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 (Short and concise):

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

California Energy Commission
DOCKETED
12-EPIC-01
TN 72618
FEB 13 2014

Issues and Barriers:

Describe the issues and barriers that are impeding full market adoption of the proposed clean energy technology or strategy (such as cost, integration, or lack of information).

Thermal energy storage (TES) is a proven technology that shifts cooling energy use to off-peak period, which is appropriate when peak cooling load is significantly higher than average load. On the other hand, higher demand charges and time-of-use (TOU) rates makes TES more cost-effective compared with conventional cooling systems.

First, TES has the capabilities of charging and discharging cooling energy at any time of a day, which enables the integration of TES with different time scales of demand response (DR) programs. Both utilities and customers need far greater understanding of the potential of the integration of different use cases of TES for DR.

Second, compared with conventional cooling systems, TES has higher first cost, system operation and maintenance cost which is associated with a long payback period. Typically, given a fixed TOU rate, TES system designers and customers follow a relatively standardize procedure to design TES systems and related operational control strategies of charging and discharging time and period. However, with the implement of dynamic pricing such as real-time pricing (RTP), TES can benefit greatly from higher-cost hours by using its flexibility of cooling energy use over each hour of the day. The issue is that the design and operation of TES with RTP requires an innovative procedure or tool to achieve the most cost-effective scheme with shorter payback period and higher long-term cost savings.

Third, for existing TES sites, customers may need to understand more about benefits of the application of TES for different time-scales of DR and the implement of RTP. Several motivations for customers to participate those programs include system operation, energy and cost savings, and

impacts on building comfort. The issue is that there is lack of such tools to evaluate those effects and impacts, which could limit the adoption of TES application and its participation in DR programs and dynamic pricing programs.

Initiative Description and Purpose:

How will this technology or strategy help address the issue/issues? Describe knowledge to be advanced to overcome critical barriers. Include the recommended funding level (minimum and maximum) for each project under this initiative.

The purpose of this study is to create a framework of thermal energy storage (TES) systems and their use in permanent load shifting and potential applications in DR, including analysis of field test data and economics. With the TES modeling capabilities of the building energy simulation (EnergyPlus), a tool with friendly interface will be developed for assisting the TES design with different utility rate programs, evaluating the potential of TES for different time-scales of DR and identifying the optimal control strategies to respond demand response event and hourly pricing signals. At least three TES sites will be selected as case studies to put into practice of the tool we developed and conduct surveys and interviews to get an understanding of customers' experience of TES operations and concerns about TES for DR and RTP.

This study will enable the customers who have installed TES systems to potentially add another value stream to their investments while increasing the reliability of the electricity grid by shifting their load to off-peak hours, and help the TES designers and customers to better understand TES cost-effectiveness of different types of design and operational schemes.

Stakeholders:

Identify the stakeholders who support the initiative.

The California Energy Commission, Pacific Gas and Electric Company (PG&E), San Diego Gas & Electric Company (SDG&E), and Southern California Edison Company (SCE), TES manufacturers.

Background and the State-of-the-Art:

- What research development and demonstration has been done or is currently being done to advance this technology or strategy (cite past research as applicable)?
- Describe any public and/or private successes and failures the technology or strategy has encountered in its path through the energy innovation pipeline: lab-scale testing, pilot-scale testing, pre-commercial demonstration, commercial scale deployment, market research, workforce development.
- Identify other related programs and initiatives that deal with the proposed technology or strategy, such as state and federal programs or funding initiatives (DOE, ARPA-E, etc.).

Permanent load shifting technologies such as the TES are supported by the Public Utilities Commission by incentives being made available to customers through utility programs. California utilities offer permanent load shifting programs that include incentives of about $2,000/kW. However, the full potential of these systems for various timescales of DR and the implement of real-time pricing has not been fully understood.

