DOCKETED

Docket Number:	17-EPIC-01
Project Title:	Development of the California Energy Commission Electric Program Investment Charge 2018 â€“ 2020 Triennial Investment Plan
TN #:	216717
Document Title:	Professor Richard Wirz Comments regarding â€œDevelopment of the CEC Electric Program Investment Charge 2018-2020 Triennial Inv
Description:	N/A
Filer:	System
Organization:	Professor Richard Wirz/ Energy Innovation Laboratory at UCLA
Submitter Role:	Public
Submission Date:	3/27/2017 11:54:12 AM
Docketed Date:	3/27/2017

Comment Received From: Karthik Nithyanandam
Submitted On: 3/27/2017
Docket Number: 17-EPIC-01

Comments regarding â€œDevelopment of the California Energy Commission Electric Program Investment Charge 2018-2020 Triennial Investment Planâ€

Additional submitted attachment is included below.

Comments regarding "Development of the California Energy Commission Electric Program Investment Charge 2018-2020 Triennial Investment Plan"

Richard Wirz, Parker Wells, Karthik Nithyanandam and Amey Barde

Professor Richard Wirz and the Energy Innovation Laboratory at UCLA is responding to the CEC's Triennial Investment Plan. We interact with CEC and EPIC through three main channels:

1. Prof. Richard Wirz and the Energy Innovation Laboratory are currently executing on an EPIC supported project: "Low-Cost Thermal Energy Storage for Dispatchable CSP" EPC-14-003
2. Prof. Richard Wirz and Mr. Parker Wells have leveraged the thermal storage technology developed with CEC support to co-found Element 16 Technologies, which has received a CEC PIER NOPA, "Small-CCHP Packaged System with Innovative Quick-Response, Compact, and High-Temperature Thermal Energy Storage" GFO-16-503
3. Prof. Richard Wirz is a member of the Los Angeles Grand Challenge's Energy steering committee, which is focused on finding pathways to make Los Angeles County 100% renewable by 2050.

This response is based on our team's experience from interacting with CEC as an academic research group, a startup company, and a technical advisory team to policy makers. We are commenting only on select parts of the Triennial Investment Plan, in which we have some insight or expertise.

Initiative 1.3.3: Manufacturing and Designing Improved Heat Exchangers

We would like to voice our support for this initiative. Our thermal energy storage system (TES) is a combined thermal energy storage and heat exchanger (HX) system. We have found that the largest single cost in constructing these energy storage systems are manufacturing costs and have started investigating additive manufacturing in order to reduce the overall cost of the system. Though this initiative might be focused on separate heat exchangers instead of integrated or packaged HX-TES systems, the lessons learned in using new manufacturing methods could be directly applicable in adjacent industries.

Initiative 1.7.4: Large Scale Deployment of Pre-commercial Technologies with Demonstrated Potential

This is vitally important for implementation of new technologies for industrial applications. Given the scale of industrial facilities, industrial products often require significant capital for early installations. This is often an insurmountable barrier to attract early adopters, especially in risk averse markets. The CEC has also already had great successes in supporting large projects, such as the "Demonstration of Combined Heat and Power with Thermal Storage for Modern Greenhouses" at Houweling Tomatoes. These types of projects allow for essential derisking of technologies and products for new markets. With support from PIER, Element 16 is

installing the first of its energy storage systems, but even after technologies are proven they still face the challenge of becoming widely accepted into the market.

While it is unclear which industries will be targeted with this initiative, those mentioned in Initiative 1.7, such as breweries and agricultural operations commonly use combined heat and power plants to drastically reduce energy costs and carbon emissions. The US lags behind many of our European peers in implementation of CHP systems. Another option for this heat would be to use concentrated solar thermal for industrial process heat, reducing the need for electricity or natural gas. Many of these industries also have significant waste heat, which could be used to drive absorption chillers or generate electricity. This initiative works well in conjunction with 1.3.3.

Initiative 3.3.3: Advance Distribution Planning Tools

In this initiative, we find significant overlap with Initiative 3.3.2, though that could be due to the relatively short descriptions in this Theme. It is important to understand the DERs currently deployed on the grid. However, coordinating between many independent DERs could present significant practical challenges. For the grid as a whole, however, we believe intelligent planning could have a significant upside. We are less convinced that one of the main reasons for the slower adoption of DERs in disadvantaged communities is related to the planning tools for DER optimization. Understanding the actual energy market needs of low-income communities, visible installations, and appropriate financing models (as found in Theme 8) appear to be more appropriate approaches to reducing GHG emissions in disadvantaged communities.

Initiative 4.2.1 & 4.2.2: Utility-Scale Land-Based Wind Turbine Components and Facilitate Deployment of Offshore Wind

Our group suggests that the CEC apply the majority of its focus to offshore wind power. As can be seen in Stanford Professor, Mark Jacobson's paper "A roadmap for repowering California for all purposes with wind, water, and sunlight" offshore wind would likely need to play a large role (10%) in a CA powered by renewable energy. Since offshore wind is often at depths greater than 50m, significant work is still left to do to make this a reality. The land-based wind market is relatively well developed, and instead faces non-technical challenges, such as land-use issues.

