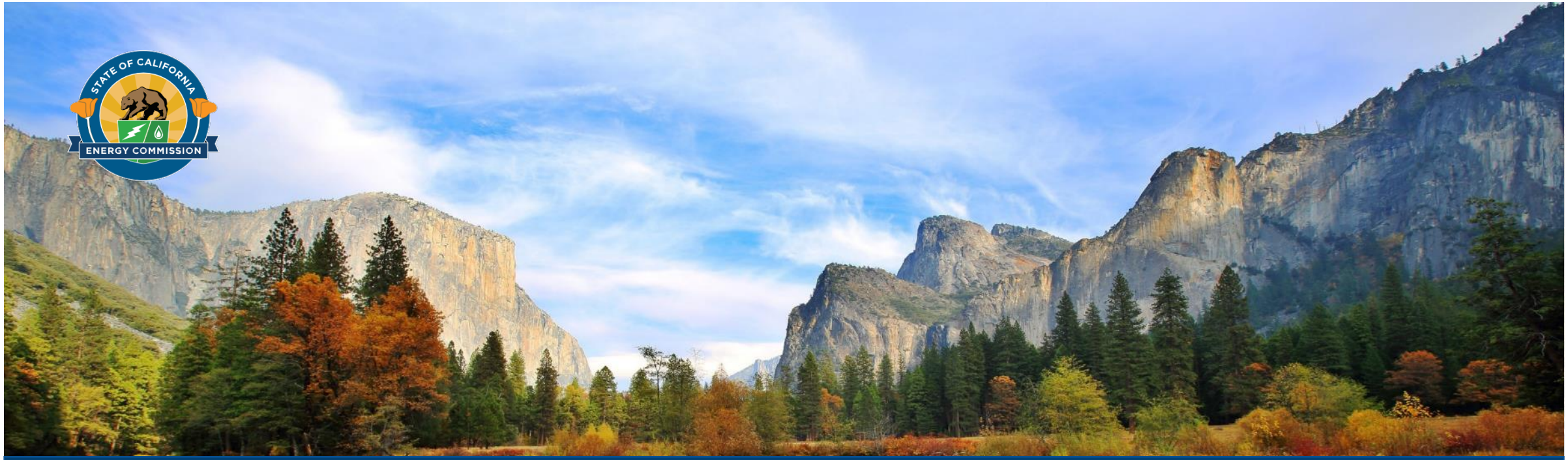

Methodologies and Tools Related to Assessing Benefits of Research and Development Investments

11-19-20

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Electric Program Investment Charge Overview

- The Electric Program Investment Charge (EPIC) supports the development of new, emerging, and pre-commercialized clean energy technologies in California.
- Funding for EPIC is provided by electric ratepayers from PG&E, Southern California Edison and SDG&E at ~$160 million/year.
- EPIC consists of three program areas: Applied Research and Development, Technology Demonstration and Deployment and Market Facilitation.
- The CEC administers EPIC along with PG&E, Southern California Edison, and SDG&E.

Fiscal 2018-19 Funding Levels for State Programs Supporting Clean Energy and Transportation Technology ($ in Millions)

Technology Category	Fundamental Research	Applied Research	Prototype	Demonstration	Commercial Deployment
Renewable Energy	$0	$20	$20	$90	$420
Energy Efficiency	$0	$20	$20	$80	$930
Clean Transportation	$0	<$2	<$2	$50	$1,080

Paul Jacobs and John Thompson (Senate Office of Research), *State Investments in Clean Energy and Transportation Technology*, 2019, p. 9. https://sor.senate.ca.gov/sites/sor.senate.ca.gov/files/policy%20matters%2003.19%20final.pdf (Accessed April 10, 2010.)

