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STAFF REPORT

Electric Program Investment Charge 2023 Annual Report

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PREFACE

The California Energy Commission's (CEC) Energy Research and Development Division (ERDD) supports energy research and development programs to spur innovation in energy efficiency, load flexibility, renewable energy and advanced clean generation, transportation, grid transmission and distribution, and energy-related environmental protection.

In 2011, the California Public Utilities Commission (CPUC) established the Electric Program Investment Charge (EPIC) to fund public investments in research that create and advance new energy solutions, foster regional innovation, and bring ideas from the laboratory to the marketplace. The CPUC initially authorized the program through 2020 and selected the CEC and the state's three largest electric investor-owned utilities (IOUs) — Pacific Gas and Electric Company, San Diego Gas & Electric, and Southern California Edison — to administer EPIC funds. EPIC is funded by a ratepayer surcharge from customers of these IOUs and its investments deliver benefits back to ratepayers.

In 2020, the CPUC renewed EPIC for an additional ten years, through 2030, and approved the CEC to continue as a program administrator. In 2021, the CPUC extended the role of the IOUs as administrators of the EPIC program until 2025. Moreover, CPUC Decision 21-11-028 established a mission statement that EPIC investments provide "equitable access to safe, affordable, reliable, and environmentally sustainable energy for electricity ratepayers;" revised the guiding principles to ensure project benefits in the areas of improved safety, increased reliability, increased affordability, improved environmental sustainability, and improved equity; and established a number of administrative requirements to increase transparency and better align future EPIC investments with its Environmental Social Justice and Distributed Energy Resources action plans, as well as the federal Justice40 Initiative.

ERDD is responsible for executing the EPIC program at the CEC. For more information about ERDD's work on EPIC, please visit the CEC's website at https://www.energy.ca.gov/programs-and-topics/programs/electric-program-investment-charge-epic-program.

ABSTRACT

The Electric Program Investment Charge (EPIC) is California's premier electricity sector research and development program. EPIC drives innovation and advances science and technology in energy efficiency, load flexibility, renewable energy and advanced clean generation, transportation, grid transmission and distribution, and energy-related environmental protection, among other areas important to California's electricity system. EPIC is funded by a ratepayer surcharge from the state's investor-owned utilities and its investments deliver benefits back to ratepayers. EPIC is overseen by the California Public Utilities Commission (CPUC) and administered by the California Energy Commission (CEC) and investor-owned utilities. CEC-administered EPIC investments support applied research and development, clean energy demonstration and deployment projects, and market facilitation activities, that both benefit electricity ratepayers and lead to technological advancements that can help overcome key barriers to the state's statutory energy goals.

This report outlines the progress and status of EPIC-funded CEC activities from January 1, 2023, through December 31, 2023. The report was prepared in accordance with applicable CPUC decisions and California Public Resources Code Section 25711.5.

Keywords: Advanced generation, agriculture, buildings, California Energy Commission, California Public Utilities Commission, clean energy economy, climate change, decarbonization, demand response, disadvantaged community, distributed generation, Electric Program Investment Charge, electricity, electrification, energy efficiency, energy equity, energy policy, energy research, energy storage, entrepreneurial ecosystem, environmental, greenhouse gas, heat pumps, innovation pipeline, jobs, low-income community, ratepayer benefits, renewable energy, resilience, safety, smart grid, transmission, transportation, U.S. Department of Energy, water

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Program Overview

Through the Electric Program Investment Charge (EPIC), the California Energy Commission (CEC) funds innovation to advance a clean, safe, reliable, and affordable electricity system that benefits all California ratepayers. EPIC was established in 2011 and, as of December 31, 2023, has invested $1.2 billion across 501 public research and development projects. Collectively, these EPIC-funded projects have gone on to receive $10.1 billion in follow-on funding from other public and private investors, a nearly tenfold amplification that demonstrates EPIC's success in launching innovative clean energy technologies.

Last year marked a monumental period for clean energy research and infrastructure deployment. At a federal level, the United States Department of Energy (U.S. DOE) rolled out a significant tranche of funding from programs created in 2022 through the Infrastructure Investment and Jobs Act and the Inflation Reduction Act. Some of the money bolstered or complemented state efforts directly. For example, California was awarded up to $1.2 billion from U.S. DOE in October through the federal H2Hub Initiative and selection of the state's application to establish a sustainable statewide clean hydrogen hub led by the Alliance for Renewable Clean Hydrogen Energy Systems, otherwise known as ARCHES. The commitment of federal funds not only creates new opportunities for research and technology deployment, spurred by public and private partnership, but also sends strong market signals that can attract future companies and investors.

The U.S. DOE also provided grants to companies across the United States to encourage rapid development and deployment of targeted technologies, including to several companies in California that emerged or grew from prior EPIC funding. These grants validate the state's implementation of clean energy research and deployment programs that foster technology development from the private sector. Moreover, EPIC-funded companies that receive significant additional funding from the federal or private sector embody the success stories of public research investments. Their innovative ideas received support at a critical stage of product development and then went on to raise scale-up funds to expand research or manufacturing, helping accelerate the clean energy transition in California and across the United States.

The historic availability of funding in 2023 enabled EPIC to make significant progress toward achieving the strategic objectives and initiatives established in previous and current investment plans. Most of the active projects are funded from the EPIC 3 and EPIC 4 investment plans. For this annual report, progress is reported toward the most recent EPIC 4 investment plan strategic objectives and initiatives.

EPIC had a banner year in 2023 as companies and projects funded in prior years began to achieve technology validation, at-scale deployment, early-stage manufacturing, and product commercialization. At a staff level, EPIC activities consisted of progressing and concluding project agreements funded under previous investment plans while concurrently planning, scoping, and disbursing grant opportunities detailed in the CEC's EPIC 4 investment plan. This

plan codifies program guidelines until 2025 and was approved by the California Public Utilities Commission (CPUC) in April 2022.

Key Successes and Highlights at a Portfolio Level

The success metrics for clean energy projects vary widely depending on the research topic or deployed technology. For companies seeking to bring a product from laboratory to market, success could be reaching the next technology readiness level (TRL), securing follow-on funding from a public or private source, or establishing the first low-production manufacturing site for a prototype. In contrast, EPIC research projects focused on expanding the knowledge base for the clean energy transition may achieve success when the data they generate result in tangible benefits, such as improved utility infrastructure planning or earlier evacuation warnings due to more precise weather modeling and predictions.

EPIC garnered further successes in 2023. An increasing number of companies and projects funded in the prior EPIC 3 investment cycle (2018–2020) reached the later stages of their grant timeline and achieved new milestones. Gradient, a company featured in last year's EPIC Annual Report for its innovative, window-mounted heat pump that received a 10,000-unit contract from the New York City Housing Authority, continued to see success in 2023. The company closed a $27.5 million Series A funding round in June and then was selected for a $17.5 million Defense Production Act Award by the U.S. DOE in November. The company also showcased its heat pump at the White House's Demo Day and met with President Joseph R. Biden Jr. to discuss the benefits of the highly efficient electric heating and cooling technology. Gradient first received $2.7 million in EPIC funds in 2017 to expand manufacturing. It then received $2.8 million in EPIC follow-on funding in 2019 to support the company's research to expand the temperature use range of the heat pump.

EPIC projects are also providing direct economic and nonenergy benefits to California ratepayers. Since 2018, RMI (formerly known as the Rocky Mountain Institute) has been implementing $7.2 million in EPIC funds to demonstrate quick and reliable retrofit installation packages tailored to low-income, affordable multifamily housing. Participants enrolled in the project experience real-world benefits of improved living comfort and climate resilience following the installation of better building envelopes and highly efficient electric appliances. The ongoing project has sites throughout the state in Richgrove, Corona, Fresno, and East Palo Alto. RMI's use of prefabricated building envelopes in this California model, known as REALIZE-CA, was recognized by the U.S. DOE and awarded $4.4 million to replicate deployment of the integrated retrofit package in Massachusetts.

Additional highlights from the EPIC portfolio of investments in 2023 include the following:

- Twenty-four EPIC projects were completed by grant awardees.
- Almost half of EPIC funding granted was awarded to small- and medium-sized businesses.
- About $1.5 million in on-bill energy cost savings were generated through 18 EPIC-funded projects across the state, including in under-resourced communities.
- More than 2,000 single-family and multifamily residential units in California involve building electrification efforts from 20 EPIC projects.
- More than 4,000 subsequent deployments of clean energy technologies resulted from 22 EPIC-funded demonstration projects.

- Eighteen EPIC-funded projects reported approximately 16,854 metric tons of avoided carbon dioxide (CO_2) equivalent emissions savings in 2023.
- Four EPIC award recipients reported that their EPIC projects had generated more than $10 million in revenue, each.

Challenges and Impediments at a Portfolio Level

A number of common challenges were cited by projects and companies across EPIC's expansive research and deployment portfolio. Demonstration and deployment projects broadly reported supply chain issues, delaying construction and installation of devices such as electric vehicle chargers and electric heat pumps. Other sources of implementation delays noted by grantees included inflation and rising costs; challenges hiring staff and contractors in a post-pandemic economy; complications with obtaining fire permits for energy storage units; and difficulty engaging local stakeholders to solicit input on proposed projects or buy-in on the installation of clean energy devices using novel technologies.

EPIC Advances Energy Equity

Essential to a just and fair transition, California is expanding opportunities for participation from disadvantaged and low-income communities, tribes, and rural communities in the development of the state's clean energy economy. Through 2023, nearly 60 percent of CEC EPIC technology demonstration and deployment (TD&D) funds were invested in projects with demonstration sites in low-income communities or disadvantaged communities, as defined by Assembly Bill (AB) 523 (Chapter 551, Statutes of 2017). Additionally, $21 million of TD&D funds were invested in projects located on California Native American tribal lands.

Status of EPIC

In Decision 20-08-042, the CPUC renewed EPIC for 10 years, 2021 through 2030, and authorized the CEC to continue as an EPIC administrator with an annual budget of $147.26 million for the first five years of this period. The CPUC approved the CEC's Interim EPIC 4 investment plan covering the first year of EPIC 4 funding in July 2021. A year later, the CPUC approved the EPIC 4 investment plan covering 2022-2025.

In August 2023, the CPUC began the initial stages of development for the EPIC 5 investment plan. As directed by CPUC Decision 23-04-042, the project coordinator for CPUC's Policy and Innovation Coordination Group (PICG) held a series of five workshops between August 16, 2023, and September 20, 2023, to develop recommended strategic goals for EPIC. These strategic goals will form the basis for the strategic objectives in the EPIC 5 investment plans. The PICG also developed a Uniform Impact Analysis Framework, which will be used to measure the progress of EPIC 5 investments toward these strategic objectives. In March 2024, the CPUC approved Decision 24-03-007, which adopted five strategic goals for EPIC 5:

1. Transportation Electrification
2. Distributed Energy Resources Integration
3. Building Decarbonization
4. Achieving 100 Percent Net-Zero Carbon and the Coordinated Role of Gas
5. Climate Adaptation

CHAPTER 1:
Introduction and Overview

Background on the Electric Program Investment Charge

In 2011, the California Public Utilities Commission (CPUC) established the Electric Program Investment Charge (EPIC) and authorized the California Energy Commission (CEC) as one of four administrators alongside California's three largest investor-owned electric utilities (IOUs), whose ratepayers fund the program – Pacific Gas and Electric Company (PG&E), San Diego Gas & Electric, and Southern California Edison (SCE). The CEC administers 80 percent of the program's total funds, investing in clean energy technologies and approaches to help benefit California ratepayers. The CEC funds projects in all three investment areas of the EPIC program: applied research and development, technology demonstration and deployment, and market facilitation.

Using a competitive selection process, the CEC awards EPIC funding to advance technological breakthroughs and accelerate the achievement of the state's statutory energy goals, including goals to reduce greenhouse gas emissions, adapt to climate change, improve energy efficiency and load flexibility, advance renewable energy, support low-emission transportation, and expand economic development.

The CPUC oversees the administration of EPIC funds, including approval of the CEC's EPIC investment plans. In 2021, the CPUC adopted a mission statement to focus EPIC investments on "innovation to ensure equitable access to safe, affordable, reliable, and environmentally sustainable energy for electricity ratepayers" and revised the mandatory guiding principles for projects to provide benefits of improved safety, increased reliability, increased affordability, improved environmental sustainability, and improved equity.[1] In addition, the state legislature must grant the CEC spending authority to disburse EPIC funds for project awards and to use EPIC funds for administrative expenses. State law requires the CEC's EPIC projects to not only benefit electricity ratepayers and help achieve California's statutory clean energy goals, but also reduce the costs of building electrification and strategically focus investments to make advancements on overcoming significant technological challenges.[2]

This EPIC Annual Report is provided to the CPUC in accordance with CPUC EPIC decisions to date. To ensure consistent reporting among all four administrators, those decisions specify the outline and contents of this report, including project reporting requirements. The CEC also provides this EPIC Annual Report to the legislature, following California Public Resources Code Section 25711.5, and makes the report publicly available on the CEC's website.

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1 California Public Utilities Commission. 2021. "Decision on Approving the Utilities as Electric Program Investment Charge Administrators with Additional Administrative Requirements," Appendix A. https://docs.cpuc.ca.gov/PublishedDocs/Published/G000/M425/K515/425515575.PDF

2 California Public Resources Code § 25711.5.

EPIC Program Components

The CEC has invested in 501 EPIC projects to date, spanning 12 years and four EPIC investment plans. Detailed information on reportable projects that were active, completed, terminated (with funds spent), or pending through 2023 can be found in Appendix C. A discussion of how the CEC project portfolio is driving progress, achieving success, and addressing barriers across current EPIC strategic objectives and initiatives for 2023 reportable projects is detailed in Chapter 3.

Table 1 summarizes quantifiable impacts and benefits that CEC EPIC-funded projects have achieved through 2023, based on surveyed EPIC projects that were active or completed that year. The impacts are grouped into the following overarching categories: technology advancement and commercialization, technology diffusion, knowledge generation and dissemination, and diversity and equity.

Table 1: Quantifiable Benefits of California Energy Commission Electric Program Investment Charge Investments by Impact Category

Impact Category	Quantifiable Benefits Through 2023
Technology Advancement and Commercialization	• Private companies that have received EPIC funding or support have collectively attracted more than $10.1 billion in follow-on private investment, significantly leveraging EPIC's initial investment. • EPIC recipients with active projects in 2023 were able to leverage their EPIC awards to attract nearly $463 million in federal and state (non-EPIC) funding. • At least 36 companies supported by EPIC have executed successful exits, including mergers and acquisitions. These exits are a notable measure of market interest in the technologies developed using EPIC funding.
Technology Diffusion	• 40 EPIC projects reported advancing technologies and approaches in 2023 to improve the effectiveness of energy-related codes and standards, a key tool to enabling widespread diffusion of new technologies and data-driven practices.[3] • More than 4,000 subsequent deployments of clean energy technologies have resulted from 22 EPIC-funded demonstration projects. • The CEC's Empower Innovation platform surpassed 4,000 members with over 1,000 organizations and more than 420,000 page views.

3 Of the survey responses, 24 indicated their project advanced tools or technologies that support compliance with regulatory codes and standards, 18 indicated identified codes and standards updates needed to improve energy performance, 8 indicated identified codes and standards needed to improve health and safety, 5 indicated other project-specific outcomes that had improved the efficacy of regulatory codes or standards.

Impact Category	Quantifiable Benefits Through 2023
Knowledge Generation and Dissemination	• Staff conducted the annual 2023 EPIC Symposium to share research results. Total attendance exceeded 840. • Staff hosted a series of five technology showcase webinars for 11 Next EPIC Challenge design-phase recipients in 2023. The webinars featured best practices, lessons learned, and emerging clean energy technologies funded under other EPIC projects to promote innovative collaboration. • EPIC projects have advanced more than 55 online tools that make complex information and data more accessible, scalable, and cheaper to operationalize.
Diversity and Equity	• Nearly 60 percent of the CEC's technology demonstration and deployment funds have been invested in projects located in and benefiting low-income or disadvantaged communities as defined by AB 523. • Approximately $21 million of the CEC's technology demonstration and deployment funds have been invested in projects located on California Native American tribal lands. • More than 54 EPIC projects in 2023 reported having a women-, minority-, or LGBTQ-led business as the prime recipient or a subcontractor.[4] • EPIC recipients conducted more than 500 community engagement activities, including events and surveys, in 2023. Recipients estimate these activities engaged a combined total of approximately 62,000 participants both in-person and online.

Source: California Energy Commission staff

Table 2 shows the match funds attracted to California by CEC EPIC projects. For every $1 million dollars of CEC funding, partners contributed more than $520,000 in match funding as part of the project award.

4 Based on representation of the group of top executives defining and implementing corporate strategies.

Table 2: Total Match Funds

Match Funds	EPIC Funding Awards	Match as Percentage of EPIC Awards
$635 million	$1,208 million	52 percent

Match funds are funds contributed by partners as part of the project award.

Source: California Energy Commission staff

While the CEC has active projects across multiple investment plan cycles, each with their corresponding strategic objectives and initiatives, progress is reported in relation to the current EPIC 4 investment plan strategic objectives and initiatives for the purposes of this annual report. The summary below details how 2023 CEC EPIC activities have made progress in addressing EPIC 4 strategic objectives and strategic initiatives.

Strategic Objective 1: Accelerate Advancements in Renewable Generation Technologies

Investments under this objective primarily fund research and development activities advancing key renewable energy technologies in support of Senate Bill (SB) 100 (De León, Chapter 312, Statutes of 2018) implementation. The four main topic areas for CEC investments are solar photovoltaics, offshore wind, biomass, and geothermal energy generation. Notable progress toward this objective in 2023 included:

- One EPIC project was completed successfully with results that could provide a potential pathway to more efficiently recover lithium from geothermal brines, such as in the Salton Sea in Riverside and Imperial counties, compared to conventional methods.
- The CEC executed seven new grant agreements totaling over $21 million focused on development and testing of floating offshore wind environmental monitoring technologies and floating offshore wind components.

Strategic Objective 2: Create a More Nimble Grid to Maintain Reliability as California Transitions to 100 Percent Clean Energy

As California works to meet its clean energy targets, the development of zero-carbon firm resources, increased load flexibility, grid modernization, and cybersecurity risk mitigation will all be critical to maintain a flexible and reliable grid. Under Strategic Objective 2, the CEC focused EPIC activities on these key areas in 2023. Notable progress toward this objective in 2023 included:

- Three long duration energy storage projects designed to improve grid reliability and resilience for disadvantaged communities, low-income communities, and tribes were selected for a total of over $26 million in EPIC funds and approximately $12.2 million in match funds.
- Three EPIC projects, OhmConnect, Polaris Energy, and AgMonitor, increased demand flexibility across the state and collectively contributed approximately 56 MW of additional load reduction (a clean, dispatchable resource) during the grid stress events of summer 2023.

Strategic Objective 3: Increase the Value Proposition of Distributed Energy Resources (DERs)

In 2023, CEC invested EPIC funds in technologies that increase the value of DERs for both customers and the electric grid. Improvements in DERs can increase the affordability and reliability of the electricity supply for California ratepayers. The CEC invested in a variety of demonstration and deployment projects in 2023. Notable progress toward this objective in 2023 included:

- The CEC selected four winners of a Next EPIC Challenge solicitation in December. The Challenge will support teams of architects and housing developers to design new, mixed-use developments that are zero-carbon, all electric, resilient, and grid responsive. The winning designs collectively include a total of 733 new affordable housing units with advanced energy features that serve low-income households. The combination of modern building designs and highly efficient electric appliances are expected to provide up to 100 percent electric bill savings to residents. At least one winning project seeks to start construction in 2024.
- The Redwood Coast Airport Microgrid serves as the first fully renewable, multi-customer, front-of-the-meter microgrid in PG&E's service territory and operates in the California Independent System Operator (California ISO) Ancillary Services and Energy markets when connected to the grid. The microgrid automatically and seamlessly islands and provides backup power to commercial customers, including two critical facilities, the local airport and a U.S. Coast Guard Air Station. The microgrid islanded during eight separate power disruptions in 2023 for up to 17 hours at a time due to earthquakes, atmospheric rivers, and high wind-speed events. PG&E is using the project as a model for its Community Microgrid Enablement Program and Microgrid Incentive Program, which can assist other communities in deploying similar solutions.

