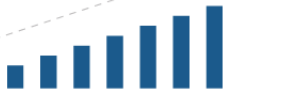
Methodologies and Tools Related to Assessing Benefits of Research and Development Investments

Colleen Kredell
Energy Research & Development Division
April 02, 2024

California Energy Commission

PRIMARY FUNCTIONS OF THE

CALIFORNIA ENERGY COMMISSION



Advancing State Energy Policy

Investing in Energy Innovation

Developing Renewable Energy

Preparing for Energy Emergencies

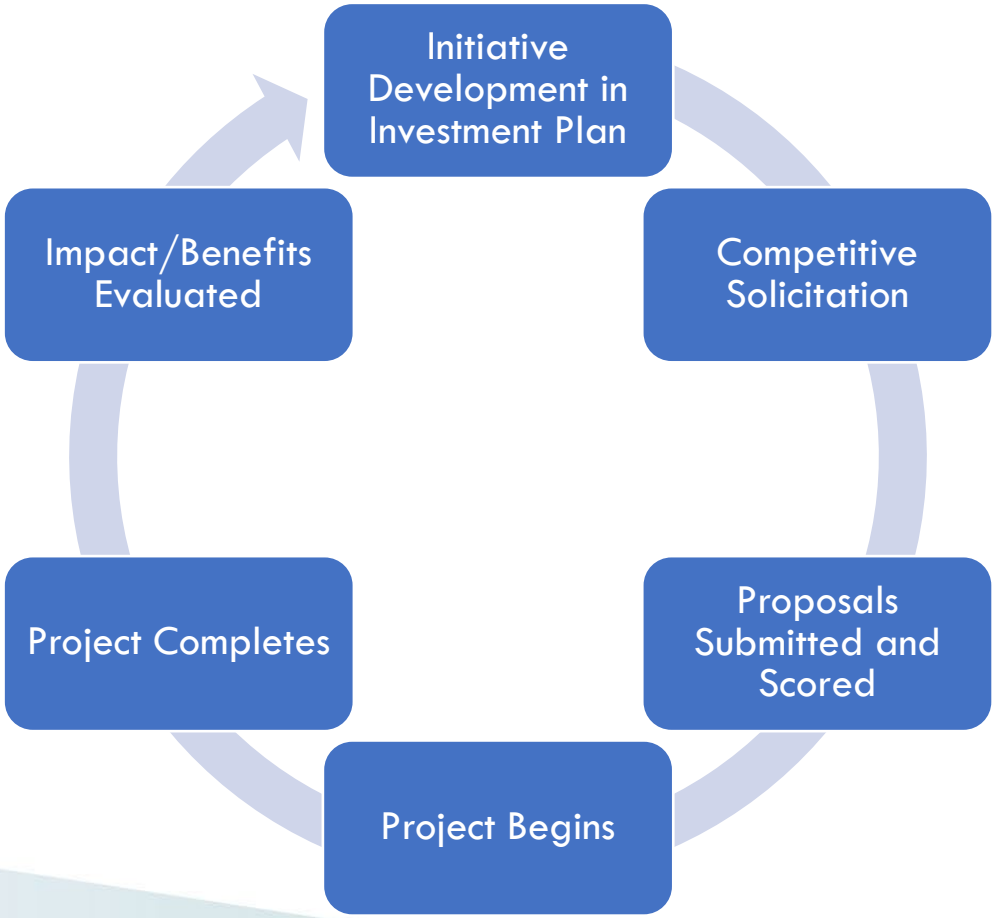
Achieving Energy Efficiency

Transforming Transportation

Overseeing Energy Infrastructure

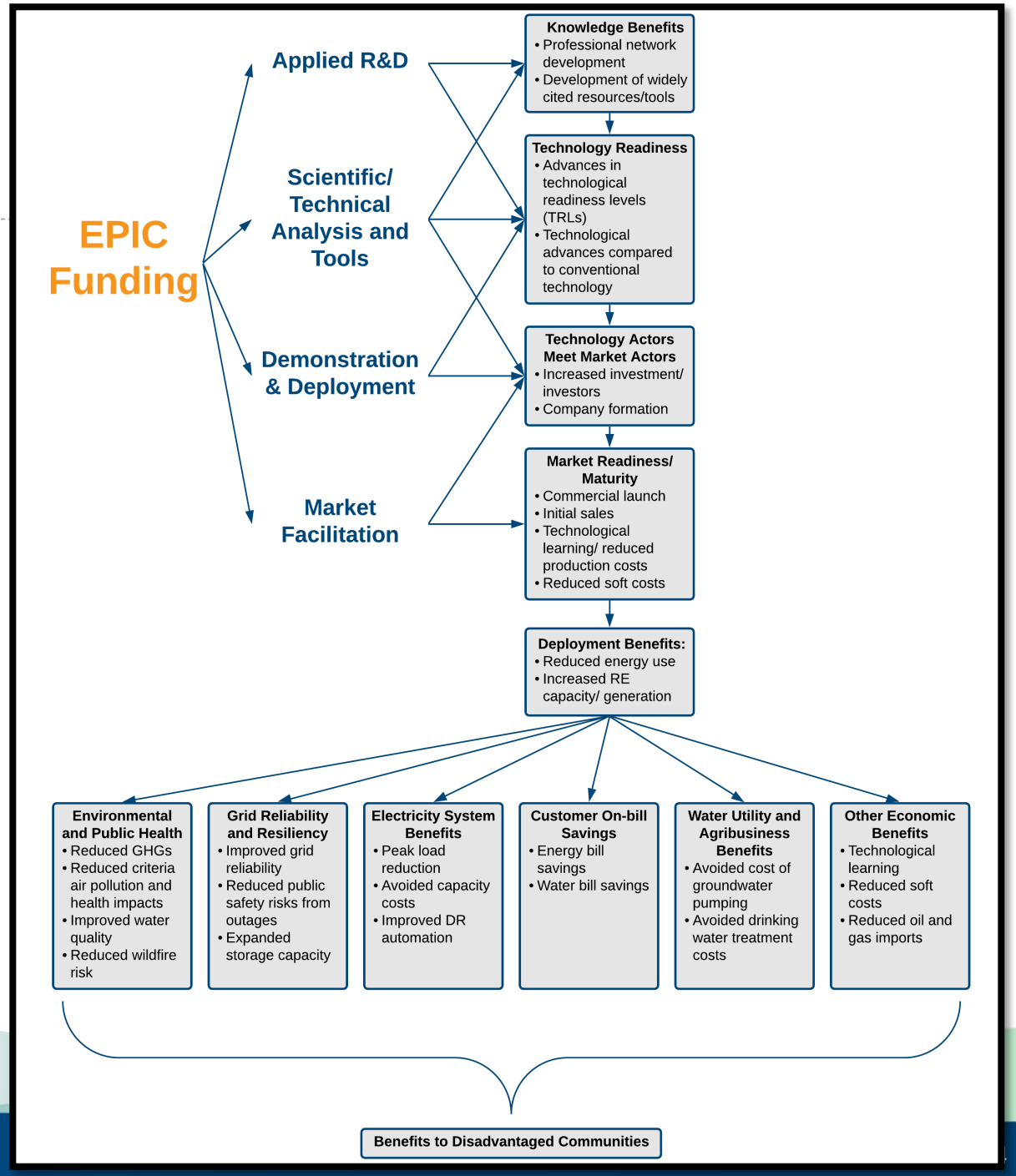
Intergovernmental Collaboration

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



EPIC Benefits Taxonomy

- Projects divided by:
  - Applied R&D
  - Scientific/Technical Analysis and Tools
  - Demonstration & Deployment
  - Market Facilitation



Overview: 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 Dissemination	• 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 • Job Growth (small- to medium-size businesses)

Data Sources

- Benefits Questionnaire
  - Completed at beginning and end of a project
  - Collects data to inform KPIs and inputs for IEc tools
- Annual Survey
  - Conducted for all active projects
- Project Performance Metrics
  - Developed at project start and reported on throughout project term
- PIMS & Energize Innovation
  - Internal CEC database containing project information
- Pitchbook
