistance is the EPIC Market Facilitation program area in which the CEC proposes funding initiatives to help overcome non-technical barriers to accelerate the commercial viability of high-priority technologies and strategies in IOU service territories. Project teams were asked how helpful the Market Facilitation program area was in accelerating the commercial viability of their technology/tool. While this is less of an issue for the IOUs due to their types of projects, those relatively few projects for which Market Facilitation could be potentially helpful have had no contact with the Market Facilitation program area. For the CEC grantees, none have had any contact with this part of the EPIC portfolio. This seems in large part due to the fact that some projects have not progressed to the point where such services could be effective and a general lack of awareness of the Market Facilitation services.

16.2.3 Development of Partnerships and Investors (Logic Model Box O)

Business Development as a Result of Project Activity

As project grantees are selected and project implementation activities progress, it is understood that a key benefit of these actions will be to increase the visibility of these technologies and their parent organizations to potential partners and investors. The underlying theory is that this increased visibility will increase the likelihood of the parent organization receiving additional resources in the form of partnership developments, third-party investors or even company acquisitions. These additional resources will increase the chances that the technology will not fall into the CVD.

Of the active CEC TD&D projects with the intent to commercialize, very few have thus far met with interested parties to form partnerships, and only one has added a partner. For those that have not as yet met with any potential new partners, they often mentioned that before engaging with interested partners or investors, they needed to first identify fuller product configurations for the project application. In addition, some grantees were public institutions or non-profit agencies that are not likely open to such external resource activity. Furthermore, none of the grantees reported that they had discussed possible acquisition of their companies with any manufacturers or venture capital firms. This is likely due, at least in part, to the fact that all of the CEC projects are still active with the final outcome of the projects yet to be determined. While not yet engaged with the Energy Innovation Ecosystem that includes the four Innovation Clusters and the California Sustainable Energy Entrepreneur Development Initiative (CalSEED), TD&D projects (and Applied R&D projects) can clearly benefit from these resources. A recommendation is made in Section 11 to increase the use of these resources.

Increased Technology Production (Logic Model Boxes O & T)

As illustrated in the TD&D logic model, the final project output leading toward short-term outcomes includes increasing awareness and knowledge among the targeted populations regarding the technologies in real-life situations. Subsequently, the intention of this increased awareness is to help increase the number of producers and manufacturers in the market for the demonstrated technologies as a short-term outcome of EPIC. To evaluate the overall increase in technology production, we asked TD&D project teams about the scalability of their EPIC technologies, the cost-effectiveness of their EPIC technologies at commercial scale, and their knowledge of new producers or manufacturers of their technologies that had entered the market since the launch of their EPIC project.

Technology/Output Scalability in Commercial Applications

The scalability of the EPIC-produced technologies and tools is one metric used to help evaluate the effectiveness of increasing awareness and knowledge leading to increases in private investments and leading eventually to increased levels of production. For the sampled 22 TD&D projects that planned to commercialize their technology and were far enough along in the program process to evaluate the potential scalability of their technology outputs, all but one project team said their technology was either "very" or "completely" scalable.

One of the primary reasons project teams said their EPIC technologies were scalable was because they were applicable to a variety of commercial applications, were beneficial to different types of communities (including disadvantaged communities), were software applications that could be installed universally, and were modular to the extent that they could be scaled depending on the size of the commercial application. For example, one CEC-administered project focused on demonstrating biogas technologies that can be installed individually for smaller applications or in parallel with multiple components for larger landfills. Similar rationales were provided for TD&D projects focused on compressed air monitoring systems and wastewater treatment facilities.

We also asked CEC grantees whether, since the launch of their projects, they had attracted public and/or private investors. Thus far, very few grantees had attracted any public and/or private investment beyond EPIC funding. Again, this is, at least in part, due to the fact that all of the CEC projects are still active. Another possible explanation is that before they received EPIC funding, they might already have received funding at the earlier proof-of-concept stage of their technology.

Cost-effectiveness at Commercial Scale

Additionally, cost-effectiveness of the EPIC-supported technologies and tools when manufactured at commercial scale is another metric used to evaluate a project's push toward increased levels of production and increased number of producers. Overall, slightly less than half of the sampled TD&D projects (n=17) were either not far enough along in their project or did not have plans to commercialize, and subsequently did not attempt to evaluate the potential cost-effectiveness of their technologies and tools. However, among the TD&D projects that were far enough along in their project process and planned to commercialize, 81 percent across all administrators said their technologies were either "likely" or "extremely likely" to be cost-effective when manufactured at or near commercial scale, while only one project team acknowledged it was "unlikely" their technology would be cost-effective.