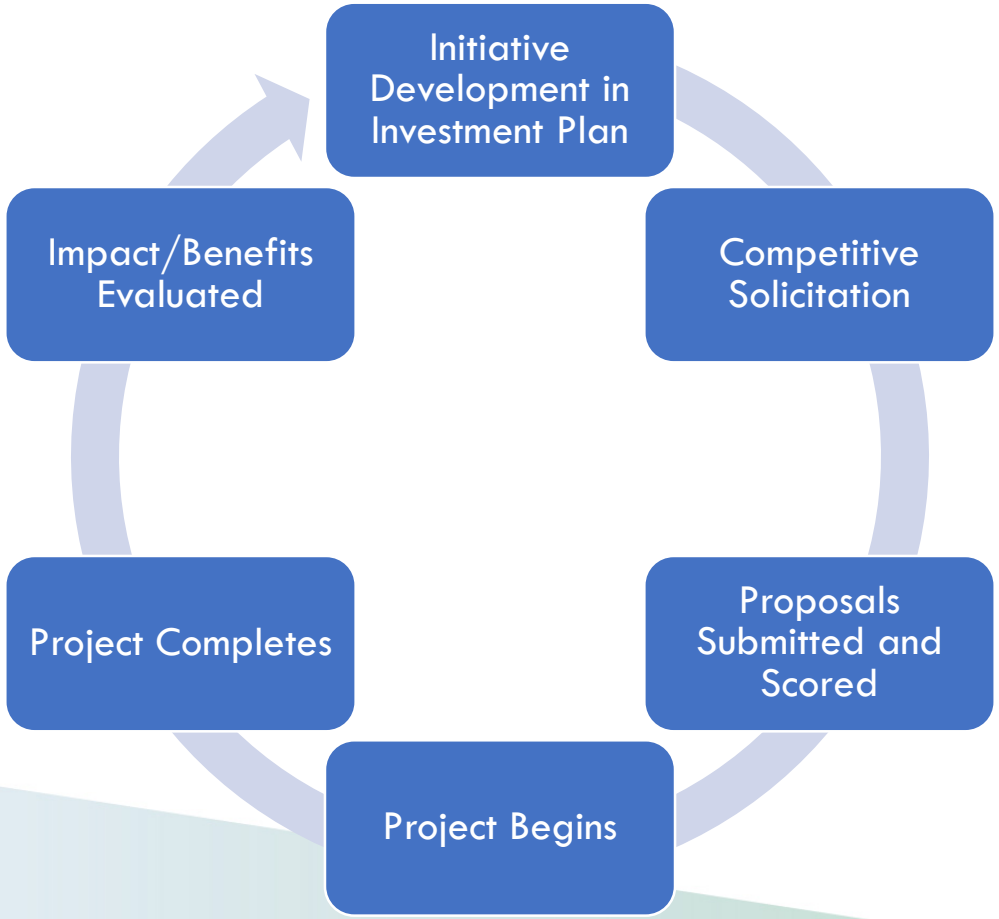
Key Policy Direction for EPIC

- **Senate Bill 96** directs the CEC to award EPIC funds for projects that will benefit electricity ratepayers and lead to **technological advancement and breakthroughs to overcome the barriers** that prevent achieving the state's statutory energy goals.

- **CPUC Decision 12-05-037** established electric ratepayer benefits as the mandatory guiding principle for EPIC along with complementary guiding principles:
  - Mandatory: Greater Reliability, Lower Costs, Increased Safety
  - Complementary: Societal Benefits, GHG emissions mitigation and adaptation in the electricity sector, Loading Order, Low-emission vehicles/transportation, Economic Development. Efficient use of ratepayer monies

- **AB 523** direct the CEC to award a minimum of 25% and 10% of Technology Demonstration and Deployment funds to project located in and benefitting Disadvantaged- and Low-Income Communities respectively.