Strategic Objective 4: Improve the Customer Value Proposition of End-Use Efficiency and Electrification Technologies

EPIC funds have been critical in advancing the TRL of promising innovations in both industrial and building decarbonization. For example, several prototypes offer lower emission solutions for industrial processes that are difficult to decarbonize due to thermal or chemical conditions. In the buildings sector, low and ultra-low Global Warming Potential (GWP) refrigerants for heating, ventilation, and air conditioning (HVAC) systems can enable further emissions reductions as consumers adopt more electric appliances. Notable progress toward this objective in 2023 included:

- General Engineering & Research is finalizing a prototype for magnetic refrigeration, which can be deployed in the electronics industry where manufacturing needs require temperatures near absolute zero. As conventional cooling techniques require relatively large amounts of energy, the technology aims to reduce energy consumption by up to 50 percent.
- EPIC funding has also helped UC Davis demonstrate affordable low and ultra-low GWP heat pumps at various TRLs. Their ultra-low GWP solution incorporates an innovative heat exchanger in the secondary loop to improve its efficiency. This technology won the research journal ASHRAE's Best Paper Award of the 2022-2023 Volume Year and the UC

Davis team working on this technology received a $3.5 million ARPA-E award in 2023 to demonstrate this technology for Data Centers.

Strategic Objective 5: Enable Successful Clean Energy Entrepreneurship Across California

The CEC's California Energy Innovation Ecosystem supports new clean energy technology ventures by providing entrepreneurs with access to the networks, funding opportunities, mentoring, facilities, and expertise needed to take their inventions from idea to market. The California Sustainable Energy Entrepreneur Development Initiative (CalSEED), CalTestBed, and the four Regional Energy Innovation Clusters (Southern California Energy Innovation Network, Los Angeles Cleantech Incubator, Activate, and BlueTech Valley) comprise the entrepreneurial ecosystem. These programs had supported more than 340 companies by the close of 2023. Notable progress toward this objective in 2023 included:

- The CEC issued the latest round of its of Realizing Advanced Manufacturing and Production for Clean Energy Technologies (RAMP) solicitation. A total of $19.4 million in EPIC funds with more than $22 million in matching funds was awarded across seven projects. The RAMP award recipients are advancing diverse clean energy technologies to the Low-Rate Initial Production stage—a critical step in moving from hand-built prototypes to final products that can be commercialized at scale.
- Antora Energy is developing a zero-carbon, flexible, combined heat and power (CHP) system that can support industrial decarbonization. Antora's technology uses renewable energy to resistively heat a low-cost storage medium where thermal energy is stored and can be deployed on-demand as process heat, up to 1,500 degrees Celsius, or as electricity through use of Antora's novel thermophotovoltaic (TPV) heat engine. In 2023, Antora achieved two major milestones with the support of EPIC funding. The company brought online its first pilot-scale system at an industrial facility in Fresno County and commissioned a pilot production line capable of producing 2 MW of TPV cells per year in Sunnyvale.

Strategic Objective 6: Inform California's Transition to an Equitable, Zero-Carbon Energy System that is Climate-Resilient and Meets Environmental Goals

Climate resilience and environmental sustainability continue to be a priority at the CEC. The Commission has leveraged over $24 million in EPIC funding this past year to ensure health, equity, and climate considerations are taken into account during California's clean energy transition. Notable progress toward this objective in 2023 included:

- EPIC-funded Lumen Energy Strategy conducted a series of workshops hosted by CPUC to identify, analyze, and integrate resiliency needs within California's electric grid planning process. Lumen's project is dedicated to modernizing electricity resource planning and resilience assessments by integrating data and methods that reflect deep renewables penetration and changing climate. The work contributed to the 2023 California Energy Demand forecast, which was part of the 2023 Integrated Energy Policy Report (IEPR) cycle and will continue to be utilized to expand the use of climate data in the 2024 IEPR update.

- EPIC-funded researchers at UC San Diego's Scripps Institution of Oceanography contributed to the State of California Sea-Level Rise Guidance Update by the Ocean Protection Council, which incorporates EPIC research results for hourly sea-level projections at 13 stations along the California coast, San Francisco Bay, and Delta.
- EPIC-funded subrecipient Eagle Rock Analytics worked with PG&E to identify gaps in the utility's weather station network used for risk management, including for fire and situational awareness, leading PG&E to add weather stations in its service territory and informing PG&E's 2023 Wildfire Mitigation Plan.

Coordination

In 2023, the CEC continued to build partnerships and collaboration efforts across diverse stakeholder groups, including through activities to engage networks and partners and to coordinate with EPIC administrators, federal and state agencies, the Disadvantaged Communities Advisory Group (DACAG), Environmental Social Justice (ESJ) communities and advocates, tribes, and other clean energy market actors. The CEC also regularly corresponds with technology developers and industry associations as part of its statutory activities, including the development of grant solicitations, the annual IEPR or IEPR Update, and public knowledge-sharing events.

The Coordination and Transparent Public Process and Competitive Solicitations section provides more detailed information and data on this topic, demonstrating how the CEC as an EPIC administrator leverages public processes, workshops, CPUC proceedings, policies, legislation, and other direction to continue to refine coordination and engagement processes.

Table 3 provides a summary of the different engagement activities conducted by staff in 2023.

Table 3: Summary of EPIC Staff Engagement Activities in 2023

Type of Engagement	Number of Efforts in 2023
Knowledge Sharing	39
Scoping Efforts for Research Roadmaps or Solicitations	29
Interagency Coordination with Local, State, and Federal Agencies	16
EPIC Administrator/CPUC/PICG Coordination	11
Pre-Application Workshops	6
Tribal Engagement	6
Community Engagement	2
Disadvantaged Community Advisory Group	2
Total	111

Note: This does not represent event totals, as several efforts include monthly, quarterly, or semi-regular meetings.

Source: California Energy Commission staff

Market and Other Actors

U.S. Department of Energy (DOE) and National Organizations

- Ongoing coordination between the CEC and the U.S. DOE Advanced Research Projects Agency — Energy (ARPA-E) continued in 2023 to help move transformational energy technologies out of the laboratory and into the market. Common areas of research included energy efficiency, energy storage, transportation, DERs, and power electronics. Activities in 2023 included:
    - Monthly meetings in which the agencies shared perspectives and analyses on emerging technology advancements, identified market opportunities for technologies within their respective portfolios, discussed best practices and lessons learned regarding program design and administration, and coordinated participation as advisory members on related projects.
    - In January 2023, the agencies collaborated with Cleantech San Diego to host a regional summit promoting companies that received funding from each government agency's investment programs.
    - In March 2023, CEC staff attended the ARPA-E Summit in Maryland to gain greater exposure to ARPA-E projects and strengthen working relationships.
- Ongoing coordination occurred with several U.S. DOE offices to inform and align EPIC research efforts for transportation electrification and building decarbonization topics. Activities included:
    - Quarterly calls with national laboratories on heat pump research, participation in Argonne National Laboratory's Megawatt+ MultiPort Electric Vehicle Charging

Industry Work Group, and meetings with Oak Ridge National Laboratory took place related to building equipment, low-GWP refrigerants, and building envelope research.

- Quarterly calls with the National Emerging Technologies Collaborative (NETC) to address important building energy technology RD&D needs, and meetings with staff from the Building Technology Office's (BTO) Advanced Building Construction program regarding innovative solutions for building envelope upgrades.
- Participation in the National Association of State Energy Officials – National Association of Regulatory Utility Commissioners' Grid Interactive Efficient Buildings Working Group focused on demand flexibility.

U.S. Department of Defense (DOD)

Similarly, CEC continued collaboration with different branches of the U.S. military to coordinate research and demonstration of innovative clean energy technologies that are of joint priority interest, such as base energy resiliency and reliability. During 2023, the CEC held monthly calls with the Navy to share updates and implement action items aligned with the memorandum of understanding (MOU) signed by both entities in December 2021. The CEC also received approval to develop a similar MOU with the Air Force and will hold a formal signing ceremony in 2024. Additionally, CEC Chair Hochschild and his military advisor met with energy directorates of the Navy, Air Force, and Army at the Pentagon to discuss possible future projects between the DOD and CEC. Other notable activity includes:

- Two EPIC project milestones: 1) Indian Energy's commissioning of the Rapid Commercialization and Integration Unit at Marine Corps Air Station Miramar, where one of the EPIC-funded long duration energy storage (LDES) technologies is currently being evaluated (EPC-19-051); and 2) the start of operations to electrify the non-tactical vehicle fleet at the Los Angeles Air Force Base (EPC-16-059), which aims to be the Air Force's model for zero-emission vehicles.
- Three microgrid projects with the Navy, Marines, and Army continued efforts to install and evaluate system capabilities. Marine Corps Air Station Miramar microgrid project for flight line resilience (EPC-17-032), an Army microgrid project at Camp Park (EPC-17-038), and a Port Hueneme Navy Data Center microgrid project (EPC-18-001) are strong examples of how clean energy microgrids are improving base resilience.
- CEC leaders and staff toured Fort Irwin and Camp Pendleton to meet with civilian and military leaders regarding efforts to electrify and decarbonize buildings, expand onsite renewable generation and storage, and increase deployment of EV chargers.

Other California State Agencies

In 2023, staff coordinated with multiple state agencies to help advance research, demonstration, and deployment activities for emerging clean energy technologies. Representative activities include:

- CEC presented updates to the Port Collaborative Interagency Working Group on hydrogen and port-related RD&D activities, including EPIC projects to develop a green hydrogen roadmap and to demonstrate DER integration of medium- and heavy-duty (MHD) charging infrastructure.

- CEC and CARB met to share knowledge of utility energization and interconnection processes, transit agency challenges, and the potential for DERs to support charging in the context of EPIC-funded projects under grant opportunity "Realizing Acceleration (GFO-20-304).
- CEC provided presentations about EPIC projects to the Office of Energy Infrastructure Safety to help scope climate change and fire risk-consequence modeling, including the solicitations "Development of Climate Projections for California" (EPC-20-006), "Cal-Adapt Analytics Engine: Enhancements Underway to Support Energy Sector Resilience" (EPC-20-007), and "Long-Term Wildfire Scenarios to Support California's Fifth Climate Change Assessment" (EPC-18-026).
- Quarterly Transportation Research Roundup meetings occurred with CARB, the California Department of Transportation (Caltrans), the California Transportation Commission, the Department of Housing and Community Development, and the California Strategic Growth Council to share status updates on research projects and upcoming activities and identify opportunities for coordination.
- Grant recipients gave multi-agency presentations. EPIC-funded research consortium Pyregence, which considers urban growth modeling for California's Fifth Climate Change Assessment, among other wildfire-related topics, presented to the Governor's Office of Planning and Research (GO-Biz), CARB, and the Department of Conservation to solicit feedback on their research. Additionally, Eagle Rock Analytics, Inc., the lead on the webtool Cal-Adapt, which provides access to open data and analyses to support adaptation planning, presented to the CEC's Climate Data Analysis and Working Group, in which multiple agencies participate (EPC-21-038 and EPC-20-007).

EPIC Administrator and CPUC Coordination

Coordination among administrators helps make the CEC's EPIC program more effective for California ratepayers by ensuring program efforts are complementary and that lessons learned from the most significant technological innovations are enhancing future grant offerings. The CEC is committed to ongoing coordination and collaboration with the three IOU administrators of EPIC funds and with the CPUC PICG.

IOU Administrators and PICG

CEC staff continued collaboration with the three IOU EPIC administrators to share project results and best practices in administering EPIC and to discuss opportunities for collaboration on technology areas of shared interest. These activities help to align resources across the program and transition the most promising innovations to market. The administrators hold bi-weekly meetings, coordinate notification and outreach for upcoming events, and participate in joint public workshops. In addition to these regular efforts, the following are notable activities from 2023:

- Monthly calls were held between CEC and PG&E to discuss vehicle-to-grid-integration (VGI) topics, including dynamic rates, pilots, energization and interconnection, standards and interoperability, and submetering.
- Knowledge sharing between CEC staff and SCE's EPIC 3 project team regarding SCE's project "VGI Using On-Board Inverter" (GT-18-0015).

- CEC and SCE staff discussed automated load management, experience with Rule 29 projects, and utility processes for distribution grid upgrades.
- CEC coordinated and participated with the IOUs and PICG for a series of five workshops to inform recommendations of measurable strategic goals for the EPIC 5 investment cycle. CEC staff provided presentations on the CEC's process for EPIC investment plan development, incorporating equity considerations in EPIC planning, and EPIC research results on clean hydrogen for industrial decarbonization.
    - Following these workshops, the PICG submitted a report listing recommendations for the EPIC 5 strategic goals. Based on this, the CPUC proposed the five strategic goals of Transportation Electrification, Distributed Energy Resources Integration, Building Decarbonization, Achieving 100 Percent Net-Zero Carbon and the Coordinated Role of Gas, and Climate Adaptation, which were adopted in Decision 24-03-007 in early 2024.
- Monthly calls were held with the Energy Transition Coordinating Council (ETCC), formerly known as the Emerging Technologies Coordinating Council, which is a collaborative among the CEC, three electric IOUs, Southern California Gas, Los Angeles Department of Water and Power, and Sacramento Municipal Utility District. The ETCC focuses on expanding knowledge of emerging technologies and has shared project results, methodologies, and coordination opportunities for advanced lighting, water heating, space heating, and air-conditioning systems.
    - An ETCC summit featured two CEC EPIC-funded projects that demonstrated advanced zero or low-global warming potential heat pump systems for multi-family and small to medium commercial applications (EPC-19-014 and EPC-19-030).

California Public Utilities Commission

In addition to the efforts with PICG mentioned above, the CEC and its recipients coordinated with the CPUC on the following EPIC-related activities in 2023:

- CEC participated in an "all-party" EPIC administrators workshop to discuss the CPUC's staff proposal on establishing strategic goals and objectives for EPIC.
- CEC provided a briefing on current CEC research efforts for decarbonization of mobile and manufactured homes (EPC-19-035, EPC-19-043, GFO-22-305).
- CEC reviewed the load impact reports and helped CPUC's Demand Response Unit determine the qualifying capacity for third-party demand response providers in California.
- Lumen Energy (EPC-22-001) conducted three workshop presentations at the CPUC's series of resilience workshops to build consensus on electricity system resilience evaluation. During the last workshop, Lumen facilitated discussions exploring opportunities for local authorities, community leaders, load-serving entities, and state regulators to integrate resiliency into grid planning.
- Monthly meetings were convened between the CEC and CPUC, regarding coordination on transportation electrification related proceedings. Topics included utility TE make-ready programs, utility VGI pilots, bidirectional charging, EV submetering, IEPR, grid planning for charging infrastructure, energization timelines, and funding.

Community and Environmental Social Justice Stakeholder Coordination

The CEC is committed to ensuring all Californians benefit from clean energy research. Consistent with legislative and CPUC direction, the CEC has prioritized energy equity in its research programs to ensure that the most vulnerable communities benefit from emerging clean energy technologies.[5] The CEC incorporates equity throughout the EPIC portfolio of projects, aligning with the CPUC's Environmental Social Justice (ESJ) Action Plan.

Energy and Equity: Assembly Bill 523 Implementation

In 2017, the legislature passed AB 523 (Reyes, Chapter 551, Statutes of 2017), directing the CEC to invest at least 25 percent of the EPIC TD&D funds to projects located in and benefitting disadvantaged communities, and an additional 10 percent for projects located in and benefiting low-income communities.[6] While this requirement was set to expire in July 2023, the CPUC instituted it permanently in April 2023 and expanded the requirement to include IOU investments as well.[7]

CPUC Environmental Social Justice Action Plan and Federal Justice40 Initiative Goals

In 2019, the CPUC adopted its first ESJ Action Plan, providing a framework with nine overarching goals and associated objectives, plus 95 action items, to help inform programmatic considerations when incorporating equity into investment planning. In 2021, the CPUC adopted an updated action plan, known as ESJ Action Plan 2.0. This plan revised the nine goals and objectives and narrowed the number of action items to 91.

The CPUC defines ESJ communities as "predominantly communities of color or low-income communities that are underrepresented in the policy setting or decision-making process, subject to a disproportionate impact from one or more environmental hazards, and are likely to experience disparate implementation of environmental regulations and socioeconomic

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5 In 2015, the Energy Commission adopted a diversity policy resolution outlining its commitment to ensure all Californians have an opportunity to participate in and benefit from CEC programs. https://www.energy.ca.gov/commission/diversity/documents/pdfs/diversity_policy_resolution.pdf. In 2016, the CEC's Low-Income Barriers Study recommended the CEC's EPIC program should target a minimum of 25 percent of technology demonstration and deployment funding for sites located in disadvantaged communities. See https://www.energy.ca.gov/sb350/barriers_report/.

6 *Disadvantaged communities* are those designated under to Health and Safety Code Section 39711 as representing the 25 percent highest-scoring census tracts in California Communities Environmental Health Screening (CalEnviroScreen) Tool 3.0. https://calepa.ca.gov/envjustice/ghginvest/. *Low-income communities* are those within census tracts with median household incomes at or below 80 percent of the statewide median income or the applicable low-income threshold listed in the state income limits updated by the California Department of Housing and Community Development.

7 California Public Utilities Commission. 2023. "Decision on Phase 2-C of Electric Program Investment Charge Rulemaking," https://docs.cpuc.ca.gov/PublishedDocs/Published/G000/M507/K499/507499284.PDF.

investments in their communities."[8] The CPUC noted this definition was designed to target the following communities:

- Disadvantaged Communities: California Communities Environmental Health Screening Tool 4.0 (CalEnviroScreen) designated census tracts scoring in the top 25 percent, along with those that score within the highest 5 percent for pollution burden but do not receive an overall CalEnviroScreen score.
- All tribal lands: any land within any Indian reservation, as defined in 18 U.S.C. 1151 subsection (a).
- Low-income households: households with incomes below 80 percent of the area median income.
- Low-income census tracts: tracts where aggregated household incomes are less than 80 percent of area or state median income.[9]

In Decision 23-04-042,[10] the CPUC directed EPIC administrators to address the ESJ Action Plan goals and objectives in future investment plans and provided guidance to strengthen current efforts in embedding equity into EPIC projects. In addition to achieving the minimum TD&D investment and benefits goals discussed above, administrators must engage with ESJ communities and California Native American tribes early in the scoping process and consult with them about workforce development opportunities.

The CPUC also defines "disadvantaged vulnerable communities" (DVCs) as consisting of communities in census tracts with the 25 percent highest overall score according to the most recent version of CalEnviroScreen, as well as all California tribal lands, census tracts with median household incomes less than 60 percent of state median income, and census tracts that score in the highest five percent of Pollution Burden within CalEnviroScreen, but do not receive an overall CalEnviroScreen score due to unreliable public health and socioeconomic data."[11] While the definition of DVCs was used for the EPIC mandatory guiding principle to improve equity, the CPUC provided clarity in Decision 23-04-042 that its staff proposal does not change state definitions of DACs or DVCs. In the same decision, CPUC also distinguishes that its ESJ Action Plan uses a metric based on the project's location, while Justice40 measures the accrual of benefits from the investment.

Furthermore, the CPUC directed EPIC administrators to align with the Justice40 goal that at least 40 percent of benefits are allocated to DVCs. It also allowed EPIC to fund front-of-the-

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8 California Public Utilities Commission. 2022. "Environmental & Social Justice Action Plan Version 2.0," https://www.cpuc.ca.gov/-/media/cpuc-website/divisions/news-and-outreach/documents/news-office/key-issues/esj/esj-action-plan-v2jw.pdf

9 Ibid.

10 California Public Utilities Commission. 2023. "Decision on Phase 2-C of Electric Program Investment Charge Rulemaking," https://docs.cpuc.ca.gov/PublishedDocs/Published/G000/M507/K499/507499284.PDF.

11 California Public Utilities Commission. 2020. "Decision on Energy Utility Climate Change Vulnerability Assessments and Climate Adaptation in Disadvantaged Communities (Phase 1, Topics 4 And 5)," https://docs.cpuc.ca.gov/PublishedDocs/Published/G000/M346/K285/346285534.PDF

meter projects upstream of disadvantaged and low-income communities that have clear and verifiable disadvantaged community benefits. CPUC Decision 23-04-042 clarified that it does "not include projects with state- or region-wide impacts (such as wildfire reduction) because that may circumvent legislative requirement for DAC/low-income-specific-benefits." The PICG series of workshops to develop strategic goals and objectives for EPIC 5 will also be used to establish equity criteria and metrics for incorporating Justice40 into future annual reports and EPIC cycle evaluations.

In 2023, the following activities illustrate how CEC aligned EPIC investments and activities with selected ESJ Action Plan 2.0 goals. The goals below reflect modified language to provide context for CEC activities.

