CALIFORNIA ENERGY COMMISSION
EPIC TRIENNIAL INVESTMENT PLAN 2015-17
Proposed Energy Research Initiative Questionnaire

Title of Proposed Initiative: *Advanced Dispatchable Integrated Solar Thermal Generation and Energy Storage Demonstration*

Investment Areas (Check one or more)

- Applied Research and Development
- X Technology Demonstration and Deployment
- Market Facilitation

Electricity System Value Chain (Check **only one):**

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

Issues and Barriers: *Several problems plague existing renewable electrical power generation technologies. They typically cannot provide dispatchable electricity to meet variable load demands all day and any day at competitive prices. Advanced solar thermal generation with integrated thermal storage using air as the working fluid are conceptually capable of resolving these problems and provide renewable power that is fully dispatchable, available 24/7, does not use toxic materials or water, and holds the promise of achieving a price of 6 to 8 cents/kilowatt-hour. These findings have been predicted from research and testing funded by the U.S. DOE but have not been verified through demonstration of a full-scale pilot project.*

Initiative Description and Purpose: *U.S. DOE studies completed in 2011 and 2013 concluded the technology exists for producing low cost, reliable, fully dispatchable renewable electricity using a state-of-the-art ceramic low-pressure solar receiver, heat exchanger, and integrated thermal storage unit, with air as the working fluid. This technology does not emit greenhouse gases or air pollutants, use toxic materials or water except for cleaning mirrors, produce noise, and has minimal ground disturbance. This initiative would result in the construction of a pilot demonstration project to test and verify these expectations.*

Stakeholders: *Stakeholders in these technologies include electric utilities, air quality management districts, the CAISO, and state energy policy makers.*

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)? *Research and analysis studies funded by U.S. DOE and materials testing performed by Oak Ridge National Laboratory have been successfully completed ("Brayton-Cycle Baseload Power Tower CSP System" completed under DOE award number EE003587).*

- 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. *Research and lab-scale testing has been successful. The technology is ready for pilot scale demonstration.*

- 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.). *No known program exists. Research and analysis studies funded by U.S. DOE and materials testing performed by Oak Ridge National Laboratory have been successfully completed ("Brayton-Cycle Baseload Power Tower CSP System" completed under DOE award number EE003587).*

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. *This technology is modular and hence scalable for use in the electricity generation sector in the form distributed generation (as small as 300 kW) and central station generation ranging from several to several hundred MW in capacity. It can also be used for self-generation and, if used in a hybrid configuration, can be used in combined, cooling, heating, and power applications.*

- Quantifiable performance improvements for the proposed technology/strategy. *Compared to existing solar technologies, this technology is projected to have 24/7 firm dispatchability, 2 to 4 hours of storage for peaking power and 13 hours for baseload power, less than 5 minute ramp rate to full power, target cost of 6 cents/kWh, and 54 to 60% efficiency.*

- Maximum market potential, if successful. *Because of the modular and fully dispatchable nature of the technology, it has significant market potential ranging from distributed generation to central station to CCHP applications. It also holds promise of running in a hybrid mode using biofuels or natural gas to further enhance reliability. Markets are expected initially to focus on distributed applications with high reliability requirements and low water availability but move to other areas as development reduces production costs.*

- Number of direct jobs created in California. *Over time this technology has the potential to bring significant green-energy jobs to California.*

- Why this research is appropriate for public funding. *This technology has significant public and ratepayer benefits including improved reliability and system operation, lower environmental impacts, ability to meet state GHG and renewable targets, reduced water consumption, and reduced renewable energy generation costs.*

Ratepayer Benefits (Check one or more):
X Promote greater reliability
X Potential energy and cost savings
X Increased safety

X Societal benefits
X Environmental benefits – specify: *Benefits in air quality, climate change goals, water use, noise, toxic and hazardous materials, waste, and land use (see Benefits discussion below)*
X GHG emissions mitigation/adaptation in the electricity sector at the lowest possible cost
Low emission vehicles/transportation
Waste reduction
X Economic development

Describe specific benefits (qualitative and quantitative) of the proposed initiative: *This technology provides the system benefits of a fossil-fuel power plant without the air emissions or water requirements. It is expected to provide fully dispatchable power, rapid response time, load following capability, and other system benefits. Because it has minimal moving parts and does not rely on water, steam, or molten salts, it is expected to be highly reliable with low operational maintenance costs. Its modular nature allows it to be sized to match the power needs and transmission capability at a particular location. Since it uses air as the working fluid, this renewable generation technology holds the promise of having no regulated air of greenhouse gas emissions, no water or steam except for occasional mirror washing, no salts or oil, no gases, no hazardous or toxic materials, minimal noise, and minimal waste generation since most components and materials are common and can be recycled, minimal land disturbance and vegetation removal, and variable site locations and sizes. It can be sited on brown-field sites, abandoned agriculture land, and areas with marginal land use value. Unless used in a hybrid capacity with biofuels or natural gas to produce greater reliability, this technology does not produce any greenhouse gas emissions and uses minimal greenhouse gasses in its component materials.*

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. *As described above, this technology holds the promise of meeting the following sections of CPUC Code 740.1: (a) offer a reasonable probability of providing benefits to the ratepayers, (d) do not duplicate other research, (e)(1) environmental improvement through reduced water consumption, air and greenhouse gas emissions, (e)(3) reducing or shifting system load, (e)(4) development of new resources particularly renewable resources, and (e)(5) improving operating efficiency and reliability. It also meets the following sections of CPUC Code Section 8360: (b) dynamic optimization of grid operations, (c) deployment and integration of cost effective distributed resources and generation including renewable resources, and (g) deployment and integration of cost effective advanced electric storage technologies.*