  - External data source providing funding and investment data

EPIC Project – Evaluation of EPIC Benefits Methodology

- CEC contracted Industrial Economics (IEc) to help assess the EPIC program and mission and recommend benefits assessment methodologies
- Developed a suite of tools and analysis developed by to estimate benefits that address the guiding principle of EPIC
- Developed instructional and supporting documents for the use and validation of the tools
- Developed a data collection template to ensure tool inputs are captured

Project Outcomes

- Over 15 Excel based tools to translate observed project performance into economic benefits (with associated documentation)
- Five analysis deliverables
  - Retrospective analysis on select portions of EPIC portfolio
- Recorded training presentations

Data Analysis Tools

Energy Savings & Shifting

- On-bill Energy Savings
- Demand Response Savings
- System-Level Savings Calculator

Emissions

- Emissions Calculator
- Air Quality Benefits
- Social Cost of Carbon

Resilience

- Grid Reliability
- Public Safety

Project Deployment

- Soft Cost Savings

Case Study – Estimating Impact

- IEc projected on-bill energy savings from 2025-2045 for a sample of 19 EPIC-funded building energy efficiency technologies.

- Selected portfolio of building EE technologies
  - Low-GWP heat pumps, ground heat exchangers, networked lighting controls, triple pane insulating glass, etc.