- Goal 1: Consistently integrate equity and access considerations throughout CEC's EPIC activities.
    - The CEC prioritized discussions on equity, affordability, accessibility, and energy resiliency in the 2023 EPIC Symposium.
    - The CEC collected input on providing non-energy and social cost benefits to ESJ communities at the scoping workshop, "Indoor Air Quality and Co-Benefits of Integrated Energy Retrofit Packages in California's Residential Buildings," and accepted written public comments to inform the grant opportunity "Non-Energy Impacts and Process Evaluation of Integrated Energy Retrofit Packages in California's Residential Buildings" (GFO-23-310).
    - The CEC applied specific scoring criteria to half of the TD&D solicitations issued. These contained equity funding carve-outs to ensure ESJ communities could benefit from clean energy resources.
        - These criteria include considerations for anticipated benefits, community engagement efforts conducted prior to project development and during project implementation, localized health impacts, budget allocation for community engagement activities, support from the community where the project will be located, and the proposed community partner.
    - The CEC reduced or eliminated match requirements in certain TD&D solicitations that contained equity funding carve-outs or preference points.
- Goal 2: Increase investment in clean energy resources to benefit ESJ communities, especially to improve local air quality and public health.
    - The CEC issued a grant opportunity "Advanced Prefabricated Zero Carbon Homes" (GFO-22-305), to develop, test, and demonstrate zero-carbon or near zero-carbon, cost-effective modular and manufactured homes to be readily deployed in ESJ communities. The solicitation required incorporation of solar and energy storage technologies and replacement of gas appliances with high-efficiency heat pumps. The resulting projects have the potential to demonstrate non-energy benefits of improved indoor air quality and associated health benefits as well as quickly deployable affordable housing units.
- Goal 4: Increase climate resiliency in ESJ communities.

- In 2023, the CEC issued two solicitations aimed at providing climate resiliency in ESJ communities.
    - Grant opportunity "Optimizing Long-Duration Energy Storage (LDES) to Improve Resilience and Reliability in Disadvantaged and Low-Income Communities and Native American Tribes" (GFO-22-307). The solicitation seeks TD&D projects to accelerate commercialization and validate the capability of LDES technologies to improve grid reliability and resilience in California under-resourced communities.
    - In grant opportunity "Power Electronics for Zero-Emission Residential Resilience (PEZERR)" (GFO-23-302), applicants are required to demonstrate technologies within disadvantaged, low-income, or tribal communities. These communities are disproportionally impacted by power outages and stand to benefit the most from clean, affordable backup power solutions.
  - The four awardees of the Next EPIC Challenge were selected to receive funding to build out their designs of all-electric, mixed-use buildings. Designs included technologies to provide resiliency during power outages and innovations to supply power from onsite renewable generation during peak hours.
- Goal 8: Improve training and staff development related to environmental and social justice issues within EPIC's electricity service territories.
  - The CEC ERDD Equity and DACAG Liaisons attended California Natural Resources Agency trainings on cultural awareness and best practices for tribal engagement.
  - The CEC participated in monthly DACAG meetings and engagement with ESJ advocates to stay informed about ESJ priority concerns.
  - The CEC facilitated monthly internal meetings to discuss equity-related challenges and solicitation considerations, and to disseminate updates on terminology usage, ESJ concerns, and community engagement best practices.

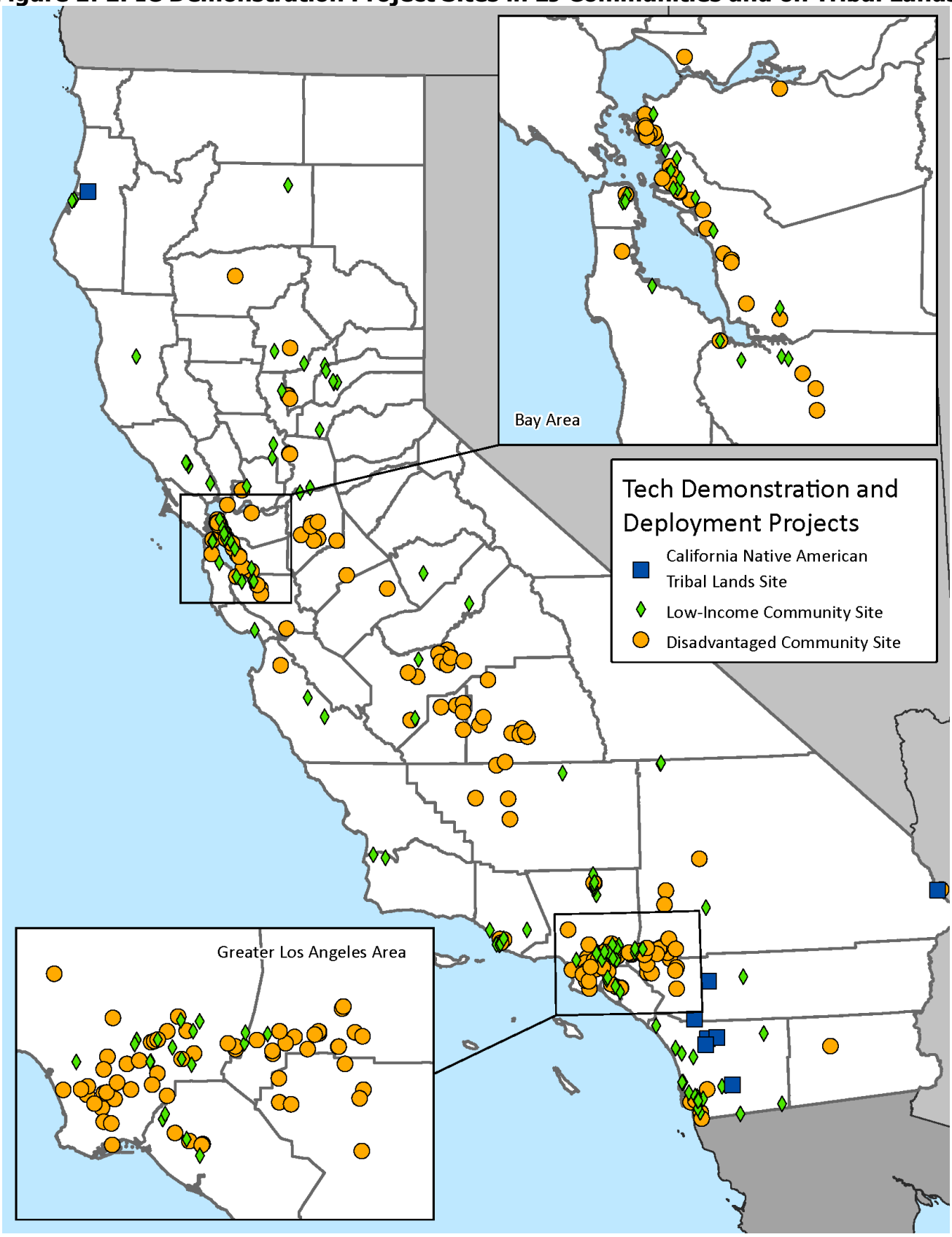
The CEC's EPIC TD&D investments exceeded AB 523 and CPUC requirements for projects located in and benefiting disadvantaged and low-income communities. Through 2023, 34 percent of TD&D project funding was awarded to projects in sites located in DACs, and an additional 25 percent was awarded to projects sited in low-income communities. Together, nearly 60 percent of CEC EPIC funding has been awarded to projects located in and benefiting disadvantaged and low-income communities.[12] Additionally, $21 million of TD&D funding was awarded to projects with sites located on California Native American tribal lands.[13]

12 This data excludes combustion-related technology demonstration and demonstration projects.

13 Tribal lands refer to lands located in the State of California that are tribally owned lands, buildings, or facilities, lands a tribe exercises jurisdiction over, or lands that the Bureau of Indian Affairs holds in trust for tribes, individual allottees, or public domain allottees, or lands managed through conservation easements or through lease agreement, or through co-management agreements, for the benefit of tribes.

Figure 1 illustrates the cumulative number of CEC EPIC project sites located in disadvantaged communities, California Native American tribal land, and low-income communities that are not also designated as disadvantaged as of December 2023. This methodology helps to avoid double counting as most of California's disadvantaged communities are also low-income communities, and these communities are accounted for in the disadvantaged community category only.

Figure 1: EPIC Demonstration Project Sites in EJ Communities and on Tribal Lands



Source: California Energy Commission staff

Staff will continue to monitor the development of equity metrics through the PICG workshop process for EPIC 5 to continue to improve the CEC's incorporation of equity into all aspects of EPIC administration.

Outreach and Engagement with Disadvantaged Vulnerable Communities

In 2023, CEC staff participated in several outreach activities with disadvantaged and low-income communities and tribes. One key example is staff's regular participation in the DACAG monthly meetings. Other notable efforts in 2023 include the following:

- The CEC attended the SAFE Symposium hosted by Schatz Energy Research Center and the California Strategic Growth Council. The symposium focused on rural and tribal community resilience and brought together researchers, tribal leaders, agencies, and industry representatives to share knowledge about community resilience needs and prioritization, emerging microgrid research, and other related topics. The event included a listening session in which tribal members communicated the energy resilience challenges that rural communities face, providing helpful information to staff for proposal evaluations and future solicitations aimed at providing resilience to ESJ communities.
- The CEC participated in a series of three tribal outreach meetings with the Tribal Council and representatives of the Enterprise Rancheria, the Big Lagoon Rancheria, and the Tuolumne Band of Mu-Wuk Indians. CEC Commissioner Gallardo discussed CEC tribal affairs activities, and staff gave an overview of CEC's clean energy transition goals and funding opportunities and incentives. CEC staff also provided a review of AB 525's Offshore Wind Strategic Plan and Sea Space to the Big Lagoon Rancheria. Attendees toured the facilities at both the Hard Rock Hotel and Casino Sacramento at Fire Mountain and the Black Oak Casino Resort and community.
- Staff conducted presentations at the Offshore Wind Central Coast Intergovernmental Roundtable Meeting and the Offshore Wind Tribal Information Session for North Coast Intergovernmental Roundtable Meeting. At each meeting, staff shared information on EPIC and its role in researching technologies for offshore wind. Staff also presented on ongoing research investments and priorities related to floating offshore wind energy development in California, including recent project awards resulting from grant opportunity "Advancing Environmental Monitoring Technologies for Floating Offshore Wind" (GFO-22-401) and grant opportunity "Advancing Designs for Floating Offshore wind Mooring Lines and Anchors" (GFO-22-402).
- Next EPIC Challenge design-phase recipients and CEC staff participated in community engagement events in Stockton and Woodland. These events aimed to solicit feedback from the local communities where the project sites were being planned for all-electric, multi-use buildings that would include affordable housing. Feedback informed design features and residential spaces for both community and occupant usage.
- Several CEC EPIC equity-related project recipients presented at the 2023 EPIC Symposium. CEC Commissioner Gallardo led the plenary discussion on "Scalable and Meaningful Impacts with Environmental Justice Communities," featuring project recipients from the "Bassett-Avocado Advanced Energy Community" solicitation (EPC-19-006), the "Oakland EcoBlock Advanced Energy Community" solicitation (EPC-18-013), and the Mobile Backup Generation solicitation featuring an installation with the La

Jolla Band of Luiseño Indians entitled, "Enabling California's Resilient Tribal Communities with Mobile Renewable Power" (EPC-21-001). The panelists shared about successes and lessons learned, as well as common challenges that many of California's most impacted communities face regarding pollution and climate-related events. Next EPIC Challenge videos showcasing final designs for the 11 projects were also featured at the Symposium.

- CEC staff made two formal presentations to the DACAG in 2023 during the group's monthly meetings. One summarized how EPIC and other CEC research programs incorporate equity and the impacts of equity-related projects. The other described EPIC compliance with AB 523 requirements for investments in disadvantaged and low-income communities.

Coordination on CPUC's DER Action Plan 2.0

California has been at the forefront of Distributed Energy Resource (DER) integration into the electric grid for over ten years. Pursuant to State AB 327 (Perea, Chapter 661, Statutes of 2013) and Public Utilities Code Section769(a), DERs include:

- Distributed renewable generation resources (e.g., solar photovoltaic panels),
- Energy efficiency in buildings,
- Energy storage,
- Electric vehicles, and
- Demand response technologies.

In 2016, the CPUC published the *Distributed Energy Resources Action Plan: Aligning Vision and Action*, now known as DER Action Plan 1.0, to align the organization's visions and actions. The plan informed the development of the Distribution Resources Plans proceeding and Integrated Distributed Energy Resources proceeding — two proceedings established to guide state efforts on utility DERs. In April 2021, the CPUC approved the current DER Action Plan 2.0. Two months later, the CPUC issued Order Instituting Rulemaking to Modernize the Electric Grid for a High Distributed Energy Resources Future, otherwise known as the "High DER" proceeding. This proceeding sought to spearhead achievement of the overall vision and action elements of the DER Action Plan. One factor prompting these actions was the CEC's 2020 IEPR forecast of large increases in behind-the-meter (BTM) solar generation, BTM energy storage capacity, and electric vehicle demand from 2019 to 2030. In that report, the CEC cited advancements in technology and cost declines, which public investment programs like EPIC can help accomplish, as the primary factors driving DER growth.

Since its inception in 2011, CEC's EPIC program has closely coordinated with the CPUC and its proceedings and action plans to develop DER-related advancements in technology and cost declines that help the state achieve its clean energy goals. In April 2023, the CPUC directed EPIC administrators to "demonstrate that they have taken the DER Action Plan into account in developing their Strategic Initiatives," starting with the EPIC 4 investment plan. Although the CEC's EPIC 4 investment plan was approved in June 2022, projects funded across EPIC's investment plans and strategic objectives have contributed to the goals of the DER Action Plan.

CEC staff closely monitor developments in the High DER Proceeding and coordinate on biweekly calls with CPUC Energy Division and IOU staff to ensure that development of future CEC solicitations is closely aligned with the current DER Action Plan. In 2023, CEC staff also met with the following stakeholder groups in relation to DERs:

- Energy storage technology developers
- Electric vehicle supply equipment (EVSE) technology developers
- The Ports Collaborative, an interagency working group with California ports
- State agencies, such as CARB, Caltrans, and GO-Biz
- California ISO
- Think tanks, national laboratories, and academic institutions
- U.S. DOE
- National Association of State Energy Officials and National Association of Regulatory Utility Commissioners
- DER Aggregators

The CEC hosted or participated in more than 25 events in 2023 to support EPIC coordination with the CPUC DER Action Plan 2.0. Some notable events included:

- CEC participated in eight Interagency Transportation Electrification Coordination monthly meetings with CARB, CPUC, California Department of Food and Agriculture, GO-Biz, and Caltrans to share program updates and discuss transportation electrification topics.
- An EPIC PICG Workshop was held in September on the development of the future EPIC 2026-2030 investment plan strategic objectives and initiatives and included a focus on increasing the value proposition of DERs.

Transparent Public Process and Competitive Solicitations

The CEC has a robust outreach strategy to shape research priorities, investment planning, and grant solicitations. Public workshops, conducted in-person and virtually throughout all stages of a grant opportunity, are a core function through which CEC shares information with and solicits input from stakeholders. Other components of the CEC outreach strategy include:

- Increasing diversity and equity in all aspects of EPIC.
- Broadening scoping and engagement efforts with local governments, community-based organizations and advocates, environmental justice organizations, academics, industry representatives, and market actors.
- Actively sharing knowledge, results, and lessons learned to inform policies, proceedings, codes, standards, and protocols.
- Promoting geographic diversity in EPIC project funding to accelerate technology learning and diffusion.

Pre-application Workshops

CEC staff holds pre-application workshops with potential applicants for all solicitations to discuss their purpose and scope in a public forum. These workshops provide an opportunity for

potential applicants to ask in-depth questions and to network with stakeholders. All questions and answers are posted online following the pre-application workshop. In 2023, staff held six pre-application workshops. Select pre-application workshops include:

- March 12: grant opportunity "Precipitation Enhancement and Environmental Research for Hydropower Generation (PEER-Hydro)" (GFO-22-306). Research funded by this solicitation will foster cost-effective, robust approaches to balance anticipated needs for zero-carbon, fast-ramping resources with environmental protection.
- July 14: grant opportunity "Decarbonizing Heating, Ventilation, and Air Conditioning Systems in Large Buildings" (GFO-22-308). The solicitation emphasized technology advancements, energy efficiency, replicability, and use of ultra-low GWP refrigerants.
- September 14: grant opportunity "Energy Efficiency and Load Flexibility in Industrial and Commercial Cold Storage Facilities" (GFO-23-3010). This solicitation focused on demonstrating advanced energy efficiency and load reduction technologies that can reduce energy use and/or costs, enable load shifting to benefit the grid, and reduce greenhouse gas emissions.

Scoping Efforts

CEC staff solicit input on research roadmap development, research scenario development, and draft competitive solicitations by holding scoping workshops and meetings or by issuing requests for comments. Staff conducted 29 scoping activities in 2023. Notable activities included:

- May 31: A Transportation Electrification Research Scoping Workshop was held to present and solicit feedback on proposed EPIC 4 transportation electrification research funding concepts. Input received on the funding concepts is informing the development of future solicitations.
- July 11: Staff issued a Request for Information (RFI) to gather information for a potential GFO focused on research to enable efficient power delivery for direct current-based electrical systems. The information gathered is helping to define critical research needs in this area and to identify high-impact use cases that a future research GFO may target.
- July 18: Staff held a workshop on virtual power plants (VPP) and demand flexibility to identify research needs that advance the use of VPP approaches to manage increased load shifting on the grid. Input received informed the development of a solicitation released in March 2024, the grant opportunity "Virtual Power Plant Approaches for Demand Flexibility" (VPP-FLEX) (GFO-23-309).
- July 21: Staff held a Grid Modernization Research Scoping workshop to present and solicit feedback on proposed funding concepts. Input received will inform the development of a future solicitation. Panel presentations were given by California ISO, PG&E, SCE, NREL, and Idaho National Laboratory.
- July 28: Staff held a scoping workshop for the grant opportunity "Non-Energy Impacts and Process Evaluation of Integrated Energy Retrofit Packages in California's Residential Buildings" (GFO-23-310) and solicited feedback from stakeholders on a forthcoming solicitation.

- August 9: Staff released a draft solicitation concept detailing a potential competitive grant solicitation on dispatchable generation technologies to support grid reliability. Input received on the concept informed solicitation development.
- December 13: Staff held a scoping workshop to seek public comment on an anticipated research solicitation to help California achieve an environmentally sustainable clean energy transition.
- December 22: Staff released a draft solicitation concept for a potential competitive grant solicitation on energy storage innovations to support grid reliability. Input received will inform the development of a future solicitation.
- July-December: Staff conducted a series of meetings with five developers to gain insights into the variety of emerging dispatchable generation technologies. Input received is being used to inform the development of an upcoming solicitation.
- July-October: Staff conducted a series of meetings with 10 energy storage technology developers to gain insights into emerging innovations. Input received will be used to inform the development of an upcoming solicitation.

Sharing Knowledge and Lessons Learned

As a public research program administrator, the CEC shares knowledge and lessons learned from EPIC projects with technology innovators, adopters, and investors, architectural and engineering firms, industry leaders, start-up and product incubator services, public funding providers, local communities and governments, environmental justice advocates, researchers, and policymakers. This exchange is an important method for scientific and technological diffusion and accelerates uptake of innovative achievements. Staff attendance at in-person and virtual events and meetings is critical to enabling direct knowledge transfer of CEC and others' research and findings, such as learnings from adopting clean energy technologies, which then help to identify future investment needs. In 2023, the CEC participated in over 39 knowledge sharing efforts. Results are shared through multiple pathways. Efforts to which CEC contributed include:

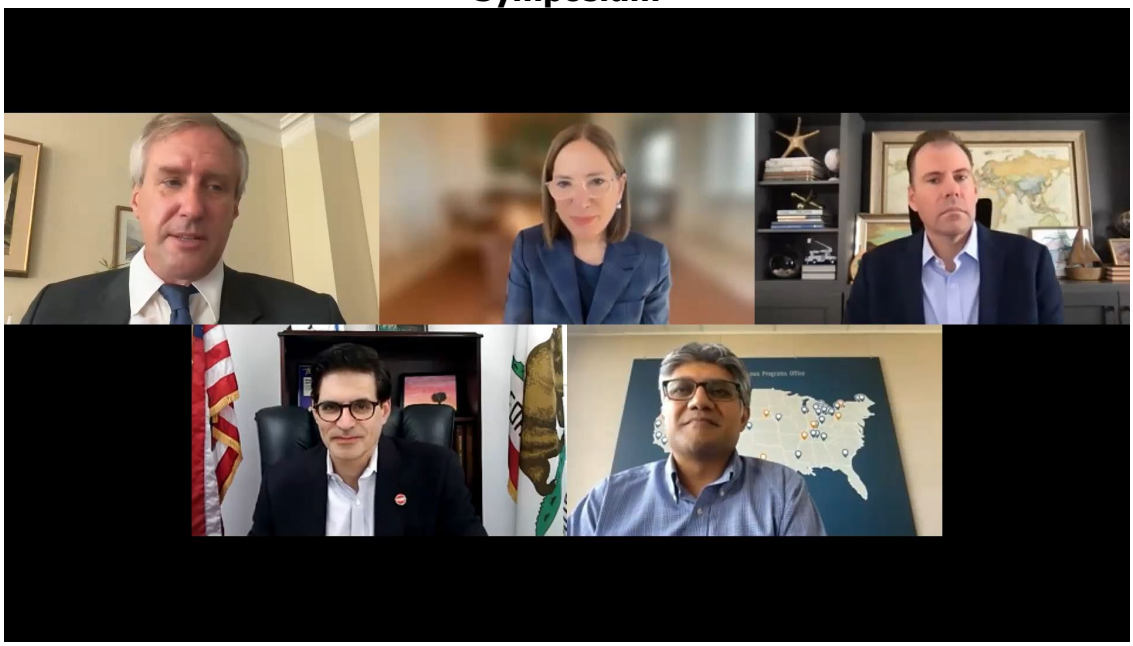
- The May 9 workshop presented Energy & Environmental Economics, Inc.'s (E3) final analysis results conducted under the "Assessing Long-duration Energy Storage Deployment Scenarios to Meet California's Energy Goals" project. (EPC-19-056)
- The CalTestBed 2023 Symposium on June 14 promoted companies to a broad range of stakeholders including investors, potential customers, and other end-use adopters. The symposium also promoted EPIC-supported testbed facilities to attract future participants to the program and build a robust pipeline of participating companies. (EPC-18-002)
- On October 3 and 4, the CEC hosted the 2023 EPIC Symposium. The virtual event was coordinated with the U.S. DOE, CPUC, and IOUs and offered discussions on recent state and federal clean energy incentives, California's clean energy entrepreneurial ecosystem, building decarbonization, load flexibility, battery storage system safety, the CEC's partnership with the U.S. DOE's ARPA-E, success stories and lessons learned from EPIC investments in environmental justice communities, wildfire prevention and resilience, and innovations in transportation electrification.
    - The 2023 EPIC Symposium attracted 845 attendees and 1,148 registrations, indicating the event continues to generate high interest from stakeholders. In

total, 52 state and federal policy makers, industry leaders, clean energy visionaries, and researchers shared insights, including 29 CEC EPIC recipients. For a detailed agenda, see the CEC's 2023 EPIC Symposium website.