Ratepayer Benefits is Embedded in Every Aspect of the CEC Funding Lifecycle



CEC Approach to Benefits/Impact Analysis

- Project-Level
  - Measures the scientific and technological advancement from a project.
- Portfolio-Level
  - Measures benefits to ratepayers from EPIC investments around critical portfolio topics.
  - Evaluates how EPIC projects have overcome key barriers (qualitative)
- Program-Level (Key Performance Indicators)
  - Measures the overall success and impact of the program

Project-Level Impacts

Performance Metric	Metric Category	Performance Metric Unit	Benchmark Performance	Current Project Performance	Minimum Target Performance	Goal Target Performance	Evaluation Method	Significance of Metric
Electrolyzer specific energy consumption	Energy - Energy efficiency and generation related	kWh/kg	50-70	20.00	15.00	10.00	Controlled experiment with data analysis and modeling	Reduction of specific energy consumption to levels below 15 kWh/kg H2 is necessary for this technology to have an advantage over conventional water electrolysis, with energy consumption of greater than 50 kWh/kg.
Production rate of hydrogen for energy storage	Technology - Industry standards and barriers being advanced	mA/cm^2	NA	200.00	300.00	400.00	Controlled experiment with data analysis and modeling	Increase in rate of hydrogen (and thus energy) production is necessary to ensure AES can meet the energy consumption demands of the end user. No data available for determining a benchmark performance.
Round-trip electrical efficiency	Energy - Energy efficiency and generation related	%	25-36	50.00	60.00	80.00	Controlled experiment with data analysis and modeling	A high overall roundtrip efficiency is necessary to reduce AES operating costs and ensure that AES is economically competitive.

- Other metric categories include:
  - Economic- Cost and life factors
  - Manufacturing - Quality control and production related
  - Programmatic - Goals related to data collection, outreach, and project execution

Portfolio-Level Impacts – Key Barriers

The following key is used:

- ● - successfully demonstrated the research or technology in a real-world environment in real-world conditions.
- ◒ - successfully demonstrated the research or technology in a controlled or simulated environment such as a laboratory setting.
- ○ - project has the potential to address the challenge or barrier but is still in progress.

Project	Use case(s) explored	Charger segment Vehicle segment	This project evaluated and informed standards to enable greater interoperability	This project advanced power flow algorithms for managed and/or bi-directional charging	This project developed new charger power electronics with greater functionality, efficiency, and/or safety
Demonstrating Plug-in Electric Vehicles Smart Charging and Storage Supporting the Grid (EPC-14-056)	Time-of-Use (TOU) optimization Demand reduction Vehicle-to-grid	Public, Fleet/ Light-duty	●	●	●
Smart Charging of Plug-in Electric Vehicles with Driver Engagement for Demand Management and Participation in Electricity Markets (EPC-14-057)	TOU optimization Demand reduction Proxy Demand Response (PDR) market	Public, Fleet/ Light-duty	●	●	
Next-Generation Grid Communication for Residential Plug-in Electric Vehicles (EPC-14-078)	TOU optimization	Residential/ Light-duty	●	●	
Distribution System Aware Vehicle to Grid Services for Improved Grid Stability and Reliability (EPC-14-086)	Vehicle-to-grid	Residential, Public, Workplace/ Light-duty	◒	◒	◒

Program-Level Impact (KPIs)

Impact Category	Quantifiable Impacts
Technology Development and Commercialization	• Follow-on private investment • Leveraged public funding • Number of commercialized technologies
Technology Diffusion	• Number and geographic distribution of project sites (technology learning) • Connections of stakeholders in EPIC's recipient network • Codes and Standards improved by EPIC projects
Knowledge Generation and Dissemenation	• Number of publications and citations • Number of online tools and the count of their usership • Views of final project reports • EPIC Symposium attendance
Diversity, Equity and Inclusion	• Percentage of TD&D funding in disadvantaged- and low-income communities
Economic Impact	• Economic Output (IMPLAN Analysis) • Job Growth (small- to medium-size businesses)

Estimating Direct Benefits and Projecting Long Term Impacts

- Leverage a suite of tools and analysis developed by IEc to estimate benefits that address the guiding principle of EPIC such as:
  - On-bill energy savings
  - Increased safety, reliability, and resiliency
  - Green house gas reductions
  - Increased equity
  - Improvements in cost of technology

Thank You

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