Initiative 4.3.1: Making Flexible-Peaking Concentrating Solar Power with Thermal Energy Storage Cost Competitive

Our group is most knowledgeable about this Initiative, as we are currently partnered with Hyperlight Energy, a CEC awardee CSP company, on our own CEC CSP-TES project. We throw our full support behind this initiative, as it hits some of the most important directions CSP must take to gain more traction in the US. One of the portions of this topic that are most exciting to us is the potential for <10 MWe systems. Current projects have costs in excess of $1B and take years to be completed. Smaller systems will allow for quicker iteration, easier permitting and financing, and increase the number of potential sites. As far as the study of various designs and economics surrounding operating CSP as a peaker plant, that is something we (and likely

many CSP researchers and corporations) already complete as part of our tech-to-market efforts. Having standardized models would be greatly beneficial.

One of the metrics mentioned is the system temperature over 700°C. Our thermal energy storage system is capable of reaching temperatures in excess of 700°C, however, the economics of high temperature CSP receivers and TES are both hindered by the cost of the materials (e.g. metals) that can safely operate in this range. We recommend some research into potential low cost, high temperature metals is circulated as well.

The metric for <$15 kWht is also a good metric to use for thermal energy storage. We recommend another metric surrounding the charge and discharge rate of the TES. Or, if evaluating the CSP-TES system as a whole, the number of hours the system generates. If CSP should operate as a peaker plant, it must be responsive and be capable of generating electricity quickly. This could mean discharging a day's heat in a matter of hours. While certain types of thermal energy storage can meet $15/kWht such as rock-based TES, they discharge too slowly to be useful for non-baseload operation.

We also suggest CEC to pursue research initiatives focusing on concentrated solar thermal for non-power generation applications such as production of fuel for transportation and industrial sector needs.

Initiative 4.3.2: Geothermal Energy Advancement for a Reliable Renewable Electricity System

CSP-boosting for declining geothermal facilities is a good idea to leverage the infrastructure already constructed at this facility, and we fully support this initiative. We are also interested in the idea of planned CSP-boosted geothermal, which uses CSP to raise the temperature of the geothermal brine to operate higher-temperature, higher-efficiency turbines. This would take advantage of both the geothermal heat and the solar heat at the same facility and could continue to operate even if the geothermal well experiences a premature decline.

Separately, since our thermal energy storage system at UCLA and Element 16 uses sulfur as a key component, we should note that sulfur is a very low value product. We are confident that capturing sulfur from geothermal brine buildup would not produce significant economic value. However, Pacific Northwest National Laboratory extracted rare earth metals from geothermal brine as part of a DOE GTO project, which likely has drastically more value than sulfur.

Initiative 5.1.1: Continue CalSEED Initiative to Provide Early Stage Support for Clean Energy Technology Entrepreneurs

As founders of Element 16 Technologies, we understand first-hand the current dearth of cleantech venture funding available for entrepreneurs. Programs like CalSEED, DOE's Cyclotron Road and Chain Reaction, and few others are critical. The capital and time required to produce physical products is far greater than that of software, but entrepreneurial activity is one

of the few ways to bring truly transformative renewable energy products to the mass market. Even though it just started, as entrepreneurs we cannot overstate the value of initiatives like CalSEED.

Initiative 5.1.2: Expand Entrepreneurial Services from Innovation Clusters

Our team is excited about this Initiative as well. We would prefer if the entrepreneurial support was not focused on the Regional Energy Innovation Clusters. Given that some require significant equity and payment from startups, offering support through the cluster could make the assistance and services less accessible.

Initiative 6.1.1: Develop and Test Novel Energy Efficient Methods for Conventional and Non-Conventional Sources of Water Supply

Our team extends our full support to this initiative. From our feasibility study that focused on achieving Sustainable LA 100% renewable energy goal, we concluded that the energy responsible way to meet the water demand is either water reuse or brackish water desalination, especially since sea water desalination is very energy intensive. To this end, we are happy to see CEC focusing on research initiatives to develop innovative energy efficient methods for wastewater treatment and brackish water desalination. The executive summary of our study (along with key results) titled "A Preliminary Assessment of 100% Renewable Energy for LA County" is publicly available in "2016 Southern California Clean Energy Innovation Ecosystem Roundtable Report".

Initiative 6.1.3: Develop and Demonstrate Advanced Energy Efficiency Improvements to Allow for On-site Wastewater Treatment for Industrial Facilities and Reuse for Water Intensive Industries

The industries targeted in this initiative namely, refineries, breweries, paper/pulp mills, etc. also waste significant amount of energy mainly in the form of heat. Although most waste heat may be low grade (< 250 ^{o}C), the temperature regime is ideally suited for thermal based distillation approaches (such as membrane distillation) for wastewater reclamation. Hence, tremendous opportunities exist for recovering this waste heat for productive end-use, such as low-energy treatment process for direct on-site reuse of the water. We also see synergies with Initiative 1.7.4, where in CHP with TES can be deployed in wastewater treatment facility for cogeneration of electricity and heat using biogas from the digester.

Initiative 6.2.2: Demonstrate Advanced Water and/or Energy Efficiency Technologies to Reduce Carbon Intensity of Food Processing Operations

Since CEC is focused on implementation of opportunities including waste heat recovery, we believe focusing on thermal compression based absorption chillers will be impactful (instead of traditional motor- or engine- driven mechanical vapor compression refrigeration systems). Absorption chillers can substantially reduce operating costs as they can be energized by the low-grade waste heat. On-site concentrated solar thermal with storage for cooling requirements (and thermal management) can provide further opportunities to cost-effectively decarbonize the food processing industry.