- The November 3 CalFlexHub Symposium shared updates on demand flexibility research findings. Industry stakeholders also discussed new and yet-to-be-addressed barriers to mass adoption of demand flexibility. (EPC-20-025)
- On December 5, staff attended the Healthy, Equitable Energy Transition Working Group Meeting, "Understanding Air Quality and Equity Impacts of Clean Energy Interventions Using Models and Measurements." Knowledge gained at this meeting will inform future solicitations.
- Staff and grant recipients presented EPIC project findings at the following 2023 IEPR workshops:
    - August 8: Load Modifier Scenario Development
    - September 8: CEC's hydrogen project portfolio
    - December 6: California Energy Demand Forecast Results, Part II

Figure 2 provides a screenshot of the "Living Room Chat" speakers featured at the 2023 EPIC Symposium.

Figure 2: Knowledge Sharing at the 2023 Electric Program Investment Charge Symposium



From top to bottom, starting top left: Chair David Hochschild, California Lieutenant Governor Eleni Kounalakis, SCE President and Chief Executive Officer Steve Powell, California State Senator Josh Becker, and Director of the Loans Program Office at the U.S. DOE Jigar Shaw.

Source: California Energy Commission staff

Other examples of ongoing knowledge dissemination efforts include the following:

- Updated EPIC project information and results are shared through the CEC's online Energize Innovation Showcase.

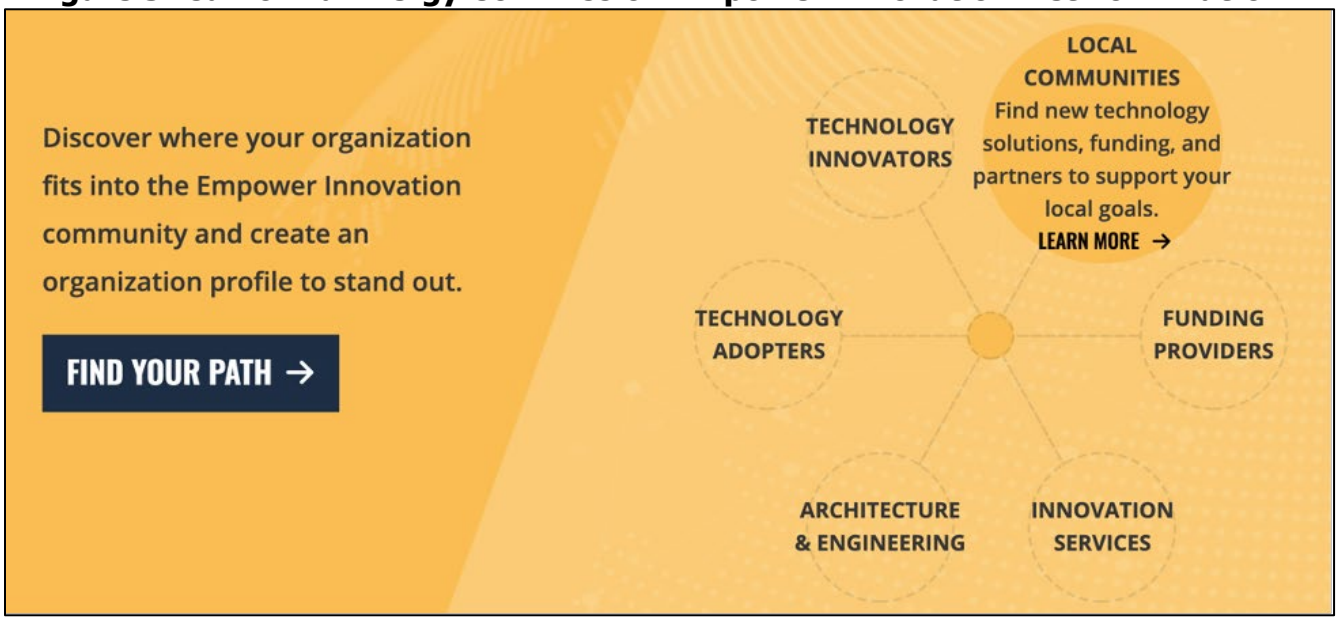
- Project recipients are encouraged to share project results in academic and scientific journals, industry recognized publications, and public conferences.

Promoting Partnerships for EPIC Projects

Participation from a broad range of stakeholders helps ensure that local insights and concerns inform the products and impacts resulting from demonstration and market facilitation projects. Stakeholder contributions can help accelerate access and adoption of clean energy innovation across California. The partnerships developed in EPIC are the result of intentional actions, consistent dialogue, and deliberate structuring of the program's solicitation documents.

Launched in 2019, Empower Innovation (available at https://www.empowerinnovation.net/) is the first clean energy networking platform designed for professionals seeking to advance and improve the accessibility of the clean energy economy. Participation in the platform has grown quickly. As of December 31, 2023, the Empower Innovation Network platform had more than 4,000 members 1,097 organizations. Notably, the platform also had more than 420,000 page views and hosted more than $14 billion in funding opportunity announcements. Figure 3 shows the different partner groups represented in the Empower Innovation Network.

Figure 3: California Energy Commission Empower Innovation Network Platform



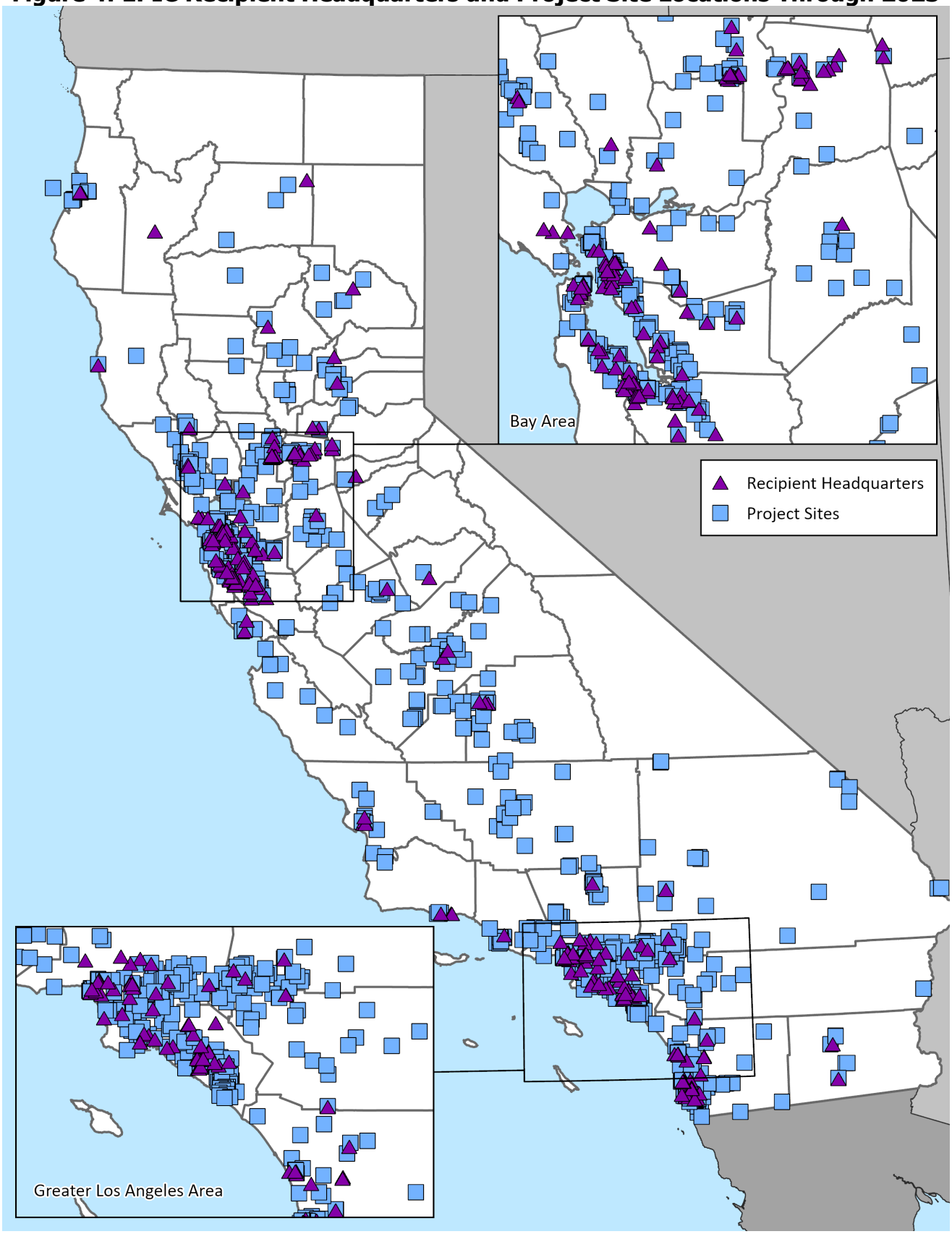
Source: Empower lab Innovation, an initiative funded by the California Energy Commission, https://www.empowerinnovation.net/

Geographic Diversity to Accelerate Technological Learning and Technology Diffusion

Successful emergence and diffusion of clean energy innovations from to market require technological learning and iterative feedback from local installers, workers, early adopters, inspectors, and regulators. Technological learning within EPIC is cultivated primarily in the TD&D program area, in which new technologies, devices, and equipment are tested in the real world under careful observation, measurement, and performance verification. To ensure direct benefits to the ratepayers that fund EPIC, these projects are limited to California IOU electric utility service territories.

Figure 4 shows CEC EPIC awardee headquarters and project sites across California, illustrating the wide reach and range of EPIC projects across the state. This map includes a cumulative total of CEC EPIC awards through 2023 for applied research and development, TD&D, and market facilitation projects.

Figure 4: EPIC Recipient Headquarters and Project Site Locations Through 2023

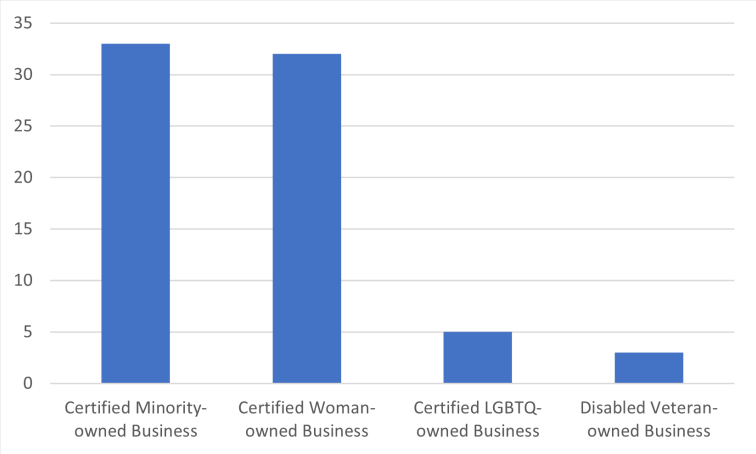


Source: California Energy Commission staff

Increasing Diversity and Equity in the Electric Program Investment Charge

California's promise, successes, and innovation stem from the rich and diverse qualities and abilities of its people. The CEC is committed to conducting outreach to inform diverse business entities and economically under-resourced communities about opportunities to participate in EPIC solicitations and activities. Additionally, CEC continuously works to make improvements in solicitations to help reduce the barriers that often prevent DVCs from accessing clean energy opportunities. Figure 5 summarizes the participation totals by a diverse business entity, broken out by category, for all EPIC projects that were active or completed in 2023.

Figure 5: Number of EPIC Projects in 2023 with a Diverse Business



Self-reported survey data for EPIC agreements that were active or completed in 2023 with one or more entities (prime or subcontractors) in each of the listed categories.

Source: California Energy Commission staff

CHAPTER 2:
Electric Program Investment Charge Budget

This chapter summarizes the CPUC authorized budget for the CEC EPIC program, as well as funding commitments and encumbrances, dollars spent on program administration, and other budget-related topics.

Authorized Budget

CPUC approved the following overall budget totals for each of the following investment plans:

- EPIC 3 investment plan (2018-2020): $441,780,000
- EPIC 4 interim investment plan (2021): $147,260,000
- EPIC 4 investment plan (2022-2025): $589,040,000

These totals include the amount allocated for CEC EPIC administration activities. Summaries of these investment plan budgets, split out by program area or funding initiative, can be found in Appendix A (Tables A3-A5). While the focus of this annual report is to align project reporting with the EPIC 4 investment plan, most reportable projects in 2023 were funded from the EPIC 3 investment plan under differently titled but comparable objectives and initiatives.

Funding Commitments and Encumbrances

To clarify the difference between commitments and encumbrances for EPIC, the CPUC adopted the following definitions in Decision 13-11-025:

"'Committed funds' are funds identified during the planning of a solicitation for a specific project that will be needed to fund a contract or grant for that project at the conclusion of a planned or released solicitation . . . 'Encumbered funds' are funds that are specified within contracts and grants signed during a previous triennial investment plan cycle and associated with specific activities under the contract or grant. All activities carried out under a contract or grant during a specific triennial investment plan cycle need not be completed and funds need not be spent during that program cycle if the activities undertaken pursuant to the contract or grant are expected to be completed. Only funds that are committed or encumbered during the prior program cycle are eligible for being rolled into the following program cycle."[14]

As of December 31, 2023, the CEC has committed 100 percent of the approved project funding for the EPIC 4 interim and 2021-2025 investment plans and encumbered approximately 21 percent of those funds. Table A-6 in Appendix A provides a summary of encumbered funding for all EPIC cycles to date.

14 California Public Utilities Commission. 2013. "Decision Addressing Applications of The California Energy Commission, Pacific Gas And Electric Company, San Diego Gas & Electric Company And Southern California Edison Company For Approval Of Their Triennial Investment Plans For The Electric Program Investment Charge Program For The Years 2012 Through 2014," https://docs.cpuc.ca.gov/PublishedDocs/Published/G000/M081/K773/81773445.PDF.

Approved Awards in 2023

In 2023, the CEC approved 28 new projects at CEC Business Meetings, totaling over $89 million in investments.

Direct Awards Made through an Interagency Agreement or Sole Source Method

As of December 31, 2023, CEC approved four direct projects through either an interagency agreement or sole source method. Table A-8 in Appendix A provides a summary for these projects as well as the action of the Joint Legislative Budget Committee (JLBC).

Follow-on Projects Awards

Public Resources Code section 25711.5(f)(8) requires the CEC's EPIC Annual Report to provide "[a] brief description of each project for which follow-on funding was awarded in the immediately prior calendar year, including the amount of follow-on funding awarded for the project and the method and criteria used to select that project," and the requirements for noncompetitive follow-on funding awards are set forth in section 25711.5(h)(4)(A).

As of December 31, 2023, the CEC had approved 12 follow-on projects, totaling more than $73 million. These projects were initially awarded EPIC project funds through an Invitation for Bid method. As part of this method, CEC staff identified grant recipients who could best leverage and benefit from follow-on funding based on prior project performance, policy impact, and statutory requirements. CEC then invited those grantees to submit a proposal for follow-on funding. A CEC technical evaluation committee then reviewed and evaluated the proposals and recommended whether the project merited a follow-on award. The proposed follow-on agreement was subsequently considered for approval at a CEC Business Meeting. Details for the 12 follow-on projects and the statutory criteria that authorize CEC to award EPIC project funds to follow-on projects can be found in Table A-9 in Appendix A.

Impacts of Tracking Equity Projects on Program Administration

AB 523 requires the CEC to provide a brief description of the "impact on program administration from the allocations required to be made" by AB 523. The required allocations are 25 percent of EPIC funds for TD&D at sites located in and benefiting disadvantaged communities and an additional 10 percent of EPIC funds for TD&D at sites located in and benefiting low-income communities.

In 2023, the CEC allocated two staff positions to implement AB 523. These staff resources coordinate efforts among agreement managers and various internal and external parties to ensure diversity and equity are properly incorporated across EPIC funding opportunities and projects. EPIC program administration activities related to AB 523 include the following:

- CEC staff participated in public workshops and outreach activities with disadvantaged and low-income communities.
- CEC staff determined whether to allocate funding set-asides in applicable EPIC solicitations aimed at funding TD&D projects that would be located in and benefitting disadvantaged or low-income communities.

- CEC staff used the EPIC equity scoring criteria, in addition to the standard scoring criteria, to further evaluate proposed projects that applied for special set-aside funding to benefit disadvantaged and low-income communities.
- CEC staff encouraged organizations representing low-income and disadvantaged communities to create a profile and network for possible project partnering on the CEC's Empower Innovation Network platform.
- CEC held internal Equity Team monthly meetings to conduct knowledge sharing and strengthen information dissemination.
- Two CEC DACAG liaisons facilitated coordination between staff and the DACAG to discuss solicitations or projects aimed at benefitting disadvantaged or low-income communities. Additionally, liaisons provided monthly input to the DACAG newsletter and coordinated with the CEC's Public Advisor's Office on equity-related efforts.

For further information on implementation of AB 523, please see "Energy and Equity: AB 523 Implementation" in Chapter 1.

Funding Shifts

In prior EPIC plans, EPIC administrators were required to obtain CPUC approval if seeking to shift more than five percent of budgeted funds from one funding category or program area to another existing or new category or program area within an approved EPIC triennial investment plan.[15] However, Decision 21-11-028, at Ordering Paragraph 9, updated that requirement. Beginning with the 2021-2025 EPIC 4 investment plan, the CEC is "authorized to reallocate up to 15 percent of funds among each of their approved initiatives without additional [CPUC] approval."

In 2023, the CEC did not shift or apply to shift more than 15 percent of funds between funding categories or program areas or to new categories or program areas. Tables 4, 5, and 6, summarize the shift of funds for each open EPIC investment plan (2018-2020, 2021-2025 Interim and 2021-2025 Full respectively) as of December 31, 2023.