One of the primary reasons that multiple project teams said they were optimistic their technologies and tools would be cost-effective is because they anticipate production costs for their technology will continue to decrease as production increases and the technologies become more readily available. For example, one TD&D project team anticipates the return on investment for their technology to drop as the price for their technology continues to decrease. Additionally, project teams noted that being able to demonstrate their technologies in demonstration or test sites further advances the cost-effectiveness of their technologies because it indicates to other potential applications and manufacturers that the technology can be effectively administered and produces the desired benefits that warrant the required project costs.

New Producers of Demonstrated EPIC Technologies

In the short-term outcomes section of the TD&D logic model, increased awareness regarding the real-life application of EPIC technologies is expected to result in an increase in the number of producers of the demonstrated technologies. The increase in producers may help increase the availability and cost-effectiveness of the EPIC technologies and further promote renewable technologies within the commercial market.

As outlined above, given that several sampled TD&D projects—especially IOU-administered projects—either did not have current plans to commercialize or were still in the early stages of their project, only 58 percent (n=22) of project teams were asked about the number of new producers for their technologies that had entered the market since the launch of their project. As shown in Table 69, among the project teams that did respond, 11 indicated there were no new producers of their technologies or tools, while six said there were new producers and five said they did not know.

Table 69: New Manufacturers Entering Market

Since the launch of this project, have new manufacturers of this technology/tool entered the market?	CEC	PG&E	SCE	SDG&E	Total
Yes	4	2	0	0	6
No	6	2	1	2	11
Don't know	4	0	1	0	5
Total	**14**	**4**	**2**	**2**	**22**

Follow-on TD&D (Logic Model Box V)

One possible outcome depicted in the TD&D logic model is follow-on TD&D research. The CEC and IOU project teams were asked whether they plan to conduct additional TD&D research for this technology/tool based on the results of their projects. Well over half of the CEC project teams indicated that they plan to conduct additional TD&D research based on the results of their projects thus far. For the IOU completed projects, nearly all respondents indicated that they do not intend to conduct additional TD&D research. Since the project teams for IOU active projects were not asked this question, it is difficult to reliably compare the results. Nevertheless, at least some of these differences might be due to the fact that the IOU projects are more narrowly defined for a very specific application and therefore require less additional research.

Technology Adoption (Logic Model Boxes P, Q and R)

The adoption of a technology by industry stakeholders is a primary indicator of program efficacy. This restricted our analysis of adoptions to the only completed TD&D projects in our sample, the IOU projects. However, this does produce some difficulty in the overall portfolio segmentation analysis, since the IOU TD&D projects tend to be targeted for adoption within the specific activity of electric grid management and operations. In addition, since the identification of future changes to grid-system operations are cycled annually and through regulatory review, any future adoptions of these technologies or processes would not be expected to occur until sometime in the next planning cycle. General results from interviewed administrators indicate that these completed projects had produced favorable results and that the further integration of these demonstrated technologies and processes would occur—primarily by the administrator of the project. Even though the adoptions were primarily by the administrator of the project, the IOU project managers also noted that utilities inside and outside California could also benefit from adopting these technologies.

16.3 Market Facilitation Projects

16.3.1 Background and Overview

In this section, for the Market Facilitation projects designed and implemented by the CEC, we present results to date with respect to key outputs and outcomes depicted in the Market Facilitation logic model in Appendix B. These results are based on a random sample of eight active CEC Market Facilitation projects. For each sampled project, we conducted in-depth interviews with the CAM and grantee. These in-depth interviews allowed us to address a broader range of issues in greater detail. The evaluation team asked interviewees about issues related to funding, knowledge creation, knowledge utilization, project scalability, and follow-on research. This section summarizes findings related to these topics.

In order to maintain respondents' confidentiality, due to the small number of projects in the sample and even smaller numbers by the logic model activity areas, this analysis aggregates findings from all projects in the sample and does not discuss findings within the main activity areas identified in the logic model. Additionally, although the sample included eight projects, not all questions were asked of every CAM or grantee. In most cases, those questions were not relevant to the specific project or the project had not been active long enough to allow the respondent to provide a response. In some instances, the question may not have been asked due to time constraints. As a result, some questions have results from fewer than the eight respondents in the sample.

