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

Title of Proposed Initiative (Short and concise): **Enhanced heat and power system efficiency through low-emission demand-following**

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
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Issues and Barriers:

Combustion systems are the backbones of electrical power generation, industrial, agricultural, and wastewater facilities. These systems are used to produce steam, hot water, mechanical and electrical power, and in process heating applications. The same types of combustion systems, sometimes of a different scale, are also installed in commercial buildings and complexes. Because of the differences in these business enterprises, a wide variation and variability in heat and power demand of combustion systems exists. For example, steam demand may change during the day, working week, season, or due to production schedules. California's strong commitment to energy efficiency and environmental protection means that all the combustion systems must meet stringent air-emissions rules. Most commercial combustion systems can only achieve demand following by trading-off high efficiency for emissions. Combustion systems with high rates of turndown (i.e. a broad range of firing rates) are needed to maximize efficiency and minimize emission across a wide range of heat and power demand.

Initiative Description and Purpose:

The purpose of the initiative is to develop and demonstrate a natural gas combustion system capable of maintaining low emissions (< 5ppm NO_x @ 3% O_2) across high rates of turndown (10:1 or greater). Commercialization of high turndown combustion systems would allow for greater system efficiency and reduced emissions within California.

Stakeholders:

Combustion system manufacturers and end-users, California ratepayers, utilities and air quality management boards, research universities, and national laboratories.

Background and the State-of-the-Art:

Commercial state-of-the-art ultra-low-emissions combustion systems are typically designed to achieve their highest efficiency and lowest emissions only when operating at full load. Due to this basic design philosophy, meeting the various heat and power demands of California's electrical generators, industries, and buildings often leads to energy waste. Specifically, the common practice of operating at full load and turning the system on and off to match heat and power demand wastes energy due to fuel purging requirement at every startup. This practice can be eliminated with modern electronic controls paired with advanced combustion systems capable of maintaining ultra-low emission through high rates of turndown (10:1 or greater). Combustion systems with high rates of turndown (i.e. reduced firing rate) are able to match heat and power demands more efficiently than with simple on-off operation.

Recent advances in combustion and control technologies provide an excellent foundation for the development of combustion systems for new or retrofit combustion systems capable of achieving high rates of turndown (10:1 or greater) while meeting stringent emissions limits. Operation of high turndown combustion systems would result in reduced natural gas consumption. One key technical challenge in developing demand following combustion systems is the smart integration of advanced combustion technologies to modern control systems. Currently, combustion systems with even limited demand following capability are high-cost premium products and typically do not meet California emission standards across their full range of operation. By lowering the cost of such products and improving the full range of emission characteristics market penetration of such combustion systems will increase.

Justification:

Combustion systems are prevalent in all aspects of the industrial, agricultural, and wastewater sectors. In California, a large fraction of combustion systems are located in non-attainment areas and must adhere to strict emissions regulations. Combustion systems are typically oversized (i.e. providing more heat and power than is needed) when installed and by increasing the turndown ratio of these oversized systems to meet partial load demand, operational efficiency can be increased by reducing the number of times they need to be stopped and started. There is an opportunity to improve overall state system efficiency through development of clean burning combustors with high turndown (10:1 or greater). Current combustion systems can be either completely replaced or be refurbished and retrofit with an advanced combustor. Retrofit or replacement with low turndown combustion systems would reduce natural gas consumption and lower ratepayer expense through increase operational efficiency.

This strategy will provide natural gas ratepayer benefits through:

- Enabling the industrial and commercial sectors to reduce natural gas consumption by allowing their combustion systems to follow heat and power demand.
- Successful development of high turndown combustors will have maximum technology potential for combustion systems used in the industrial and commercial sector.
- Maximum market potential will be attained through retrofit and new combustion systems that are compatible with currently installed system configurations.

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

☒ Promote greater reliability

☒ Potential energy and cost savings

☒ Increased safety

☒ Societal benefits

☒ Environmental benefits – reduced pollutant emission, increase energy conversion efficiency

☒ 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

This initiative will impact most combustion systems that are required to follow load demand and maintain ultra-low emissions. This includes gas turbine engines, boilers, water heaters, furnaces, process heaters, and micro-turbines.

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.

As described above, this technology meets Code Section 740.1 (a) offer a reasonable probability of providing benefits to the ratepayers, (e)(1) environmental improvement through reduced water consumption and air emissions, (e)(3) reducing or shifting system load, and (e)(5) improving operating efficiency and reliability. It also meets Code Section 8306, the State's policy to modernize the electrical transmission and distribution system to maintain safe, reliable, efficient, and secure electrical service (b) dynamic optimization of grid operations, (c) deployment and integration of cost effective demand response and demand-side resources, (d) deployment of cost-effective smart technologies that optimize the physical operation of consumer devices.