15 Ibid

Table 4: Fund Shifts 2018-2020 Electric Program Investment Charge Investment Plan (as of December 31, 2023)

Program Area	Approved Total	Funding Shift from a Program Area	Funding Shift to a Program Area	Current Total
Applied Research and Development	$158,912,222	-$4,810,336	$217,980	$154,319,866
Technology Demonstration and Deployment	$172,237,778	-$125,015	$23,213	$172,135,976
Market Facilitation	$66,230,000	-$115,263	$4,809,421	$70,924,158
Subtotal	**$397,380,000**	**-$5,050,614**	**$5,050,614**	**$397,380,000**
Administration	$44,400,000	$0	$0	$44,400,000
Total	**$441,780,000**	**-$5,050,614**	**$5,050,614**	**$441,780,000**

Source: California Energy Commission staff

Table 5: Fund Shifts 2021-2025 Interim Electric Program Investment Charge Investment Plan (as of December 31, 2023)

Program Area	Approved Total	Funding Shift from a Program Area	Funding Shift to a Program Area	Current Total
Applied Research and Development	$41,200,000	-$1,200,000	$797,153	$40,797,153
Technology Demonstration and Deployment	$75,000,000	-$797,153	$1,200,000	$75,402,847
Market Facilitation	$16,334,000	$0	$0	$16,334,000
Subtotal	**$132,534,000**	**-$1,997,153**	**$1,997,153**	**$132,534,000**
Administration	$14,726,000	$0	$0	$14,726,000
Total	**$147,260,000**	**-$1,997,153**	**$1,997,153**	**$147,260,000**

Source: California Energy Commission staff

Table 6: Fund Shifts 2021-2025 Electric Program Investment Charge Investment Plan (as of December 31, 2023)

Program Area	Approved Total	Funding Shift from a Program Area	Funding Shift to a Program Area	Current Total
Non-Variable Renewable Energy	$23,000,000	$0	$0	$23,000,000
Variable Renewable Energy	$29,000,000	$0	$1,809,421	$30,809,421
Clean, Dispatchable Resources	$55,000,000	$0	$0	$55,000,000
Grid Modernization	$27,240,000	$0	$6,250,000	$33,490,000
Distributed Energy Resource Integration and Load Flexibility	$86,000,000	$0	$0	$86,000,000
Transportation Electrification	$59,000,000	-$6,250,000	$0	$52,750,000
Industrial Decarbonization	$46,000,000	$0	$0	$46,000,000
Building Decarbonization	$60,000,000	$0	$0	$60,000,000
Entrepreneurial Support	$63,800,000	-$1,809,421	$0	$61,990,579
Scaling Clean Energy Technology	$18,200,000	$0	$0	$18,200,000
Climate Resiliency	$18,000,000	$0	$0	$18,000,000
Environmental Sustainability	$15,000,000	$0	$0	$15,000,000
Subtotal	**$500,240,000**	**-$8,059,421**	**$8,059,421**	**$500,240,000**
Administration	$88,800,000	$0	$0	$88,800,000
Total	**$589,040,000**	**-$8,059,421**	**$8,059,421**	**$589,040,000**

Source: California Energy Commission staff

Uncommitted and Unencumbered Funds

Uncommitted funds are those not committed during the planning of a solicitation. Unencumbered funds meet one of the following conditions:

- The funds are committed but have not been encumbered.
- After funds were encumbered, the funds were disencumbered for projects in which the encumbrance period had expired. This includes projects canceled or terminated with no CEC EPIC funds spent, or projects amended to reduce the original budget.

As of December 31, 2023, there were no uncommitted funds from the first, second, third, or fourth EPIC investment plans. Table 7 summarizes the unencumbered project funds for each EPIC investment plan. CEC plans to encumber the balance from the 2021-2025 investment plans by June 30, 2027. Chapter 4 provides a list of anticipated solicitations for 2024.

Table 7: Encumbered and Unencumbered Project Funding by Electric Program Investment Charge Investment Plan (as of December 31, 2023)

Investment Plan	Approved Plan Project Funds	Encumbered Project Funds	Unencumbered Project Funds
2012-2014	$331,800,000	$328,246,114	$3,553,886
2015-2017	$365,004,500	$348,857,997	$16,146,503
2018-2020	$397,380,000	$396,716,248	$663,752
2021-2025 Interim	$132,534,000	$78,283,007	$54,250,993
2021-2025	$500,240,000	$55,884,393	$444,355,607
Total	**$1,726,958,500**	**$1,207,987,759**	**$518,970,741**

Source: California Energy Commission staff

Interest Accrual

In 2023, the CEC accumulated about $12.2 million in interest from all funds in the EPIC account. Due to administrative limitations, instead of returning accumulated interest, the CEC takes accumulated interest into account when submitting invoices to the IOUs. Per CPUC Decision 13-11-025, once the accumulated interest is determined for the prior year, the CEC subtracts the amount of accrued interest from invoices it submits to the IOUs.

CHAPTER 3:
Electric Program Investment Charge Projects

Through EPIC, the CEC funds innovation to advance safety, reliability, sustainability, and affordability in California's electricity system. The CEC awards EPIC funds through a competitive process to projects that will accelerate achievement of California's ambitious clean energy, greenhouse gas reduction, and climate adaptation policies.

CEC staff apply dedicated expertise to fund a strategic portfolio of EPIC research projects in the public's interest. This portfolio of projects will make California's transition to 100 percent clean energy faster, lower cost, and more inclusive by supporting entrepreneurship, deploying clean energy technologies directly in communities, and providing public access to data and lessons learned, among other activities.

EPIC advances innovations for resilience and safety, energy equity, and decarbonization of California's building, industrial, agricultural, water treatment, transportation, and electricity sectors. Since the beginning of EPIC, the CEC has funded 501 project awards, investing about $1.2 billion to benefit California electricity ratepayers.

Summary of Project Data & Information

Appendix C of this report includes a detailed list of EPIC-awarded projects since the program's inception, through December 31, 2023. Additional project information is available on the Energize Innovation Project Showcase.

Appendix B (Tables B-1 through B-5) provides summaries for each investment plan that includes the number of active, completed, and terminated (with funds spent) reportable projects and total funding for 2023, broken out by strategic objective and initiative. Reportable projects span from the first EPIC investment cycle through to the current EPIC 4 investment cycle, and several projects are funded from multiple investment plans and/or multiple strategic objectives and strategic initiatives. Appendix D provides a comprehensive list of the 2023 reportable projects showing the agreement number and the investment plan, strategic objective, and initiative they are funded by.

Completed Projects: In 2023, grant recipients completed 24 EPIC projects. Final project reports by recipients, available upon request, have been or will soon be submitted to the CEC. Once approved, finalized, and formatted to be digitally accessible, each final project report is posted on the CEC website at the Research and Development Reports and Publications page at https://www.energy.ca.gov/energy-rd-reports-n-publications. Please see Table B-6 in Appendix B for more information on the final reports for projects completed in 2023.

Terminated Projects: Two projects were terminated in 2023. These projects began research and partially spent EPIC funds but were unable to successfully reach completion.

Description of Projects by Strategic Objective

The sections that follow provide 2023 project overviews, highlighting successes, challenges, and next steps by strategic objective. While not a comprehensive list of all projects funded and

active in 2023, the spotlights below showcase projects and lessons learned across the CEC's EPIC portfolio. To view detailed project data and information for all projects funded by EPIC through 2023, see Appendix C or the Energize Innovation project showcase.

Strategic Objective 1: Accelerate Advancements in Renewable Generation Technologies

Introduction

Technologies that promote the growth and commercialization of renewable and zero-carbon energy sources are essential to meeting the state's 2045 climate goals. Advanced renewable energy and zero-carbon generation technologies that EPIC funds span offshore wind, solar, bioenergy, and geothermal energy. Investing in these cutting-edge energy generation sources can help lower their production cost, increase their energy output, or improve their business case, all key to implementing these technologies at scale and accelerating progress toward California's climate goals.

Progress and Success Stories

CEC has closed out or is in the process of closing out several grant agreements from EPIC 3, including for solar, offshore wind, and geothermal and lithium recovery technologies. For example, a solar project developed a tandem silicon-perovskite module that improves efficiency and lowers costs while utilizing fewer toxic materials (EPC-19-004). A project focused on wind energy manufactured wind turbine tower sections using innovative three-dimensional concrete printing methods to facilitate deployment and lower costs of large land-based and offshore wind technologies (EPC-19-007). One geothermal and lithium recovery project was completed successfully (EPC-19-017) with promising results, providing a potential pathway to more efficiently recovery lithium from geothermal brines compared to conventional methods. Another project is in progress with the goal of more efficiently and cost-effectively removing silica from geothermal brines, a key step prior to lithium recovery (EPC-19-029).

After the approval of the EPIC 4 interim investment plan, the CEC has invested significantly in offshore wind, executing seven new grant agreements in 2023, totaling over $21 million. These agreements focus on developing and testing floating offshore wind environmental monitoring technologies (e.g., sensors, data processing) to facilitate accurate and timely information gathering, which will be helpful to permitters and regulators, and floating offshore wind-specific components (e.g., mooring lines, anchors). Projects are expected to be completed in 2027, and grant recipients will present interim research findings at various conferences and to CEC staff to help disseminate findings.

Additionally, CEC will provide up to $5 million for co-funding floating offshore wind R&D (EPC-22-009). National Offshore Wind Research and Development Consortium, or NOWRDC, will develop a grant solicitation and the resulting subawards. NOWRDC is a nationally focused, non-profit organization aimed at collaborating with industry on prioritized research and development activities that reduce the levelized cost of energy (LCOE) of offshore wind in the U.S. while maximizing other economic and social benefits. This partnership is expected to leverage funding from other federal and state agencies to issue research solicitations of mutual benefit related to offshore wind. The funded projects will be consistent with the goals

of the EPIC program to provide benefits to IOU ratepayers. NOWRDC is developing draft solicitation concepts, and the final solicitation is anticipated to be released later in 2024.

Impediments and Setbacks

Some renewable generation projects have encountered difficulties due to technology-related obstacles. A few projects focused on lithium recovery from geothermal brines encountered technological challenges, including lower-than-expected performance from lithium recovery systems. The constituent products in the geothermal brines are complex, and additional innovation is needed to improve brine treatment processes. One project was completed successfully with promising results, providing a potential pathway to more efficiently recover lithium compared to conventional methods (EPC-19-017). Another project is in progress with the goal of more efficiently and cost-effectively removing silica from geothermal brines, a key step prior to lithium recovery (EPC-19-029).

Some funding opportunities – particularly those requiring a two-step application process to pair with federal funding – have experienced issues with the level of applicant responses. In 2023, the CEC issued two solar-related federal cost share solicitations through the federal Bipartisan Infrastructure Law (BIL) to provide cost share funding to California applicants who apply for and receive a federal award. The first funding opportunity, Silicon Solar Manufacturing and Dual-use Photovoltaics Incubator (DE-FOA-0003057), seeks to enable solar cost reductions while developing new solar technologies and encouraging solar manufacturing. The second solicitation, Advancing U.S. Thin-Film Solar Photovoltaics (DE-FOA-0003058), was designed to promote the research and development of affordable solar panels. Across the two opportunities, the CEC received only one proposal for cost share, which did not receive a passing application score. Therefore, the CEC did not issue any Letters of Intent to provide funding. CEC issued another federal cost share solicitation focused on offshore wind, Installation Noise Reduction and Reliable Moorings for Offshore Wind and Marine Energy (DE-FOA-0003121), which funds research into risk aversion and environmental compatibility of offshore wind developments. The CEC did not receive any proposals in response to this cost share opportunity and therefore did not provide funding.

Next Steps

To advance the use of geothermal energy, the CEC issued a $23 million solicitation in January 2024. The grant opportunity, "Geothermal Energy Operations and Lithium Innovation," or GEO/LI, focuses on innovations to reduce the costs and infrastructure impacts of scaling and corrosion at geothermal plants in California (GFO-23-304). Additionally, the solicitation also aims to promote recovery of valuable minerals such as lithium from the Salton Sea. These co-products are essential for securing a domestic supply chain to support battery production that enables meeting the state's clean energy goals. In formulating this part of the solicitation, the CEC leveraged input from eight public responses, as well as from expert stakeholder discussions, to ensure accuracy and applicability. Applications for the solicitation are due April 15, 2024.

CEC is also conducting solicitation scoping to develop solicitations for floating offshore wind, and solar technologies, as identified in the EPIC 4 investment plan. Solicitations are expected in 2024 and 2025.

Strategic Objective 2: Create a More Nimble Grid to Maintain Reliability as California Transitions to 100 Percent Clean Energy

Introduction

Most energy storage systems today use lithium-ion battery technologies that provide capacity for a duration of four to six hours, covering typical trends of intermittency with renewable generation. Achieving 100 percent zero-carbon electricity cost-effectively will require innovations in these short duration energy storage systems, in addition to LDES, which has the potential for eight to 100 hours of instantaneous dispatch, and seasonal energy storage, which may offer days or weeks of capacity.

Like the grid services that LDES can provide, zero-carbon fuels, including hydrogen gas or methane gas derived from biomass, have the potential to serve as clean, firm dispatchable resources when paired with devices that can convert them into electricity, such as fuel cells or gas turbines. Grid modernization – particularly to address grid congestion, enable the installation of more inverter-based resources, and enhance cybersecurity – will require a nimbler electric grid, futureproofed to manage increased variable generation and connection points.

Progress and Success Stories

Zero-Carbon Fuels: As part of its mission to deploy clean dispatchable energy across California, the CEC has supported a portfolio of projects that have advanced the production and use of biofuels, such as ethanol and biogas, as well as biomass, or remnants from landfill waste and forest management. The use of biomass and biofuels as opposed to fossil energy sources can have long-term, positive impacts on the state's carbon footprint.

West Biofuels, a California-based company with a focus on thermochemical biomass technology, is leveraging EPIC funding to complete one such project. In February 2023, the company was awarded $30 million dollars by the U.S. DOE to amplify its efforts to adequately supply secure, low-carbon energy for numerous rural areas throughout the state (EPC-14-024). West Biofuels' technology converts woody biomass, defined for the project as the byproduct of wildfires or forest management including tree parts and plants from high hazard zones, into renewable, low-carbon methane gas and value-added, mixed alcohol byproducts. The company plans to implement bioenergy systems for rural communities in Mammoth Lakes, Mariposa, and Burney, California. Demonstration of a technically feasible bioenergy system that can be deployed to utilize woody biomass on-site could help reduce vulnerability to natural disasters, bolster energy resiliency, and supply a stable low-carbon fuel source.

An additional project demonstrating the CEC's support of biomass and biofuels to advance clean dispatchable energy and reduce wildfire risk is the solicitation "Forest Resource and Renewable Energy Decision Support System," or FRREDSS (EPC-17-016). FRREDSS was developed through a $1.2 million EPIC-funded agreement with UC Davis as a comprehensive, web-based decision support system that allows users to quickly quantify anticipated economic and environmental impacts of woody biomass projects. The online tool promotes participation in regulatory processes and public funding by enabling public users to generate data that can influence decision making. Researchers created an online application and user guide that

provides harvesting cost, location, lifecycle environmental performance metrics, and other important information for interested stakeholders.

Finally, the CEC completed a $1.5 million agreement in 2023 that made significant advancements in processing forestry waste to reduce the risk of wildfires (EPIC-17-017). The project developed a commercial-scale CHP machine, known as the Powertainer+ (PT+), to process thousands of tons of forestry waste into low-cost energy and bioproducts that sequester carbon. This multi-modal power and products platform included components for making biochar via the Chartainer (PT+ Chartainer) and a 50-kilowatt (kW) Microgrid-CHP Power PalletContainer. Biochar, like charcoal, is partially combusted forestry waste and can be used for carbon sequestration.

All Power Labs (APL) developed these two solutions to process forestry waste with a goal of reducing wildfire risk related to tree mortality. This project also developed a digital model for funding and scaling proactive forestry management and wildfire remediation. The products developed provide distributed-scale strategies that focus on local deployment of power and reduction of wildfire risk. The 50 kW CHP system received an EPIC grant to further its development, and a model will be deployed at an agricultural site in the city of Ontario, California. In addition, APL is in the process of commercializing a 50 kW Microgrid-CHP Power Pallet and installing a unit at a regenerative farm named Blue Marble Acres in Petaluma. The system at Blue Marble Acres will be operational in Spring 2024, while the CHP system in Ontario will be completed in the first quarter of 2025.

The CEC released a draft solicitation concept in August 2023 focused on zero-carbon renewable fuels that can supplement existing electric generation infrastructure. The proposed funding opportunity would target dispatchable generation technologies, including, but not limited to, reciprocating engines and linear generators, that use 100 percent renewable fuel blends comprised of clean hydrogen, biogas, ammonia, or other renewable fuel, or a combination of these fuels. Ideally, projects would include enhancing features such as CHP capabilities, higher system efficiency compared to fossil-based legacy systems, or carbon capture technologies to improve economic feasibility. The draft solicitation also provides funding for clean hydrogen production using biomass, such as wood and agricultural waste.

Green Hydrogen Roadmap: In August 2023, agreements with Energy and Environmental Economics, Inc. (E3, EPC-23-009) and the RAND Corporation (RAND, EPC-23-004) began scoping and developing green hydrogen roadmaps intended to answer key questions on the expected role, value, and infrastructure buildout of green hydrogen in California's electricity sector. E3 will develop new modeling tools to determine environmental impacts and evaluate least-cost configurations of green hydrogen production, storage, transportation, and end-use networks. RAND will complement E3's modeling study by developing research and development metrics and assessing the potential role of hydrogen on the grid. Both RAND and E3 will also evaluate the role of ratepayer funds in potential green hydrogen scenarios compared with the availability of other funding sources. Roadmap results expected in 2024 can inform future EPIC investment plans and SB 100 reports, relevant CPUC proceedings, hydrogen growth modeling required under SB 1075, and hydrogen policy more broadly.

Grid Modernization: In July 2023, staff held a Grid Modernization Research Scoping Workshop with panel participation from the California ISO, PG&E, SCE, National Renewable Energy

Laboratory (NREL), and Idaho National Laboratory. Parties presented research concepts for consideration in a future solicitation, and CEC solicited feedback from subject matter experts on research gaps. The proposed concepts included a targeted assessment of transmission congestion and benefits of grid-enhancing technologies; demonstrations of grid-enhancing technologies to mitigate grid congestion; wide-area monitoring, protection, and control of modern power systems; and development and demonstration of grid-forming inverters. Staff are using stakeholder feedback to inform the development of a grant opportunity to be released this fall entitled, "Accelerating Grid Modernization Research for Building a Future-Ready Grid."

Distributed Energy Systems: Staff released a federal cost share opportunity "Cost Share for Federal Clean Energy Funding Opportunities" (GFO-21-901) in March 2022 for the U.S. DOE funding opportunity announcement, *Distributed Energy Systems* (FOA-0003139), for which the submission deadline is April 2024. The grant offering seeks to fund utility- and private sector-led at-scale demonstrations that coordinate aggregated DERs for dispatchable, reliable grid services meeting distribution grid needs. Objectives include improving access to grid service financial incentive programs for historically underserved communities, enabling diverse mixes of aggregated DERs to participate in energy markets, and facilitating interoperable management of systems. Up to $6.25M of EPIC funds are available per project, and each demonstration will be required to enroll at least 5 MW of variable renewable generation and flexible load assets. In the event that a California-based project is not selected for the federal award, a stakeholder-driven scoping process to understand the barriers to DER aggregation will likely still occur, as competitive solicitations are developed in the continued implementation of the EPIC 4 investment plan.

The CEC released a competitive solicitation to fund TD&D projects that accelerate commercialization and validate the capability of LDES technologies to improve grid reliability and resilience for disadvantaged communities, low-income communities, and tribes on June 13, 2023. The grant opportunity is entitled, "Optimizing Long-Duration Energy Storage to Improve Resilience and Reliability in Disadvantaged and Low-Income Communities and Native American Tribes" (GFO-22-307). Staff received and evaluated 12 proposals and selected three applicants for funding, for a total of approximately $26.7 million in EPIC funds and $12.2 million in match funds. The three projects recommended for funding include the Barona Band of Mission Indians' demonstration of a 1.5 MW 6.6 MWh redflow zinc-bromine flow battery, Noon Energy's demonstration of a 100 kW 10 MWh CO2 O-carbon block, and RedoxBlox's demonstration of a 3 MW thermochemical energy storage with 100 kW output for 24 hours. The CEC anticipates taking the three proposed projects to a CEC Business Meeting for approval by Q3 2024.

All three proposed recipients seek to optimize LDES solutions, benefitting disadvantaged and low-income communities and tribes by improving energy resilience and reliability. The Barona Band project will deploy a LDES battery technology supporting at least 100 kW of load for 24 hours in a commercial microgrid with islanding capabilities at the reservation. The LDES system will integrate existing and planned DERs to provide resilient and economical energy supplies for essential tribal facilities.

Noon Energy will demonstrate, validate, and accelerate the commercialization of a novel, safe, and low-cost storage system. The system will store energy produced by a 7 MW solar field in

Yolo County to provide low-cost and resilient electricity to nearby critical facilities in underserved communities. RedoxBlox proposes a novel thermochemical energy storage system integrated with a CHP system. The energy storage system will be paired with a microturbine, installed on the UCSD medical campus, located within a low-income community, and serve the surrounding disadvantaged communities. These three LDES technologies will seek to provide safety improvements over conventional lithium-ion battery storage technologies, including reduced fire risk, to lower energy costs by supporting low-cost storage capable of achieving less than $0.05/kWh levelized cost of storage upon commercialization, and to improve long-duration resiliency and reliability during grid events with up to 100 hours of energy storage.