In order to connect the reader to the overarching framework provided by the Market Facilitation logic model, we have included, in parentheses next to each heading, the letters associated with the output and outcome boxes in the Market Facilitation logic model in Appendix B.

16.3.2 Funding (Logic Model Box C)

In general, grantees reported that they were satisfied with the level of funding for their project. When asked about the likelihood of whether their project would have been conducted absent EPIC funding, four grantees said that it was "unlikely" while three said that it was "extremely likely." Of course, continued funding is always an issue. Since the launch of their project, four grantees reported that they have sought additional funding. Three said that they have pursued funding from federal agencies, one from private investors, and one from a collaboration between the CEC and IOUs.

16.3.3 Knowledge Creation and Knowledge Utilization (Logic Model Boxes E, H, K, N, F, I, L and O)

From the Market Facilitation logic model, it is clear that the key output of any Market Facilitation project is knowledge and that this knowledge should be used in some way to advance innovative technologies, leading eventually to the achievement of mid- and long-term outcomes. Of course, since all Market Facilitation projects are still active, respondents could only assess their progress to date, which at least provides us with leading indicators of knowledge creation and utilization.

Knowledge Creation

The most basic question is whether, for completed projects, any new knowledge had been created. Since all of these Market Facilitation projects are still active, we asked the CAMs how successful they have been, thus far, in achieving their project/research objectives. Responses were evenly distributed from somewhat successful to extremely successful. When asked to explain their answers, most indicated that they had achieved all of the intermediate objectives thus far. A related question is how successful they have been, thus far, in validating these benefits of their project that might eventually lead to longer-term benefits once the findings/information/products are more broadly deployed. Four responded that thus far, they have been somewhat successful, while one indicated that they have been extremely successful. One indicated that it was simply too early to tell. In general, projects are on track to achieve their research objectives and their expected benefits.[114]

We also reviewed benefit questionnaires from four of seven Market Facilitation projects. Table 70 below summarizes the project benefits targeted by the following general benefit areas:

- **Potential Energy and Cost Savings** – for example, CEC project 14-037 is an applied, data-driven study to understand the role and interactions of various factors such as income, ethnicity, language and political orientation to understand the adoption

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[114] See Section 9 for a more detailed discussion of the results of our analysis of the benefits questionnaires.

and utilization of residential energy efficiency measures. Expected energy and cost savings benefits for this project include a reduction in electricity use when results are used to design energy efficiency programs, which, based on research findings, will lead to a more effective and efficient program delivery. CEC project 15-010 will seek to provide workers from disadvantaged communities with comprehensive classroom and on-the-job training in the installation and maintenance of AutoDR communication equipment. Expected energy and cost savings benefits for this project are reduced electricity costs for building owners, based on the size of buildings and energy consumption.

- **Job Creation** – for example, CEC project 15-010 will seek to provide workers from disadvantaged communities with comprehensive classroom and on-the-job training on the installation and maintenance of AutoDR communications equipment. Expected benefits for this project are to increase the number of trained workers that will fill jobs installing and maintaining AutoDR, specifically in disadvantaged communities.
- **Economic Benefits** – CEC project 14-037 is an applied, data-driven study that will serve to understand the role of various economic and societal factors in order to provide insight into the trends of adoption and utilization of residential energy efficiency measures. Expected benefits of this project will help energy efficiency stakeholders to better understand trends of sociocultural groups, which will help increase participation in energy efficiency measures, providing energy cost savings and potential job creation. CEC project 15-010 will develop and train workers from disadvantaged communities and provide them with the necessary skills to install and maintain AutoDR. There are many expected economic benefits that will come from this project, including more money coming in to disadvantaged communities through skilled labor that will go back into businesses in those communities. Also, improvement in system operation efficiencies will come from the increased utility workforce, providing quicker dispatch of customer demand side management.
- **Environmental Benefits** - CEC project 15-010 will develop the skills of workers from disadvantaged communities by providing comprehensive training on the installation and maintenance of AutoDR communication equipment. Among many other benefits, expected environmental benefits from this project are a decrease in emissions; AutoDR will shift energy use from Peak periods to Off Peak periods and reduce overall building energy use. CEC project 14-037 also predicts environmental benefits including reductions in GHG emissions due to a decrease in residential energy use.
- **Safety, Power, Quality, and Reliability (Equipment, Electric System)** – for example, CEC project 14-037 is expected to lead to greater reliability in the electric system and equipment. Expected benefits of this project are an improvement of the accuracy of market adoption forecasts of the replacement of "generation-based" resources with efficiency resources. CEC project 15-010, which is training workers

in disadvantaged communities to maintain and install AutoDR, also predicts improved grid reliability benefits due to an increase in demand response resources