Several research and demonstration has been done about TES for demand response and real-time pricing. University of California at Merced has demonstrated the DR on campus in the presence of

TES (Granderson et al., 2009). During the DR events, the maximum and average demand reduction were 14% and 13% of the whole campus demand power. It was found that the most profitable DR program for UCM is the peak choice committed option, while it needs customer to meet the committed demand reduction. A number of studies has been conducted to explore the potential of building as an energy storage device for different time-scales of demand response (Kiliccote et al., 2010; Yin et al., 2010; Page et al., 2011; Piette et al., 2012; Watson et al., 2012). However, there is lack of research and demonstration about TES for fast demand response in buildings.

In California, many TES manufacturers have been demonstrating the deployment of TES for permanent load shifting and demand response as well. Especially with the goal of a combined 1.3125 MW of energy storage by the end of 2020 issued by CPUC, there are more and more TES resources to be considered for various time-scales of DR programs and dynamic pricing implement.

The Advanced Research Projects Agency-Energy (ARPA-E) program distributed significant grand funds to study the cost-effective thermal energy storage that would enable increased use of domestic solar and nuclear energy resource. From this perspective, the TES could enable the integration with DR and intermittent renewable energy.

References

Advanced Research Project Agency – Energy (ARPA-E) projects overview, Department of Energy/Science/ Advanced Research Project Agency – Energy

Granderson, J., J. H. Dudley, S. Kiliccote, M.A. Piette. 2009. “Chilled Water Thermal Storage System and Demand Response at the University of California at Merced”, in Proceedings of the 9th International Conference for Enhanced Building Operations, Austin, TX, November 17-18. LBNL-2753E.

Kiliccote, S., M. A. Piette, J. L. Mathieu, and K. Parrish, "Findings from Seven Years of Field Performance Data for Automated Demand Response in Commercial Buildings", 2010 ACEEE Summer Study on Energy Efficiency in Buildings, Pacific Grove, CA, 2010.

Piette, M. A., S. Kiliccote, and J. H. Dudley, "Field Demonstration of Automated Demand Response for Both Winter and Summer Events in Large Buildings in the Pacific Northwest", Energy Efficiency, 2012.

Page, J., S. Kiliccote, J. H. Dudley, M. A. Piette, A. K. Chiu, B. Kellow, E. Koch, and P. Lipkin, Automated Demand Response Technology Demonstration Project for Small and Medium Commercial Buildings, : CEC/LBNL, 07/2011

Watson, D. S., N. E. Matson, J. Page, S. Kiliccote, M. A. Piette, K. Corfee, B. Seto, R. Masiello, J. Masiello,L. Molander, et al., Fast Automated Demand Response to Enable the Integration of Renewable Resources, CEC/LBNL, 2012.

Yin, R., P. Xu, M. A. Piette, and S. Kiliccote, "Study on Auto-DR and Pre-cooling of Commercial Buildings with Thermal Mass in California", Energy and Buildings, January 2010, vol. 42, issue 7, no. 7, pp. 967-975, 07/2010

Justification:

Describe how this technology or strategy will provide California IOU electric ratepayer benefits and provide any estimates of quantified annual savings/benefits in California, including:

- Name of sector and estimated size and energy use.
- Quantifiable performance improvements for the proposed technology/strategy.
- Maximum market potential, if successful.
- Number of direct jobs created in California.
- Why this research is appropriate for public funding.

TES is a proven technology that is widely deployed in commercial and industrial customers, which can significantly reduce the peak cooling energy use. Performance improvements for the TES include the permanent load shift from the peak cooling energy usage and TES also offers flexible load management to respond various DR and dynamic pricing programs. Quantifiable performance improvement is proportional to the peak cooling loads in the sector of commercial and industrial customers with TES and requires a detailed study on technical analysis and TES market potential using CEUS data (California Commercial End-Use Survey).

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

☒ Promote greater reliability

☒ Potential energy and cost savings

☐ Increased safety

☐ Societal benefits

☒ Environmental benefits - specify

☒ 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:

Please describe how this technology or strategy addresses the principles articulated in California Public Utilities Code Sections 740.1 and 8360. The California Public Utilities Code is available online at www.leginfo.ca.gov/cgi-bin/calawquery?codesection=puc.