Other EPIC-funded companies focused on developing clean dispatchable resources have also found success in receiving match funding and expanding their operations. Rejoule was named an awardee for $10 million under the U.S. DOE's BIL Long Duration Energy Storage Funding Opportunity. The company leveraged $2.5 million in EPIC funds to apply its second-life battery rapid diagnostics technology to repurpose EV batteries for stationary storage that provides resilience and supports renewable integration at both the K'ima:w Medical Center of the Hoopa Valley Tribe and an affordable housing complex in Petaluma.[3] Rejoule's project builds off of lessons learned from an EPIC 3 project that helped de-risk initial safety and regulatory issues (EPC-19-055). The U.S. DOE project will help establish a path to certify repurposed batteries using rapid battery grading technology, improve battery circularity and sustainability, and reduce costs of energy storage.

Load Flexibility as a Clean Dispatchable Resource: Services spawned from EPIC projects have also provided tangible, real-world benefits. Three EPIC projects with OhmConnect, Polaris Energy, and AgMonitor have collectively increased demand flexibility across the state and contributed approximately 56 MW of additional load reduction (a clean, dispatchable resource) during extreme summer weather events. These projects continue to attract private funding, expand the use of their platforms, and provide value for ratepayers. Using EPIC funds, OhmConnect developed partnerships with community choice aggregators (CCAs) and deployed smart thermostats, primarily in homes in the Central Valley. Polaris Energy used EPIC funds to expand its smart irrigation systems and integrate large farmers into PG&E's demand response program. The software platform developed by this funding is also being used in Valley Clean Energy's AgFIT pilot to demonstrate real-time dynamic pricing for agricultural customers. Finally, AgMonitor's innovative technology helped agricultural customers respond to time-of-use rates and resulted in about 8 MW of load shifting during the summer of 2023. It helped enroll 9 MW of agricultural loads in the CPUC's Emergency Load Reduction Program, a newer program created in 2021 that pays electricity consumers for reducing energy consumption or increasing electricity supply during electric grid emergencies.

Impediments and Setbacks

While COVID pandemic impacts have largely subsided, extended delays still affected projects in 2023. Continued supply chain challenges resulted in long lead times for equipment and materials, delaying start times and construction periods. Grant recipients also experienced challenges in hiring necessary staff and technical labor.

In discussions held by staff in 2023 with technology developers and industry associations, additional topics raised included technical challenges, policy and market barriers, the

availability of research and development funding opportunities, and the need to be future-looking in setting and implementing longer-term technology goals.

Next Steps

A solicitation entitled "Energy Storage Innovations to Support Grid Reliability" is expected to be released in Q2 2024 and will make available $30 million of EPIC 4 Clean, Dispatchable Resources funding. This solicitation will fund continued research and development of energy storage technologies to achieve cost reductions, performance and safety improvements, and greater supply chain diversity. In addition, projects will demonstrate new use cases and value streams to maximize the benefits of energy storage.

In November 2023, staff released a Notice of Letter of Intent to provide $625,000 of EPIC 4 Clean, Dispatchable Resources funds as cost share for Quino Energy, Inc.'s application to U.S. DOE's funding opportunity announcement, *Energy Storage Demonstration and Validation* (DE-FOA-0003036). If successful, this project will leverage $5 million in federal funding to support the demonstration and validation of Quino Energy's aqueous organic flow battery technology. The U.S. DOE anticipates making award announcements in Q2 2024.

In late 2025, $14 million of Clean, Dispatchable Resources funding will be considered for a solicitation on green hydrogen and zero-carbon firm dispatchable resources following results of the green hydrogen roadmaps under development from RAND and E3.

Strategic Objective 3: Increase the Value Proposition of Distributed Energy Resources (DERs)

Introduction

In 2023, EPIC invested in technologies that increase the value of DERs for both customers and the electric grid. Improvements in DERs can increase the affordability and reliability of the electrical supply for California's ratepayers. Recent DER investments include microgrid demonstration projects, multiple demonstration projects integrated with affordable housing, the first VPPs for CCAs, energy storage demonstration projects utilizing second use batteries, and the deployment of MHD EV charging infrastructure across critical shipping corridors in California. Many of the projects that EPIC has funded in these topic areas can serve as replicable models for similar projects and programs across IOU service territories and the state.

Strategic Initiative: DER Integration and Load Flexibility

Progress and Success Stories

EPIC investments in DER integration and load flexibility delivered major milestones in 2023, particularly in microgrids, VPPs, and energy efficient buildings coupled with energy storage. To help drive progress on this strategic objective, CEC staff coordinated with the CPUC, IOUs, DER aggregators, and other stakeholders regarding several key issues to improve the effectiveness of EPIC and other ERDD-administered program investments. CEC staff monitored updates on the CPUC's High DER Future Grid Proceeding as part of achieving the overall vision of the CPUC's Distributed Energy Resources Action Plan and also held a research scoping workshop, Virtual Power Plants and Demand Flexibility, to gather and disseminate information

on VPP strategies being piloted by CCAs.[2] Information gathered from this workshop was used to inform the development of a grant opportunity "Virtual Power Plant Approaches for Demand Flexibility (VPP-FLEX)" (GFO-23-309), released on March 1, 2024.

Success stories in this area include:

Zero Carbon Homes Incorporating DERs: In December 2023, CEC selected the awardees of grant opportunity, "Reimagining Affordable Mixed-Use Development in a Carbon-Constrained Future" (GFO-20-305), which originally challenged teams of architects and housing developers to design new mixed-use developments that are zero-carbon, all-electric, resilient, and grid-responsive. Of 11 applicants that designed first-of-their-kind, affordable housing and low-income units with zero net energy and advanced energy features, including microgrids and grid-interactive EV charging, four projects across four different regions of the state were selected to build out their designs. These projects will produce a total of 733 new affordable housing units with advanced energy features that serve low-income households. The awardees in each region are:

- EPC-21-028 - Electric Power Research Institute (EPRI) (Bay Area), working with Redwood Energy and Rising Sun Opportunities to recruit high school and college students from disadvantaged communities to be trained at the construction site.
- EPC-21-027 - Mutual Housing (NorCal/Central Valley), working with Stocktonians Taking Action to Neutralize Drugs (STAND) to provide services to the community, such as food distribution events and violence prevention outreach.
- EPC-21-022 - Innovative Housing Opportunities, Inc. (Los Angeles County), worked with local organizations such as Thrive and Cielo to understand the community's needs. Insights were gained into challenges related to childcare, food business incubation, transportation justice, and affordable amenities.
- EPC-21-023 - National Community Renaissance of CA (San Diego County, Inland Empire/Imperial Valley) collaborated with local organizations in San Diego to engage residents on strategies for affordable housing and energy-saving initiatives. Resident input and ideas form the basis for ongoing resident engagement for zero-carbon housing and energy-conscious behavior.

These developments are expected to provide up to 100 percent electric bill savings to the residents as well as up to 238 percent improvement in avoided GHG emissions over Title 24-compliant baseline building designs. Moreover, they will be used as templates for designing and building advanced energy buildings in affordable housing projects across California. Of the winners, Mutual Housing in Stockton (EPC-21-027) seeks to start construction on its project first, commencing in 2024.

Microgrids: CEC-funded microgrid projects demonstrated tangible benefits in 2023, and their results help inform new programs, accelerating microgrid deployment across the state. In the North Coast region, for example, the Redwood Coast Airport Microgrid (EPC-17-055) serves as the first fully renewable, multi-customer, and front-of-the-meter microgrid in PG&E's service territory. The microgrid has been operating in an automatic islanded mode since May 2022 and was able to provide backup power to critical facilities, including the local airport, a U.S. Coast Guard Air Station, and a building with life-support services that directly aided seventeen local citizens, during multiple eight natural disaster events in the winter of 2022 and

throughout 2023 and over ten short (less than one hour) power outages for a cumulative total time of 45 hours. This project also pioneered experimental tariffs and agreements for multi-customer microgrids, and PG&E is using it as a model for its Community Microgrid Enablement Program and Microgrid Incentive Program, which can help other communities deploy similar solutions for their critical facilities.

In the Bay Area, Gridscape (EPC-17-052) designed and constructed a new modular microgrid system that can easily be deployed for small- to mid-size BTM applications. The company also designed a battery enclosure unit that meets the Division of the State Architect permitting requirements to deploy batteries in schools and community colleges. Many current energy storage systems use shipping containers as a battery enclosure, which the Division of the State Architect does not accept. Gridscape originally agreed to use these innovations to deploy five solar microgrids in disadvantaged communities in two IOU service territories. However, since its model has been so successful, Gridscape was able to add private financing to EPIC funds for a total deployment of 10 microgrids across all three IOU service territories. Of the 10 microgrids, all are in or planned to be in disadvantaged communities. Three finished constructions in 2023 and have their permission to operate pending; three are under construction; two have completed permitting; and two are still in the permitting phase.

Gridscape has been able to expand its business activities to include solar microgrids and EV infrastructure products and services. As a notable example, in March 2023, Ava Community Energy, a CCA formerly known as East Bay Community Energy that serves Alameda County, chose Gridscape as its developer to deploy 30 microgrids for critical facilities in San Leandro, Berkeley, Hayward, and Fremont, California. These microgrids will include the installation of 3.1 MW of solar panels and 6.2MWh of battery storage. A second example is Gridscape's partnership with the Sacramento Municipal Utility District to deploy an integrated solution with EV charging, solar PV, and a battery storage system at the utility's headquarters.

VPPs for California CCAs: Two projects managed by the Zero Net Energy Alliance are focused on developing the first VPP programs for CCAs in California. The City of Lancaster's Advanced Energy Community (AEC) project (EPC-18-011) is partnering with Lancaster Choice Energy (LCE), and the City of Richmond's AEC project (EPC-19-005) is partnering with Marin Clean Energy (MCE). These AECs are integrating local renewables, energy storage, and flexible loads into their VPP networks. The projects will generate benefits by reducing the communities' electric bills and improving grid resiliency through lowered energy consumption during critical times to reduce the strain on the grid. These programs also developed the first VPP tariffs in California, which will enable both residential and commercial customers to receive an attractive flat-rate bill credit for integrating their DER assets into the VPPs. Clearly demonstrating the financial benefit to customers has been effective in increasing IOU customer enrollment in the pilot VPP programs. Both CCAs plan to scale these programs across their service territories, multiplying the impact of these investments.

Community Solar: EPIC investments are enabling residents of both new and existing affordable housing to reap the benefits of affordable, clean energy provided by DERs. The Bassett Avocado Heights AEC (BAAEC) (EPC-19-006) project is helping single-family, low-income homeowners deploy and directly benefit from solar-plus-storage projects in the communities of Avocado Heights and Bassett, located in an unincorporated area within the San Gabriel Valley. In 2023, the construction of two community solar projects in partnership with the Clean Power

Alliance was completed, giving low-income subscribers to Clean Power Alliance's Power Share program 100 percent renewable energy at a 20 percent bill discount due to the CPUC's Community Solar Green Tariff program. The BAAEC is also the first in the California ISO market to be designated as a Distributed Energy Resource Aggregation (DERA), or an aggregation of 100kW energy and storage systems that total at least 500kW. This allows the projects to participate in the California ISO's day-ahead, real-time, and ancillary services markets as a generator using participation models that fit the needs of the DERA. The Richmond AEC has also qualified as a DERA in the California ISO's market.

Load Flexibility: While improving load flexibility in California is critical to maintaining the reliability of the grid in the face of rising demand due to electrification, it will also play a pivotal role in shifting loads to match the variable generation of DERs, thus increasing their value. One of the most notable EPIC investments in this regard is the "The California Load Flexibility Research and Development Hub (CalFlexHub)" (EPC-20-025), which was awarded $16 million in EPIC funds in 2021. The CalFlexHub conducts electricity sector applied research, development, demonstration, and deployment projects that increase the value proposition and market adoption of flexible demand technologies and strategies. CalFlexHub research has informed the CPUC's Demand Flexibility Rulemaking (22-07-005), as well as the CEC's development of Load Management Standards and Flexible Demand Appliance Standards. CalFlexHub was featured at the 2023 EPIC Symposium, hosted, and presented its research at the 2023 CalFlexHub Symposium, and in early 2024 was featured at the Stanford-CEC Energy Summit hosted at Stanford University.

Impediments and Setbacks

All the AEC projects cited issues related to supply chain constraints that caused delays. Often, these supply shortages caused increased prices for equipment, exacerbated by inflation. Multiple projects under the DER integration initiative reported challenges with securing major subcontractors for the projects. Additionally, both the BAAEC and the Oakland Eco-Block projects cited California's Prevailing Wage and EPIC reporting and invoicing requirements as being overly burdensome. For example, the CEC has a universal internal profit cap of 10 percent, which has been cited by contractors as a reason not to participate on AEC projects, since they can receive higher profit margins elsewhere.

State regulations were also cited as a barrier to project implementation. Section 218 of the California Public Utilities Code, which requires any entity that sells energy to more than two contiguous parcels or across the street to become an electrical corporation regulated by the CPUC, was reported to have prevented the creation of a community microgrid as part of the Lancaster AEC Project. Instead, sites were redesigned to form a network of nanogrids in which individual homes operate as standalone microgrids linked by controls across the whole site. This problem was addressed by CPUC Decision 21-01-018, part of Rulemaking 19-09-009, which established rules for the commercialization of community microgrids.[3]

Second-life EV battery projects have encountered challenges in obtaining the necessary fire-safety permits from local authorities that have jurisdiction. A related challenge is obtaining UL1974, UL9540, and UL9540A certifications. These challenges have delayed deployment of the demonstration portion of all but one project and required recipients to extend the terms of their agreements.

Next Steps

In 2023, several notable solicitations were awarded and developed under the DER Integration initiative, and more continue to be developed in 2024.

In November 2023, CEC released the grant opportunity "*Power Electronics for Zero Emission Residential Resilience* (PEZERR)" (GFO-23-302) and expects to announce awardees in late May 2024. Based on Topic 15 from EPIC 4, this solicitation seeks to fund emerging power electronics technologies that reduce the cost of BTM zero-emission backup power solutions, which can sometimes contribute to 70 percent of total system costs, to incentivize the construction of more zero-emission backup power systems that can provide power during outages.

DE-FOA-0003139: The U.S. DOE FOA, *Distributed Energy Systems Demonstrations,* was announced in September 2023, for which the CEC has committed EPIC funds for a cost-share opportunity. This funding opportunity seeks to fund utility and private sector-led at-scale demonstrations that coordinate aggregated DERs for dispatching reliable grid services to meet distribution grid needs. Objectives include improving access to grid service financial incentive programs for historically underserved communities, enabling diverse mixes of aggregated DERs to participate in ISO energy markets, and facilitating interoperable control of systems.

In March 2024, CEC released the solicitation, "Virtual Power Plant Approaches for Demand Flexibility (VPP-FLEX)" (GFO-23-309). The purpose of this solicitation is to fund demonstrations of community based VPP approaches and demonstrations of innovative energy management systems in commercial buildings with the goal of increasing demand flexibility. Applications will be accepted until July 1, 2024, with the anticipated notice of awards at the end of August 2024.

In August 2023, CEC requested information to help develop a solicitation based on EPIC 4 Topic 14: Direct Current Systems for Efficient Power Delivery. A solicitation is currently under development and will be released in 2024.

Strategic Initiative: Transportation Electrification

Progress and Success Stories

EPIC-funded transportation electrification projects have been extremely successful in attracting follow-on investment from governmental agencies at both the state and federal levels in 2023. Two second-life battery companies, Smartville (EPC-19-038, EPC-22-003, & EPC-23-016) and Rejoule (EPC-19-055), were each awarded $10 million through the U.S. DOE's Office of Clean Energy Demonstrations for demonstration projects in Justice40 communities. Smartville's latest $1.5 million EPIC award (EPC-23-016) involves a $6 million cost share with U.S. DOE funds for a first-of-its-kind demonstration project in the City of San Joaquin that provides a second life for EV batteries, achieves a system cost target of $100/kWh, and fosters closer collaboration with U.S. DOE on EV battery end-of-life research topics.

Rejoule was one of the winners of the U.S. DOE's Solar Energy Technology Office's American-Made Solar Prize competition. The competition seeks to develop a quick new method for testing the health of decommissioned EV batteries, thereby enabling their function as energy storage solutions with the ability to dispatch at peak hours. Rejoule's American-Made Solar Prize proposal also won the optional Justice, Equity, Diversity, and Inclusion Contest within the

main competition that recognizes solutions targeted at solar market barriers faced by underserved communities.[4]

EPIC recipients supporting the buildout of MHD charging infrastructure in California and nationwide also leveraged EPIC funds to attract additional investment from state and federal government agencies. WattEV (EPC-21-006) in late 2023 and early 2024 received a total of $109 million in public funding. Of this total, the U.S. Federal Highway Administration awarded $75.6 million for the construction of three additional commercial electric truck charging depots along crucial freight transportation corridors in California, in partnership with the San Joaquin Valley Air Pollution Control District (APCD) and the City of Blythe. Notably, these grant awards were the largest financial allocation in the 2023-2024 U.S. Federal Highway Administration's grant cycle for any individual charging infrastructure developer in the nation. Another EPIC recipient, TA Operating LLC (EPC-20-042), whose MHD charging station was originally supported with a $4 million EPIC grant, recently received a $27.7 million grant from the California Transportation Commission to build seven MHD charging stations in southern California.

Impediments and Setbacks

For transportation electrification projects, the effects of the COVID-19 pandemic are still causing challenges. The primary obstacle to projects progressing in a timely fashion has been supply chain constraints. These constraints have led to long lead times for critical customer-side electrical equipment (e.g., AC switchgear), especially on MHD EV charging infrastructure projects, causing delayed construction and agreement term extensions.

Various project requirements, including state and local regulations, IOU incentive program requirements, and engineering certifications, have also caused delays. MHD EV charging projects have reported challenges navigating CPUC's Rule 21 Interconnection and Energization rules, which are currently being addressed by Rulemaking 24-01-018, as well as SCE's Charge Ready Transport Program requirements. These requirements have led to delays associated with long interconnection queue times and required utility service upgrades. Most second-life EV battery projects have encountered challenges obtaining necessary fire-safety permits from local authorities and engineering certifications (e.g., UL1974, UL9540, and UL9540A). The CEC has extended the agreement term on all but one second-life EV battery project.

It should also be noted that, while EPIC has successfully leveraged $5.2 million in funds to attract $17.6 million of federal funds to California for projects demonstrating innovative EV battery recycling and repurposing technologies, these awards and projects require a lengthy negotiation process of approximately one year with the federal agency before work can begin.

Next Steps

The CEC GFO, "Grid-Supportive Transportation Electrification" (GFO-23-306), was released on January 2, 2024. This solicitation aims to support technology innovations that can alleviate the need for expensive distribution upgrades caused by increases in unmitigated peak load as the state electrifies its transportation fleet. Regular coordination with subject matter experts from CPUC, the CEC's Clean Transportation Program, and the IOUs informed solicitation development. Staff also considered recommendations raised during the 2023 IEPR process, including the encouragement of strategies and technologies that allow more flexible or

dynamic levels of electric service, such as power control systems, to enable more projects to connect and to maximize use of available infrastructure capacity.

The GFO, "Cost Share for Federal Clean Energy Funding Opportunities" (GFO-21-901), continues to provide federal cost share opportunities for a variety of topics that include EV Battery recycling. In 2023, $1.8 million in funds under the transportation electrification initiative were allocated for cost share for applications to DE-FOA-0003120: *Bipartisan Infrastructure Law (BIL) FY23 BIL Electric Drive Vehicle Battery Recycling and Second Life Applications.* This U.S. DOE opportunity will fund innovations that improve the economics of EV end-of-life battery transportation, dismantling, and preprocessing.

Strategic Objective 4: Improve the Customer Value Proposition of End-Use Efficiency and Electrification Technologies

Introduction

EPIC funds have been critical in advancing the TRL of promising innovations in both industrial and building decarbonization. For example, several prototypes offer lower emission solutions for industrial processes that are difficult to decarbonize due to thermal or chemical conditions. In the buildings sector, low and ultra-low GWP refrigerants for various HVAC systems are poised to accelerate emissions reductions as consumers adopt more electric appliances. As many EPIC-funded building decarbonization technologies are being demonstrated in affordable housing units or have been used to promote programs that aim to accelerate the pace of energy-efficient building retrofits for residents in low-income and disadvantaged communities, these projects bring multiple benefits to bear.

Strategic Initiative: Accelerate Electrification and Improve Energy Efficiency in the Industrial Sector

Progress and Success Stories

Several grant agreements were initiated in 2023 under the CEC GFO, "Commercialization of Industrial Decarbonization" (GFO-22-301). This solicitation targeted mid- to high-temperature electrification technologies that integrate with thermal energy storage, advanced separation technologies to replace heat-driven evaporation, and emerging solutions for the concrete industry.

Three projects to highlight are Porifera (EPC-23-011), which focuses on recovery of water from pulp and paper wastewater; Element 16's (EPC-23-012) sulfur-based thermal energy storage system that can support high-temperature industrial processes and whose latest agreement represents a continuation of funding from previous EPIC investment plans; and Capture 6 (EPC-23-014), a company using direct air capture to reduce atmospheric CO_2. Capture 6 plans to use the captured CO_2 to treat effluent brine from the Pure Water Antelope Valley water treatment facility in Palmdale.