Table 70: Market Facilitation Project Benefits Tracked (n=4 number of Market Facilitation projects with benefits questionnaire)

Benefit	# with Quantified Benefits	# with Qualitative Benefits	Total with Benefits	Sample Size
Potential Energy & Cost Savings	0	2	2	4
Job Creation	0	1	1	4
Economic Benefits	0	3	3	4
Environmental Benefits	0	2	2	4
Safety, Power, Quality and Reliability (Equipment, Electric System)	0	2	2	4

Other more concrete indicators of knowledge creation are the publication of progress reports, final reports, databases, fact sheets, refereed journal articles, and trade journal articles. The CAMS closely monitor their projects on a monthly basis, and there is a general consensus among the CAMs that these reports are extremely useful. Such on-going reviews allowing for mid-course corrections are essential for EPIC's success and are considered best practice.

In addition, none of the projects have been re-scoped even with such careful oversight, which is one indication that the research plans finalized at the beginning of each project were very well designed. While all of these projects are still active, one article has been submitted to a refereed journal. In addition, four of the seven respondents indicated that they have published articles in trade journals and support a blog about their projects. As projects evolve, we expect their numbers to increase.

In addition, the CAMs indicated that interim and final results in the form of final reports, articles and fact sheets will also be shared through a variety of channels including the CEC's various websites, workshops and presentations given at professional conferences. These results will also be delivered to a variety of organizations and individuals that comprise their professional network. These dissemination-of-knowledge activities are described in more detail in the network analysis in Section 9.

When asked about the audiences they targeted for their findings, the CAMs most commonly mentioned the projects' TAC, members of other relevant project TACs, and the Emerging Technology Coordinating Council. Interestingly, interviewees were not as likely to cite the CEC Applied R&D grantees or TD&D grantees as primary audiences. Grantees were even less likely than CAMs to do so. This result might be due to the fact that all three program areas were launched more or less in parallel with each other. As a result, the needs of those conducting Applied R&D and TD&D projects could not be carefully reviewed prior to launching Market Facilitation projects. In the future, a more systematic assessment of the needs of those conducting projects that are upstream from the Market Facilitation projects should be considered.

Knowledge Utilization

While it is important to create knowledge both *during* and *after* the completion of a project, it is equally important for these results to be used. For projects that are still active, CAMs use the knowledge gained thus far to make any necessary mid-course corrections. One question focused on the extent to which project teams, as a result of knowledge gained thus far from their project, have deviated from their original CEC-approved research plan. All of the project teams reported that they had not deviated, although two indicated that their schedules had been somewhat modified due to unforeseen events. In addition, none of the grantees indicated that they had changed the scope of work for their projects based on feedback from the CAMs or the TACs. This suggests that their research plans were well designed and are being faithfully implemented.

While only one regional Innovation Cluster was in our sample (EPC 15-038), given their size and potential for knowledge creation and utilization, all four commercialization projects are worth mentioning. These four regional Innovation Clusters are designed to achieve a key strategic objective, S18, which is to foster the development of the most promising energy technologies into successful businesses. Innovation Clusters are defined as geographic concentrations of interconnected companies, specialized suppliers, service providers, firms in related industries, and associated institutions in particular fields (Tinguely 2013). Clusters emerge when a network of companies coexists within a geographic location, allowing each of them to collaborate—and compete—in a way that delivers greater productivity gains than they would achieve in isolation. The four Clusters that have been funded (EPC-16-015, EPC-15-030, EPC-15-032 and EPC-15-038) and their budgets are listed in Table 71.

