STATE OF CALIFORNIA
EPIC TRIENNIAL INVESTMENT PLAN 2015-17
Proposed Energy Research Initiative
Questionnaire

CALIFORNIA ENERGY COMMISSION

(This is a Request for Information only - Complete Pages 1 and 2 for each initiative)

Title of Proposed Initiative: Local and Renewable Tri-Generation of Power, Heat and Fuel

Investment Areas (Check one or more) – *For definitions, see First Triennial Investment Plan, page 12*:

☒ Applied Research and Development
☒ Technology Demonstration and Deployment
☐ Market Facilitation

Electricity System Value Chain (**Check only one**): *See CPUC Decision 12-05-037, Ordering Paragraph 12.a. http://docs.cpuc.ca.gov/PublishedDocs/WORD_PDF/FINAL_DECISION/167664.PDF.*

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

Issues and Barriers:

Local generation of power, heat and fuel can avert all of the energy costs and emissions associated with transporting power and fuel over long distances (e.g., power lines, pipe-lines, trucks). However, small energy conversion systems tend to be less efficient and more costly than centralized systems due to increased losses at smaller scales and larger per-unit capital and installation costs. The need is for a highly efficient localized means of producing (and distributing) power, heat, and fuel.

Initiative Description and Purpose:

One of the most exciting recent developments in integrated energy conversion systems is the concept of poly-generation or tri-generation of power, heat and hydrogen (or other fuels) from a high temperature fuel cell. The concept deserves attention and investment because of the significant efficiency improvement, emissions reductions, and resource conservation potential it portends.
The basic concept is to capture and purify hydrogen produced by a high temperature fuel cell for use as a fuel in fuel cell automobiles. Thus, the high temperature fuel cell could be used to co-produce electricity for a building and hydrogen for a local refueling station, avoiding the energy and environmental impacts of hydrogen transport and distribution. Key technical and strategic benefits of this concept are:

(1) Local hydrogen production avoids the negative energy and environmental impacts of traditional hydrogen transport, distribution and dispensing means,
(2) High temperature fuel cells can theoretically produce about three times as much hydrogen as is required for electricity production using heat and steam that it naturally produces and would otherwise have to reject,
(3) If all of the reformate/hydrogen stream is sent through the fuel cell its efficiency increases,
(4) Co-generated hydrogen is a much higher value product than thermal energy,

(5) Generation of varying relative amounts of hydrogen and electricity allows additional operator control to increase value added, and reduce operating costs,
(6) Additional hydrogen production provides needed cooling to the fuel cell,
(7) A cooler fuel cell can operate with less excess air, which reduces the main system parasitic load (air blower power) to additionally improve efficiency,
(8) Stationary fuel cell systems are already designed to include integrated natural gas reformation technology, and
(9) Stationary high temperature fuel cell systems with reformers have proven near-zero emissions and high fuel-to-electricity efficiency.

Recommended minimum funding level = $500,000/project; Recommended maximum funding level = $3,000,000/project.

Stakeholders:

FuelCell Energy; Air Products and Chemicals; BloomEnergy; ClearEdge Power; National Fuel Cell Research Center; Ceres Power; Ceramic Fuel Cells Limited; SOFC Power; U.S. Department of Energy; Southern California Gas; U.S. Environmental Protection Agency; Air Pollution Control Districts and Air Quality Management Districts;

Background and the State-of-the-Art:

- The National Fuel Cell Research Center of the University of California, Irvine has conducted research on the topic of tri-generation for more than 12 years.
- In recent years attention to this concept has become especially pronounced with the demonstration of a tri-generation system operated on anaerobic digester gas at the Orange County Sanitation District in southern California.
- Significant additional research and development is required to optimize the systems, develop dynamic dispatch capabilities for each product, and to scale up the technology to larger, more efficient systems.
- Projects to advance tri-generation have been supported previously by the following entities: FuelCell Energy; Air Products and Chemicals; National Fuel Cell Research Center; U.S. Department of Energy; Southern California Gas; South Coast Air Quality Management District.

Justification:

Tri-generation will provide California IOU electric ratepayer benefits, including:

- The IOU electric ratepayer will benefit by having additional sustainable sources of electricity that will offset their direct need to pay for more infrastructure (e.g., power plants, transmission and distribution lines)
- The IOU electric ratepayer will benefit by lower cost of electricity due to self-generation support of the utility grid network (appears as demand-side management)
- The IOU electric ratepayer will benefit by greater electric reliability caused by less stress on the network (especially during peak periods) due to self-generation
- Natural gas utilities, alternative fuel developers, zero emissions vehicle developers all have an interest in locally producing useful products of electricity, heat, and/or fuels
- Societal benefits include better ability to dispatch power, heat and fuels according to demand and/or price enabling introduction of clean technology in a cost-effective manner,
- Improvements in air quality and reductions in greenhouse gas emissions will result to the benefit of ratepayers and society.
- This research is appropriate for public funding because it is not currently being accomplished by the private sector and because the market for such technologies is currently restricted due to the recent emergence of tri-generation from the laboratory setting.

Ratepayer Benefits (Check one or more)**:**

☒ Promote greater reliability

☒ Potential energy and cost savings

☐ Increased safety

☒ Societal benefits

☒ Environmental benefits – better air quality, less waste disposal

☒ GHG emissions mitigation/adaptation in the electricity sector at the lowest possible cost

☐ Low emission vehicles/transportation

☐ Waste reduction

☐ Economic development

Describe specific benefits (qualitative and quantitative) of the proposed initiative

Public Utilities Code Sections 740.1 and 8360:

The proposed research initiative is in alignment with section (e) (1) of CPUC Code Section 740.1 by supporting environmental improvement associated with the State's climate change and air quality goals. Additionally, the proposed research meets the criteria of these public utilities code sections by (a) providing benefits to ratepayers and (d) as no similar research is currently being undertaken.