EPIC funds also advanced the TRL of two novels industrial decarbonization technologies. Nelumbo (EPC-19-025) is finalizing development of advanced coatings that reduce icing of the refrigeration coils and associated energy required for de-icing. This will advance the technology's TRL to demonstration-level. Additionally, General Engineering & Research (EPC-19-021) is finalizing the development of a prototype for magnetic refrigeration most likely to

be used in the electronics industry. Manufacturing needs in this industry require temperatures near absolute zero, and conventional cooling techniques (e.g., vapor compression) require relatively large amounts of energy. This project's technology aims to reduce energy consumption by 50 percent.

Impediments and Setbacks

Supply chain issues increased prices for materials and equipment, forcing grant recipients to reallocate funds to stay within their original budgets (EPC-19-014). Staff turnover within project teams have also been more frequent since the pandemic, as there is more demand for clean tech jobs. For agricultural projects, the heavy rain, and storms during fall 2022 and winter 2023 resulted in flooding in agricultural lands and impacted recipients' customer enrollments.

CEC expects to further emphasize the importance of community engagement for industrial decarbonization projects. Community and environmental justice stakeholders face barriers to participating in community engagement meetings for projects that may affect their community. One example is the need for meetings to be scheduled outside of community members' work hours. Another is the need for community members to have access to childcare to participate in community meetings. CEC has not been able to cover costs for meals, childcare, or compensation for participation in hosted meetings. As an EPIC administrator, the CEC is working across its portfolio of projects to address industrial decarbonization constraints to the extent feasible in the year ahead.

Next Steps

Among other efforts, the grant opportunity "Energy Efficiency and Load Flexibility in Industrial and Commercial Cold Storage Facilities" (GFO-23-301) will fund proposals that demonstrate and deploy advanced energy efficiency and load reduction technologies in industrial and commercial cold storage facilities, enable load shifting capabilities, and gather real-world energy data to help existing and planned cold storage and refrigeration facilities. The solicitation was released in late 2023, and award announcements are anticipated in spring 2024.

Strategic Initiative: Accelerate Electrification and Improve Energy Efficiency in the Building Sector

Progress and Success Stories

In 2023, the CEC allocated over $30 million across three grant opportunities under the Building Decarbonization Initiative to enhance end-use efficiency and advance electrification technologies. First, funds supported projects targeting large building HVAC systems under grant opportunity "Decarbonizing Heating, Ventilation, and Air Conditioning Systems in Large Buildings" (GFO-22-308). Funding was also geared towards zero-carbon prefabricated homes in the grant opportunity "Advanced Prefabricated Zero Carbon Homes" (GFO-22-305). Finally, the funds supported electrification without requiring electrical infrastructure upsizing in the solicitation "A Decision Tool to Electrify Homes with Limited Electrical Panel Capacity" (GFO-23-303). Additionally, the program provided half a million dollars in matching funds for California entities pursuing federal research opportunities.

EPIC-funded research in building decarbonization directly informs development and updates to CEC's triennial Title 24 Building Codes. Last year, EPIC helped shape the 2025 Building Code currently under development by contributing to the updating of standards from the American Society of Heating, Refrigerating, and Air-Conditioning Engineers (ASHRAE). Specifically, project results informed updates on ceiling fan controls in the Building Code and ASHRAE Standard 216 (EPC-16-013) and updates to HVAC control sequences in ASHRAE Guideline 36 (EPC-19-030).

Other EPIC-funded projects under this initiative helped evaluate and demonstrate strategies to increase energy efficient building retrofits in affordable housing. In October 2022, Sonoma Clean Power Authority, as part of its Lead Locally (EPC-17-041) project, held the grand opening of its AEC, which showcases electrification technologies and opportunities and offers potential customers the opportunity to demo certain technologies, assistance with paperwork for rebates, and access to a network of qualified contractors to install technologies. The AEC had over 4,500 guests, paid out over $3.3M in rebates through 1,330 projects, and issued more than 170 loans through its 0 percent financing program, delivering over $1.3M from October 2022 through December 2023. In addition, RMI's Mass Deployment of Energy Efficiency Retrofits in Disadvantaged Communities project (EPC-17-040) demonstrates standardized energy efficiency retrofit packages, specifically geared toward the low-income multifamily housing market, that can be scaled to drive down costs.

While most of the retrofits involved in this project were completed in 2022, notable project updates in 2023 included the publishing of *Energy Service Agreements for Deep Efficiency and Electrification Retrofits of Affordable Multifamily Housing in California*. The publication provides research findings from RMI's pilot project and potential solutions to address financial barriers to deep-energy retrofits in multifamily housing. RMI has used this pilot project in its development of REALIZE, a market facilitation platform that seeks to establish high-volume, net-zero, carbon retrofit delivery programs across the United States, funded by multiple awards from the U.S. DOE's Building Technologies Office.[1] Market facilitation activities have included aggregating retrofit demand while coordinating the supply chain to deploy high-quality, prefabricated retrofit packages that are easy to install and financed through utility cost savings. California's component of this program, REALIZE-CA, launched in fall of 2023 and aims to retrofit 10,000 affordable housing units.

EPIC investments have also produced progress in developing the future of all-electric heating and cooling in California. EPRI is developing a zero-GWP heat pump and distribution system for all-electric heating and cooling. At the Energy Transition Coordinating Council's 2023 Emerging Technology Summit, EPRI presented the successful use of a high-pressure CO_2 liquid pump for circulating supercritical CO_2. By adopting this design, the project paves the way for commercial deployment of various low- and zero-GWP natural refrigerants that balance safety and efficiency considerations.

EPIC funding has also helped UC Davis demonstrate affordable low and ultra-low GWP heat pumps at various TRLs. The ultra-low GWP solution incorporates an innovative heat exchanger in the secondary loop to improve its efficiency, enabling use of hermetically sealed ultra-low GWP flammable refrigerants in heat pumps. This technology was recently featured in the paper, "High Efficiency 3-D Printed Microchannel Polymer Heat Exchangers for Air Conditioning Applications," in *Science and Technology for the Built Environment*, the research journal for ASHRAE. The paper won the journal's Best Paper Award of the 2022-2023 Volume Year. In

May 2023, this project team received a $3.5 million award from ARPA-E to incorporate this technology into the development of a suite of holistic thermal management solutions to be used in a modular data center.

The Association for Energy Affordability (EPC-19-030) is testing the performance of large capacity central heat pump water heaters using low-GWP CO_2 refrigerant at five multifamily buildings located in low-income communities. The central heat pump water heating systems have been successfully installed at three sites to date. Performance data is being captured, and two additional sites are under construction. Initial system performance, noise, and other issues have been resolved at the three completed sites. The research team has already completed one round of performance testing at one of the sites, and initial performance data indicates that the heat pump water heater systems are performing at or above expected efficiencies.

The research team is assessing the potential to return recirculated water to different locations within the storage system to improve efficiencies even further. The results of the first test were promising, indicating that it may be possible, and even more efficient, to eliminate the swing tank for some central heat pump water heater systems. Based on the successful outcomes of this initial testing, a second round of testing will begin soon to verify the results, and manufacturers are already looking to develop updated product offerings that could be ready for market later in 2024. The Association for Energy Affordability is also testing two low-GWP prototype, regular-capacity central heat pump hot water heaters at two sites (EPC-19-032) with ongoing measurement and verification data collection at the second site. Measurement and verification data collection is also expected to start at the first site in 2024, as residents begin to move into the apartments. Lastly, included under this agreement, a third type of low-GWP central heat pump hot water heater built by SystemAir will be tested and demonstrated in a vacant unit in 2024.

Impediments and Setbacks

The CEC's building decarbonization efforts have encountered three common challenges. The first challenge stems from potential budget overruns in larger projects, including from inflation. This situation can prompt demonstration sites to reconsider their participation, perceiving the project as no longer cost-effective without an increase in grant funding. Without financial incentives, tenants or property owners may feel less inclined to agree to have equipment that has not been fully tested installed in their buildings, and less willing to work through the logistical and technical inconvenience of coordinating with a research team entering their property.

The second challenge results from a lack of funding for ongoing technical support at project sites after the conclusion of a project, as this hinders or prevents regular maintenance on the equipment and can cause reversals in technology deployment. Multiple instances have occurred in which demonstration sites chose to replace experimental equipment with commercially available alternatives, even after impressive initial performance has occurred.

The third challenge involves engaging stakeholders in a way that maintains the confidentiality of research concepts while soliciting valuable input from them. An effective solution is the recent CEC practice of publishing draft research concepts and seeking public input before finalizing the development. This method significantly enhances the CEC's ability to collaborate

with stakeholders and industry groups, fostering transparency and incorporating diverse perspectives in the research process.

Next Steps

Four projects are currently in development under the grant opportunity, "Decarbonizing Heating, Ventilation, and Air Conditioning Systems in Large Buildings" (GFO-22-308). Notably, the solicitation mandates that all large building HVAC systems use a refrigerant with an ultra-low GWP of less than 10, which is highly ambitious for large building systems.

Four projects are also in development under grant opportunity, "Advanced Prefabricated Zero Carbon Homes" (GFO-22-305). The intent of this solicitation is to develop, test, and demonstrate zero-carbon or near-zero-carbon prefabricated homes that can be readily deployed, particularly in under-resourced communities and tribal nations. The solicitation aims to incorporate energy efficiency solutions at the factory that, when combined with new manufacturing processes, will lower production costs, and make these homes more affordable.

The grant opportunity, "A Decision Tool to Electrify Homes with Limited Electrical Panel Capacity" (GFO-23-303), will announce its awarded projects in spring 2024. Projects under this solicitation will develop and demonstrate a decision tool that can provide homeowners with detailed information on their electricity use and panel capacity to identify pathways, whenever feasible, to electrify their homes without the need for expensive electrical panel upgrades.

Strategic Objective 5: Enable Successful Clean Energy Entrepreneurship Across California

Introduction

Ten years ago, private sector investors had largely withdrawn from the cleantech sector. Venture capital investment dropped significantly as investors learned new energy technologies had longer development timelines and higher capital needs than software start-up ventures did. New models for delivering clean energy technologies were needed. In 2016, the CEC launched an initiative called the California Energy Innovation Ecosystem to support new clean energy technology ventures that could meet the requirements of the private sector. The ecosystem has been highly successful, providing entrepreneurs with access to the networks, funding opportunities, mentoring, facilities, and expertise needed to take their inventions from idea to commercialization and scale.

Progress & Success Stories

In 2023, entrepreneurial support continued to successfully mobilize resources to help innovators in California to advance their technologies (Strategic Objective 5) while creating new economic opportunities for disadvantaged and low-income communities.

The projects that comprised the entrepreneurial ecosystem include CalSEED, CalTestBed, four Regional Energy Innovation Clusters – Southern California Energy Innovation Network, Los Angeles Cleantech Incubator, Activate, and BlueTech Valley, Bringing Rapid Innovation Development to Green Energy (BRIDGE), and Realizing Accelerated Manufacturing and Production (RAMP). In 2023, these programs continued to recruit and support remarkable entrepreneurs working on a wide range of clean energy innovations throughout the year. By the close of 2023, these programs supported more than 340 companies. Collectively, these

companies have attracted nearly $4 billion in follow-on private investment, and they employ over 6,000 people.

In 2023, CalSEED and CalTestBed conducted their latest rounds of open solicitations. CalSEED awarded $4 million to 27 companies developing innovative concepts in areas that include LDES, non-vapor compression cooling, and end-of-life battery recycling. CalTestBed added 18 companies to its program and will provide approximately $5 million in testing vouchers. This latest cohort of companies is developing innovations in areas such as early wildfire detection, circuit level energy management, and battery management optimization.

In 2023, the CEC also issued two rounds of RAMP solicitations. Both solicitations sought applicants in four categories: energy efficiency, end-use electrification, energy storage, and renewable generation. In March 2023, seven round-one applicants were awarded a total of $19.3 million in EPIC funds, with more than $22 million provided in match funds. In August 2023, staff posted a round-two solicitation. 50 applications were received; nine awards for an additional $23 million in EPIC funds and $30 million in match funds will be recommended for approval at an upcoming CEC business meeting in 2024. These RAMP award recipients are advancing diverse clean energy technologies to the Low-Rate Initial Production stage, which is a critical step in moving from hand-built prototypes to final products that can be commercialized at scale.

Some notable success stories from the 2023 entrepreneurial support portfolio include:

- Antora Energy: This company is developing a zero-carbon, flexible CHP system that can support industrial decarbonization. Antora's technology uses renewable energy to resistively heat a low-cost storage medium. That thermal energy is stored and can be provided on-demand in the form of process heat, up to 1,500 degrees Celsius, or as electricity through use of Antora's novel TPV heat engine. In 2023, Antora achieved two major milestones with the support of EPIC funding; it brought online its first pilot-scale system at an industrial facility in Fresno County, and it commissioned a pilot production line capable of producing 2MW of TPV cells per year in Sunnyvale, California.
- Calion Technologies: This Danville-based company is developing a zero global warming potential, carbon-negative heat pump using non-vapor compression technology that can serve as drop-in replacement. Vapor-compression technology has dominated cooling and heat pumping for over 100 years by using harmful refrigerants. Calion's refrigeration technology eliminates these refrigerants by using salt and water. By modulating the ion concentration in a liquid mixture, Calion's zero-emission technology cools without forming harmful vapors and eliminates the need for refrigerants. Additionally, its thermodynamic cycle is more efficient, helping to reduce cooling costs.
- Sea Dragon Energy: An innovative company based in San Diego is developing an energy management system (mPower) for homeowners to monitor and control circuits using their existing circuit breaker panel. When inserted into an existing circuit breaker panel, mPower's smart architecture allows it to be tailored to any specific number of breakers at an affordable cost. This innovation can support electrification while avoiding potentially costly infrastructure and panel upgrades.
- BioZen Batteries: This Santa Barbara start-up is developing a low-cost, carbon-based redox-active electrolyte fluid for redox flow batteries. Current dominant battery

technologies use lithium, heavy metals, and corrosive chemistries, with challenges of different degrees related to flammability, toxicity, sustainability, affordability, and scalability. Flow batteries with BioZen redoxolytes are longer lasting, which translates to a more stable, resilient, renewables-integrated grid resource that can reduce energy costs to ratepayers while preserving the environment. This cutting-edge technology has the potential to significantly reduce the cost of deploying long-duration redox flow battery energy storage on the grid, thereby significantly decreasing the pollution burden and increasing energy resilience in underserved communities.

- ExPost Technology: This La Jolla-based company is developing a reuse and recycling process for end-of-life lithium-ion batteries to conserve critical materials, reduce environmental impacts, and lower material costs of new battery manufacturing. ExPost Technology's process, known as the Purification and Regeneration Integrated Materials Engineering, or PRIME, allows for the efficient regeneration of vital cathode active materials from both manufacturing scraps and spent batteries.
- Stasis Energy Group: This company is developing a first-of-its kind phase change material for use in line with an existing HVAC system to shift peak load, thereby lowering ratepayers' energy bills. Stasis' Thermal Energy Storage System (TESS) has been tested in 11 commercial buildings with more than half of the demonstration sites located in disadvantaged or low-income communities. These installations have recorded significant peak load reduction without a loss in user comfort. In addition to shifting peak load, the cloud-connected controller can optimize thermal storage use, manage comfort settings for building occupants, and provide real-time and historical data on installed units.

Impediments and Setbacks

Broadly, projects have faced hiring challenges, various supply chain issues, and existing ratepayer incentive program gaps. Recipients have reported concerns about commercial viability due to the lack of incentives for California electricity ratepayers to invest in load-shifting technology, even with low-cost solutions available. This gap in end-user incentives may pose future barriers for consumer adoption.

While California continues to generate record amounts of low-cost renewable energy, easy access to the cheapest energy, predominantly midday solar generation that is often curtailed, remains a challenge for many clean energy developers. This low-cost resource can be critical in allowing clean energy technologies, particularly in industrial electrification applications, to compete with incumbent fossil-based technologies. Without easy access to low-cost clean electricity, electric technologies will struggle to compete with fossil-based alternatives.

Additionally, local communities' concerns with new energy projects, at least initially, coupled with the difficulties of communicating the benefits of complex energy projects with multiple components, stands out as a significant roadblock.

Next Steps

The CEC will release the next round of its BRIDGE solicitation in Q2 of 2024 – which provides funding for the most promising energy technologies that have previously received an award from an eligible CEC program or U.S. federal agency. BRIDGE seeks to help start-up companies minimize the time between when their successful publicly funded project ends and new public funding becomes available; and mobilize more early-stage capital in the clean energy space by providing non-dilutive, matching investments in promising clean energy companies alongside investors and commercial partners.

CalSEED and CalTestBed will conduct their next open solicitation rounds for their respective programs, and the four innovation clusters will also continue to recruit and solicit clean energy entrepreneurs to participate in their respective programs.

Strategic Objective 6: Inform California's Transition to an Equitable, Zero-Carbon Energy System that is Climate-Resilient and Meets Environmental Goals

Introduction

Climate resilience and environmental sustainability are key priorities for California. EPIC has leveraged over $24 million this past year to ensure health, equity, and climate considerations are considered during California's clean energy transition.

Progress and Success Stories

EPIC recipients and agreement managers engaged stakeholders to support execution of ongoing agreements, to integrate research findings and data products into clean energy transition efforts, and to inform future investments. Highlights include hosting a workshop series on climate resiliency in grid planning processes, taking initial steps toward integrating climate change into California's Energy Demand forecast as part of the 2023 IEPR cycle, developing climate projections through Cal-Adapt, and conducting multiple public workshops on a variety of environmental topics, including fire spread modeling, hydropower, and environmental sustainability of the clean energy transition.

Using funding from the EPIC solicitation, "Advancing California's Electricity Resource Planning Tools to Assess and Improve Climate Resilience" (EPC-22-001), Lumen Energy Strategy conducted a series of workshops hosted by CPUC to identify, analyze, and integrate resiliency needs within California's electric grid planning process. Lumen's project is focused on modernizing electricity resource planning and resilience assessment by integrating data and methods that reflect deep renewables penetration and the changing climate. In addition to data and tools integration, the project also targets institutional barriers to planning for energy climate resilience. The work includes contributions to the state's 2023 energy demand forecast through re-parameterization of forecasting tools in direct collaboration with the CEC's demand forecast team and development of a novel probabilistic loss-of-load resilience evaluation model developed in consultation with utilities and other stakeholders. The CEC expects development to continue over the next year with collaboration from its supply analysis branch. In addition to cross-division collaboration at CEC, the project exemplifies advances in cross-grant collaboration; Lumen's work leverages several other EPIC grant efforts and, with those

grantees, pioneers advance in "real-time," data-driven contributions to state decision-making processes.

In addition to Lumen's integral contributions to the demand forecast, the CEC has taken initial steps toward integrating climate change into California's Energy Demand forecast as part of the 2023 IEPR cycle, and EPIC projects have made progress in informing other climate policy reports and plans. For example, EPIC solicitation "Development of Climate Projections for California and Identification of Priority Projections" (EPC-20-006) funded research at UCSD's Scripps Institution of Oceanography that contributed to the State of California Sea-Level Rise Guidance Update by the Ocean Protection Council. This guidance update incorporates EPIC research results for hourly sea-level projections at 13 stations along the California coast, San Francisco Bay, and Delta. Another EPIC-funded subrecipient, Eagle Rock Analytics (EPC-18-026), worked with PG&E to identify gaps in the utility's weather station network used for risk management, including fire scenarios, and situational awareness, leading PG&E to add weather stations in its service territory and informing PG&E's 2023 Wildfire Mitigation Plan.

Staff held a wide variety of workshops to further the CEC's priority of valuing public and stakeholder feedback. The CEC convened multiple meetings of the Climate Data and Analysis Working Group to share progress on development of climate projections, updates on historical weather data, analytical approaches to support use of data, and availability of open data products through the Cal-Adapt Analytics Engine. Cal-Adapt is a web-based visualization tool designed to provide localized information on multiple climate risks (EPC-20-007). Additionally, the CEC shared results of an open-source, near-term, EPIC-funded wildfire spread model through a June 2023 public workshop. Scoping workshops were also held to support the development of two EPIC solicitations, one funding investigation into the potential environmental impacts of electrification retrofits in California homes, and the other funding research into the environmental sustainability of the clean energy transition. Finally, the CEC participated in multiple climate and environmental workshops and CPUC proceedings to provide knowledge-sharing on related EPIC-funded research.