Table 71: Innovation Clusters and Funding

Innovation Clusters	EPIC Funding	Match Funding	Total
Bay Area Regional Energy Innovation Cluster	$ 4,980,000	$ 9,000,000	$13,980,000
Central Valley Energy Innovation Cluster: BlueTechValley Energy Cluster	$ 5,000,000	$ 2,655,684	$ 7,655,684
San Diego Regional Energy Innovation Cluster	$ 5,000,000	$ 3,097,934	$ 8,097,934
Los Angeles Regional Energy Innovation Cluster	$ 4,999,247	$ 3,658,099	$ 8,657,346
Total	$ 19,979,247	$ 18,411,717	$38,390,964

The EPIC funding combined with the match funding make these regional Innovation Clusters the largest EPIC Market Facilitation project by far. In general, these four Clusters are designed to help entrepreneurs avoid the TVD and the CVD by facilitating a network of stakeholders to provide commercialization assistance and services to clean energy entrepreneurs and start-up companies. These networks will exchange ideas and best practices, information on promising technologies, and insights into specific market opportunities and customer needs. Also, this network will provide opportunities for entrepreneurs to engage with industry and investor stakeholders and receive market feedback and validation, as well as services to match entrepreneurs with customers in IOU service territories and guidance on incubators for product testing.

Each cluster has three basic activities: 1) engage regional hubs, 2) provide business and technology serves, and 3) assess energy research. In Table 72, for each Innovation Cluster, we present the number of regional hubs that are being engaged, the number of firms providing business and technology services, and the number of energy research organizations being engaged.

Table 72: Innovation Clusters, by Key Activities

Innovation Clusters	Hubs Engaged	Business & Tech Firms	Energy Research Organizations
Bay Area Regional Energy Innovation Cluster	2	2	4
Central Valley Energy Innovation Cluster: BlueTechValley Energy Cluster	2	2	8
Los Angeles Regional Energy Innovation Cluster	4	5	6
San Diego Regional Energy Innovation Cluster	3	3	3
Total	11	12	21

Not only are small entrepreneurs across California eligible to participate, but both active and completed EPIC projects are also eligible.

These Innovation Clusters will be evaluated over time on a number of performance metrics including job creation and economic development in California, future energy and environmental savings, dollar value of Ecosystem[115] resources, increased market size and potential as a result of using Ecosystem resources, improved resource effectiveness through use of market-specific and region-specific market research, number of referrals made from one Cluster to another to reward collaboration, level of customer awareness of emerging technology options in Cluster regions, and improved diversity in

[115] The Energy Innovation Ecosystem includes the four Innovation Clusters and the California Sustainable Energy Entrepreneur Development Initiative (CalSEED), which includes 1) at least $24 million in small grants for entrepreneurs, 2) at least $44 million set aside for underrepresented groups, and 3) support for early development of promising new energy concepts.

entrepreneurship.[116] In addition to the CEC annual reports, the CPUC should also receive any interim progress reports.

16.3.4 Project Scalability (Replicability) (Logic Model Boxes F, I, L and O)

The team asked each project grantee how scalable[117] they thought their project was, using a scale of "not at all" to "completely." Of the six grantees for whom this question was relevant, four said that their project's approach was "completely" scalable. Of the remaining grantees, one said that the project was "very" and other said that it was "a little" scalable. One grantee's interpretation of "scalable" was that it could be replicated anywhere in the world. Another said that it was scalable as long as there was funding.

16.3.5 Follow-On Research (Logic Model Boxes F, I, L and O)

One possible outcome depicted in the Market Facilitation logic model is follow-on research. The CEC project teams were asked whether they plan to conduct additional studies or research based on the results of their projects. Although all eight of the Market Facilitation projects are still active, two grantees responded that they would conduct additional studies. One grantee pointed out that since their project is very broad, it could apply to any of a number of areas such as community design, alternative vehicle technology, fuel cell technology, battery energy storage or PV system design. This grantee went on to note that they could conduct additional research in any one of these areas in the future.

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[116] Navigant Consulting is currently under contract to the CEC to develop and finalize a written report detailing a common methodology that can be used to evaluate the benefits accomplished by the four Regional Energy Innovation Clusters.

[117] Scalability, in the traditional sense, is the capability of a system, network, or process to handle a growing amount of work, or its potential to be enlarged in order to accommodate that growth. In an economic context, the scalability of a company implies that the underlying business model offers the potential for economic growth within the company. Scalability for Market Facilitation projects can also include the ability of a research project to be replicated in other states and jurisdictions.

17 Appendix F: Selected References Regarding Theory-Driven Evaluation

For detailed descriptions of theory-driven evaluation, see the following references:

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