- Conducted analysis on multiple scenarios.
  - Subject matter expert market penetration estimate scenario
  - 1% market share scenario

Case Study - Methodology

- Engaged panel of subject matter experts to forecast market share for each technology across sectors (residential, multi-family, commercial)
- Applied market share forecasts for each technology to relevant construction forecasts
- Combined with reported technology performance data from project results
- Aggregated year-by-year electricity and gas savings across the 19 technologies
- Translated energy savings into monetary savings using several of the excel based tools

Case Study – Contribution Analysis

- Contribution indicator calculated percentage of the EPIC-funded technologies' benefits attributable to CEC's financial contribution via EPIC, relative to other funders.

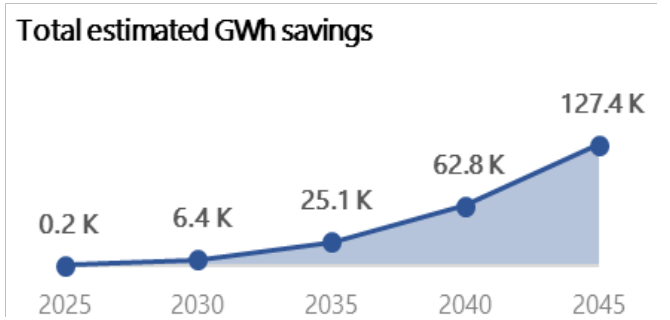
- Overall Funding Share (50% weight)
  - Share of a technology's funding coming from EPIC
- Timing of EPIC Funding (25% weight, binary)
  - If EPIC grant was first funding – EPIC receives credit, otherwise no credit
- Follow-on Funding (25% weight, binary)
  - If technology received follow-on funding – EPIC receives credit, otherwise no credit

Case Study – Contribution Analysis

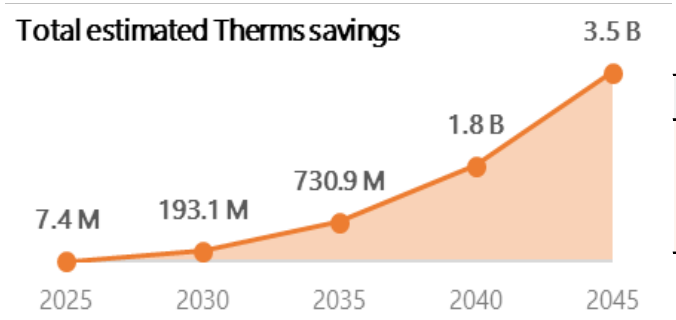
- Contribution indicator is expressed as a percentage corresponding to the amount of benefits from a project that can be attributed to EPIC's financial contribution.

- This percentage is then applied to energy and cost savings estimates by project.

Case Study - Results



GWh	2025	2030	2035	2040	2045
Total	0.2 K	6.4 K	25.1 K	62.8 K	127.4 K
Residential	0.1 K	2.7 K	10.2 K	24.6 K	47.8 K
Commercial	0.1 K	3.7 K	14.9 K	38.2 K	79.6 K

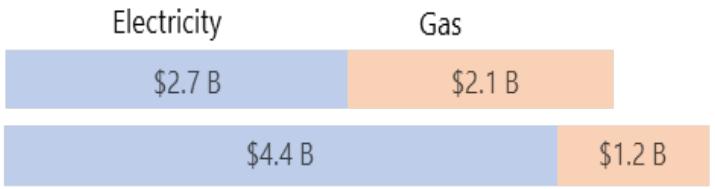


Therm	2025	2030	2035	2040	2045
Total	7.4 M	193.1 M	730.9 M	1.8 B	3.5 B
Residential	5.2 M	131.9 M	486.3 M	1.2 B	2.2 B
Commercial	2.2 M	61.3 M	244.6 M	624.5 M	1.3 B

Using the expert interview projections of market adoption and the contribution indicator the analysis estimated 127,400 GWh and 3.5 Billion therms of savings across all 19 EPIC-supported technologies

Case Study - Results

On-bill Savings	Electricity	Gas
Total	**$7.1 B**	**$3.4 B**
Residential	$2.7 B	$2.1 B
Commercial	$4.4 B	$1.2 B



On-bill savings reflect savings to rate payers based on estimated avoided energy use from implementing EPIC-supported technologies.

System Level Avoided Costs	
Total	**$4.3 B**
Residential	$1.7 B
Commercial	$2.6 B

Values reflect two broad categories of avoided costs to utilities: avoided energy procurement (including losses and ancillary services) and peak load reduction benefits (including avoided capital costs for new generation capacity, transmission, and distribution).

Considerations for Uniform Impact Analysis Framework

- EPIC portfolio is broad – will need varied methodologies to account for different types of research.
- Assumptions on market penetration and scale is combination of art and science – may be difficult to standardize, while having dramatic impact on outcome of analysis
- New methodologies will take time to implement – data collection is embedded through project management practices
- These analyses can be resource intensive, while offering a snapshot in time of impact

Thank You

Colleen.Kredell@energy.ca.gov