Impediments and Setbacks

Access to climate data is essential for advancing EPIC environmental research. Expense and challenging logistics have presented obstacles in making use of IOU weather station data that supports reliability and resilience planning. Despite discussion at an EPIC wildfire deep dive meeting in June 2022, wherein IOU and CPUC participants expressed nominal support for making these data readily available for integration into the Cal-Adapt platform, data remain behind a paywall and are not amenable to integration into Cal-Adapt on a continuous basis. With these experiences in mind, coordination across grants and with stakeholders toward integration of climate data products into planning and investment processes can be prohibitively time-consuming and expensive and needs stronger support.

Next Steps

On March 13, 2024, the Commission approved a $3,500,000 solicitation with Eagle Rock Analytics, Inc., entitled "Cal-Adapt: Analytics Engine - Scaling up to Enhance Digital Platform, Accelerate Production of Data Products, & Expand User Base" (EPC-23-024), to build on prior EPIC achievements to cost-effectively advance the co-production of new analytical features, user capacity, and guidance of the Cal-Adapt Analytics Engine. The goal of this project is to

overcome interdisciplinary knowledge and capacity gaps among climate science, information technology, and electricity sector practitioners. The project will allow for IOUs, electricity sector stakeholders, government decision makers, and researchers to use actionable, curated climate data tailored for resilience planning. Moreover, it will transition the Cal-Adapt enterprise from one that makes high-quality climate data available for download and visual exploration to an effort that supports the actual application of cutting-edge data and analytics to resilience planning and investments.

For the upcoming round of EPIC 4 funding, the CEC is working to release four solicitations in the first half of 2024. These solicitations include:

- Non-energy Impacts and Process Evaluation of Integrated Energy Retrofit Packages in California's Residential Buildings,
- Modeling and Monitoring Air Quality and Co-Benefits of Energy Interventions to Inform a Clean and Equitable Energy Transition,
- Environmental Sustainability of Clean Energy Transitions, and
- Advancing Precipitation Enhancement.

Two additional solicitations will enter the scoping phase later in 2024, with anticipated release by early 2025:

- Evaluating Air Quality and Affordability Dimensions of Residential Electrification.
- Priority topics (to be determined) related to supporting a resilient, reliable, and affordable clean energy transition.

CHAPTER 4: Conclusion

Key Results for the Year

The historic availability of funding in 2023 resulted in an exceptional year for the EPIC program. EPIC activities have continued to make progress concluding project agreements funded under prior investment plans while concurrently planning, scoping, and disbursing grant opportunities detailed in the CEC's EPIC 4 investment plan. In addition, many companies and projects funded in prior years began to achieve technology validation, at-scale deployment, early-stage manufacturing, and product commercialization.

As shown in Table 7 in Chapter 2, EPIC has encumbered $134,167,400 of $632,774,000 of approved plan project funds allocated in the Interim and 2021-2025 investment plans. As outlined below, the CEC has a series of solicitations in progress and plans to encumber the remaining funds on schedule. Below are highlights from the past year's program activities.

- 24 EPIC projects were completed by grant awardees.
- Almost half of EPIC funding granted was awarded to small- and medium-sized businesses.
- $1.5 million in on-bill energy cost savings was generated through 18 EPIC-funded projects across the state, including in under-resourced communities.
- More than 2,000 single-family and multi-family residential units in California involve building electrification efforts funded by 20 EPIC projects.
- More than 4,000 subsequent deployments of clean energy technologies resulted from 22 EPIC-funded demonstration projects.
- 18 EPIC-funded projects reported approximately 16,854 metric tons of avoided (CO_2) equivalent emissions savings in 2023.
- Four EPIC award recipients reported that their EPIC projects had generated more than $10 million in revenue, each.

Issues

Some key challenges across the portfolio may continue to have major impacts on project progress in the year ahead and years to come. Persistent supply chain issues may continue to cause delays, as grantees struggle to obtain necessary equipment to manufacture their products or implement their projects. Similarly, inflation and rising costs may also inhibit headway, as projects and companies accommodate budget shifts and unforeseen needs to raise money. Grant recipients that have experienced previous difficulties hiring technical staff and contractors in a post-COVID economy anticipate those issues to continue. Other challenges that may impact progress involve regulatory and permitting barriers, particularly related to battery storage safety and grid interconnection.

Next Steps for the EPIC Investment Plan

EPIC Funding Opportunities in 2024

In 2024, CEC anticipates releasing solicitations for EPIC funding opportunities that advance the state's transition to clean energy. Table 8 summarizes the anticipated 2024 EPIC funding opportunities. Anticipated solicitations are posted on the CEC funding webpages.[16]

Table 8: EPIC 2024 Funding Opportunities

Title	Anticipated Release Dates
Geothermal Energy Operations and Lithium Innovation (GEO/LI)	January 18, 2024
Advancing Precipitation Enhancement in California	February 2024 - May 2024
DC HVAC Nanogrid Module Development and Demonstration	March 2024 - June 2024
EPIC 4 Building End-Use Electrification solicitation	March 2024 – June 2024
Bringing Rapid Innovation Development to Green Energy (BRIDGE) 2024	March 2024 - June 2024
Grid Modernization Research	March 2024 - June 2024
Clean, Dispatchable Generation	March 2024 - June 2024
Modeling and Monitoring Air Quality and Co-Benefits of Energy Interventions to Inform Clean and Equitable Energy Transition (MAQCEET)	March 2024 - June 2024
Industrial, Agriculture, and Water Flexible Demand Research and Deployment Hub	March 2024 - June 2024
Non-Energy Impacts and Process Evaluation of Integrated Energy Retrofit Packages in California's Residential Buildings	March 2024 - June 2024
Energy Storage Innovations to Support Grid Reliability	April 2024 - July 2024
Enviro-SET: Environmental Sustainability of Clean Energy Transitions	April 2024 - July 2024
Emerging Solar Energy Technologies (EPIC IV)	May 2024 - August 2024
Evaluating Air Quality and Affordability Dimensions of Residential Electrification	June 2024 - September 2024
Transportation Electrification 2	June 2024 - September 2024

16 CEC 2024 Anticipated Solicitations. https://www.energy.ca.gov/funding-opportunities/solicitations?field_solicitation_status_target_id%5B37%5D=37&field_solicitation_type_target_id=All&field_division_1_target_id=All (filter status for "Anticipated/Upcoming")

Title	Anticipated Release Dates
Residential Envelope Technology Retrofit Opportunity for Value Proposition Improvement (RETRO-VPI)	August 2024 - November 2024
DIR–CT - Developing Infrastructure for a Resilient, Efficient grid using direct-Current based Technologies	August 2024 - November 2024

Source: California Energy Commission staff

CPUC Commissioners voted to adopt the strategic goals for EPIC 5 in March 2024.[17] Presently, the CPUC is working to convene in-person Technical Working Groups to develop the EPIC 5 strategic objectives and the new impact analysis framework that EPIC administrators will use to measure the progress of EPIC 5 investments. These technical working group meetings will take place between April and June, and CPUC staff expect to issue the proposed strategic objectives to CPUC commissioners for adoption between July and September 2024. The proposed decision on the EPIC 5 strategic objectives and uniform impact analysis framework is expected between October and December 2024. After the CPUC adopts the proposed strategic objectives, CEC staff will begin developing the EPIC 2026-2030 investment plan based on the adopted objectives, which will then be submitted for approval to CPUC in October 2025.

Conclusion

The CEC looks forward to building on successes to date and further accelerating clean energy innovation in the development pipeline, which will enable California to meet its clean energy mandates and aspirations more quickly, effectively, and efficiently. EPIC investments provide critical validation to policy makers, private sector investors, and customers of the performance, cost savings, and safety of new clean energy technologies. Results generated through EPIC, a publicly funded research program, can also increase the pace of innovation and technology scale-up across public and private sectors by sharing lessons learned broadly and openly.

17 CPUC Decision 24-03-007.

LIST OF ACRONYMS

Acronym	Spelled Out Term
AB	Assembly Bill
ARCHES	Alliance for Renewable Clean Hydrogen Energy Systems
ARD	Applied research and development
ARPA-E	Advanced Research Projects Agency-Energy – a United States Department of Energy Program advancing high-impact energy technologies by providing funding, technical assistance, and market readiness
ASHRAE	American Society of Heating, Refrigerating and Air-Conditioning Engineers
BIL	Bipartisan Infrastructure Law
BTM	Behind-the-meter
BRIDGE	Bringing Rapid Innovation Development to Green Energy
California ISO	California Independent System Operator
Caltrans	California Department of Transportation
CARB	California Air Resources Board
CalSEED	California Sustainable Energy Entrepreneur Development Initiative
CCA	Community choice aggregators
CEC	California Energy Commission
CHP	Combined heat and power
CO_2	Carbon dioxide
CPUC	California Public Utilities Commission
DACAG	Disadvantaged Community Advisory Group
DC	Direct Current
DER	Distributed Energy Resources
Disadvantaged community	A community that scores at or above 75 percent in the version of CalEnviroScreen that was available at the time of project application.
DVC	Disadvantaged vulnerable community
EASE	Electric Access System Enhancement
EPIC	Electric Program Investment Charge

Acronym	Spelled Out Term
EPRI	Electric Power Research Institute
ERDD	Energy Research and Development Division
ESJ	Environmental Social Justice
ETCC	Emerging Technologies Coordinating Council
GEO/LI	Geothermal Energy Operations and Lithium Innovation
GW	Gigawatt
IEPR	Integrated Energy Policy Report
GFO	Grant funding opportunity
GO-Biz	Governor's Office of Business and Economic Development
GWP	Global Warming Potential
HVAC	Heating, ventilation, and air conditioning
IoT	Internet of Things
IOU	Investor-owned utility
JLBC	Joint Legislative Budget Committee
LCOE	Levelized cost of energy
LDES	Long duration energy storage
LGBTQ	Lesbian, gay, bisexual, transgender, and queer
MHD	Medium- and heavy-duty
MOU	Memorandum of understanding
NETC	National Emerging Technologies Collaborative
NOPA	Notice of proposed award
NOWRDC	National Offshore Wind Research and Development Consortium
NREL	National Renewable Energy Laboratory
PG&E	Pacific Gas and Electric Company
PICG	Policy + Innovation Coordination Group
PV	Photovoltaic
RAMP	Realizing Advanced Manufacturing and Production for Clean Energy Technologies
RFI	Request for information
SB	Senate Bill

Acronym	Spelled Out Term
SCE	Southern California Edison Company
Title 24 Energy Code	California Code of Regulations, Title 24, Parts 6 and 11
TD&D	Technology demonstration and deployment
TPV	Thermophotovoltaic
TRL	Technology readiness level
U.S. DOE	United States Department of Energy
U.S. DOD	United States Department of Defense
VGI	Vehicle-to-grid-integration
VPP	Virtual power plant

GLOSSARY

For additional information on commonly used energy terminology, see the following industry glossary links:

- California Air Resources Board Glossary, available at https://ww2.arb.ca.gov/about/glossary
- California Energy Commission Energy Glossary, available at https://www.energy.ca.gov/resources/energy-glossary
- California Public Utilities Commission Glossary of Acronyms and Other Frequently Used Terms, available at https://www.cpuc.ca.gov/glossary/

Advanced Research Projects Agency-Energy (ARPA-E): a United States Department of Energy Program advancing high-impact energy technologies by providing funding, technical assistance, and market readiness.

Alliance for Renewable Clean Hydrogen Energy Systems (ARCHES): A public-private partnership established in 2022 that is designed to accelerate hydrogen's contribution to decarbonizing the economy in California and beyond. The alliance is governed by a representative board and key advisory committees, including environmental justice, organized labor, cities, and the public sector.

Carbon capture utilization and storage: The process of capturing carbon dioxide, either from a concentrated stream or from the atmosphere, then containing it for further use or storage.

Carbon dioxide (CO2): A naturally occurring gas, CO2, also referred to as carbon, is also a by-product of burning fossil fuels (such as oil, gas, and coal), burning biomass, land-use changes, and industrial processes (for example, cement production). It is the principal

anthropogenic greenhouse gas (GHG) that affects the Earth's radiative balance. It is the reference gas against which other GHGs are measured and therefore has a global warming potential of 1.

Carbon neutrality: carbon dioxide and other GHG emissions generated by sources such as transportation, power plants, and industrial processes must be less than or equal to the amount of carbon dioxide that is stored, both in natural sinks such as forests and mechanical sequestration such as carbon capture and sequestration. Executive Order B-55-18 established a target for California to achieve carbon neutrality by 2045 and maintain net negative emissions thereafter. For more information, see the CARB Carbon Neutrality web page.

Climate: Climate is the average course or condition of the weather at a place, usually over a period of years, as exhibited by temperature, wind velocity, and precipitation. The classical period for averaging these variables is 30 years, as defined by the World Meteorological Organization. Climate in a wider sense is the state, including a statistical description, of the climate system.

Climate change: Climate change refers to a change in the state of the climate that can be identified (for example, by using statistical tests) by changes in the mean or variability (or both) of its properties and that persists for an extended period, typically decades or longer. Climate change may be due to natural internal processes or external forcings such as modulations of the solar cycles, volcanic eruptions, and persistent anthropogenic (human-induced) changes in the composition of the atmosphere or in land use. Anthropogenic climate change is defined by the human impact on Earth's climate, while natural climate changes are the natural climate cycles that have been and continue to occur throughout Earth's history.

Anthropogenic climate change is directly linked to the amount of fossil fuel burning, aerosol releases, and land alteration from agriculture and deforestation.

Community Choice Aggregator: The term used to describe a local government that procures power on behalf of its residents, businesses, and municipal accounts from an alternative supplier while still receiving transmission and distribution service from its existing utility provider.

Decarbonization: The process by which countries, individuals, or other entities aim to reduce or achieve zero fossil carbon emissions. This typically refers to a reduction of the carbon emissions associated with electricity, industry, and transport. Decarbonization involves increasing the share of no- or low-carbon energy sources (renewables such as solar and wind) and decreasing the use of fossil fuels.

Demand flexibility: The ability of customers to reduce or increase load in response to grid conditions, usually through a proxy price signal or system operator or utility signal and facilitated by automation.

Disadvantaged community: Disadvantaged communities refer to the areas throughout California that most suffer from a combination of economic, health, and environmental burdens. These burdens include poverty, high unemployment, air and water pollution, presence of hazardous wastes, as well as high incidence of asthma and heart disease. One way that the state identifies these areas is by collecting and analyzing information from communities all over the state. CalEnviroScreen, an analytical tool created by the California Environmental Protection Agency, combines different types of census tract-specific information into a score to determine which communities are the most burdened or "disadvantaged." For

more information, see the California Office of Environmental Health Hazard Assessment's CalEnviroScreen Web page.

Disadvantaged Communities Advisory Group (DACAG): The Clean Energy and Pollution Reduction Act of 2015 (also known as Senate Bill [SB] 350) called upon the CPUC to help improve air quality and economic conditions in disadvantaged communities by, for example, changing the way the state plans the development and future operations of power plants, and rethinking the location of clean energy technologies to benefit burdened communities. In addition, SB 350 required the CPUC and the CEC to create a group representing disadvantaged communities to advise the agencies in understanding how energy programs impact these communities and could be improved to benefit these communities.

Distributed energy resource(s) (DER): Distributed energy resources are any resource with a first point of interconnection of a utility distribution company or metered subsystem.

Distributed energy resources include:

- Demand response, which has the potential to be used as a low-GHG, low cost, price-responsive option to help integrate renewable energy and provide grid stabilizing services, especially when several distributed energy resources are used in combination and opportunities to earn income make the investment worthwhile.
- Distributed renewable energy generation, primarily rooftop photovoltaic energy systems.
- Vehicle-grid integration, or all the ways plug-in electric vehicles can provide services to the grid, including coordinating the timing of vehicle charging with grid conditions.
- Energy storage in the electric power sector to capture electricity or heat for use later to help manage fluctuations in supply and demand.

Electric Program Investment Charge (EPIC): The CEC's EPIC invests in scientific and technological research to accelerate the transformation of the electricity sector to meet the state's energy and climate goals. Investments of about $150 million annually support research and development in renewable energy, energy storage, electric system resilience, and electric technologies for buildings, businesses, and transportation. For more information, see the CEC EPIC web page and the CPUC Energy Research, Development, and Deployment web page.

End use: Final applications for which energy is ultimately used, such as heating, power generation, or transportation or a combination.

Energy efficiency: Energy efficiency means adapting technology to meet consumer needs while using less energy. The CEC adopts energy efficiency standards for appliances and buildings, which reduces air pollution and saves consumers money. The CPUC regulates ratepayer-funded energy efficiency programs and works with the IOUs, other program administrators, and vendors to develop programs and measures to transform technology markets within California using ratepayer funds. For more information, see the CEC Energy Efficiency web page and the CPUC Energy Efficiency web page.

Environmental social justice: The fair treatment and meaningful involvement of all people in the development, implementation, and enforcement of environmental policies.

Equity (energy equity): Energy equity is the principle of fairness in burden sharing and is a basis for understanding how the impacts and responses to climate change, including costs and

benefits, are distributed in and by society in equal ways. It is often aligned with ideas of equality, fairness, and justice and applied with respect to equity in the responsibility for, and distribution of, climate impacts and policies across society, generations, and gender, and in the sense of who participates and controls the processes of decision-making.

Follow-on funding: This report uses the term "follow-on funding" to describe three different scenarios: 1) when a company receives subsequent funding from the CEC, stemming from a separate solicitation, 2) when a company receives subsequent EPIC funding from the CEC for a project having already received EPIC funds when the project has met the statutory criteria under Public Resources Code section 25711.5(h)(4)(A) and the CEC determines it would be more efficient to provide additional EPIC funds to an existing project than to issue a new solicitation, and 3) when a company receives subsequent funding from another government agency or private industry. This term is also colloquially a common metric of success for start-up companies.

Greenhouse gas (GHG): GHGs are those gaseous constituents of the atmosphere, natural and anthropogenic, that absorb and emit radiation at specific wavelengths within the spectrum of terrestrial radiation emitted by the Earth's surface, the atmosphere itself, and clouds. This property causes the greenhouse effect. Water vapor, carbon dioxide, nitrous oxide, methane, and ozone are the primary GHGs in the Earth's atmosphere. Moreover, there several entirely human-made GHGs in the atmosphere, such as the halocarbons and other chlorine- and bromine-containing substances, dealt with under the Montreal Protocol. Beside carbon dioxide, nitrous oxide, and methane, the Kyoto Protocol deals with the GHGs sulfur hexafluoride, HFCs, and perfluorocarbons. In response to Assembly Bill 32 (California Global Warming Solutions Act of 2006), the definition of GHGs defined in Health and Safety Code Section 38505 includes nitrogen trifluoride in addition to those defined under the Montreal and Kyoto Protocols.

Investor-owned utility (IOU): Investor-owned utilities (IOUs) provide transmission and distribution services to all electric customers in their service territory. The utilities also provide generation service for "bundled" customers, while "unbundled" customers receive electric generation service from an alternate provider, such as a CCA. California has three large IOUs offering electricity service: Pacific Gas and Electric Company, Southern California Edison, and San Diego Gas & Electric.

Low-income communities: refers to communities within California census tracts with median household incomes at or below either of the following levels: 1) 80 percent of the statewide median income or 2) the applicable low-income threshold listed in the state income limits updated by the Department of Housing and Community Development and filed with the Office of Administrative Law pursuant to subdivision (c) of Section 50093 of the Health and Safety Code.

Methane: Methane, also known as CH4, is one of the six GHGs to be mitigated under the Kyoto Protocol and is the major component of natural gas. Emissions also occur as a result of dairy and livestock operations and disposal of organics in landfills, and the management of these organics represents a major mitigation option. Methane is a short-lived climate pollutant. Unlike carbon dioxide, which lasts for about 100 years in the atmosphere, reductions of methane can create a relatively quick reduction in global warming.

Photovoltaic: refers to materials that generate an electric potential or current when exposed to sunlight.

Regional Energy Innovation Cluster: These four sites were funded by the CEC in 2016 as part of the creation of its California Energy Innovation Ecosystem and serve as physical locations to support local clean energy technology developers. Services provided onsite include research and laboratory facilities, meeting spaces to convene investors and share learnings, and immediate availability of technical and business consultation.

Series A funding: an investment in a privately held start-up company after it has shown progress in building its business model and demonstrates the potential to grow and generate revenue.

Sustainability: A dynamic process that guarantees the persistence of natural and human systems equitably.

Transportation electrification: The replacement of fossil fuels in the transportation sector with electrical power.

Utility: An organization supplying the community with electricity, gas, water, or sewerage.

APPENDICES

The following appendices are available as a separate volume (Publication Number CEC-500-2024-028-APA-D):

- Appendix A: 2023 CEC EPIC Reporting Requirements and Budget Summaries
- Appendix B: 2023 CEC EPIC Project Summary Tables by Strategic Objective and Initiative
- Appendix C: EPIC Projects Awarded through 2023 with Fiscal and Diversity Details
- Appendix D: 2023 Data for CEC EPIC Projects by Strategic Objective and Initiative