(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
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Issues and Barriers:

In the U.S., over half the population uses natural gas for water heating, while 40% of the population uses electricity. Electric water heaters place unneeded burden on strained transmission lines and rely upon a comparatively inefficient conversion and distribution of primary fuels to electricity. As the California electric grid becomes even more constrained and utility scale power plants becomes difficult to finance the need for ultra-clean (cleaner than the grid average) natural gas combustion hot water heaters grows. These combustion based water heaters must have higher system efficiency than grid based electricity and lower emissions than the grid average, including renewable generation.

On average, gas-fired tankless water heaters are 22% more energy efficient than gas-fired storage water heaters, saving consumers about $70-$80 per year. A study conducted on ten homes in Minnesota (Bohac et al., 2010) showed tankless water heaters saving an average of 37% of site energy consumed for water heating at ten sties, or about 6,000 kBtu per home per year. However, the initial cost associated with state-of-the-art tankless water heaters, including installation, results in a payback period of about 20 years, longer than the average lifespan of many models. Reducing the manufacturing costs of tankless water heaters will reduce the payback period and enable market penetration, resulting in greater energy savings through increased tankless water heater sales.

Typical tankless water heater combustion systems are complex, comprised of multiple small burners operated independently. These smaller burners, also known as banks, enable the system to achieve turndown ratios of up to 15:1 while each bank may only achieve 2:1 turndown. To operate the banks independently, several costly control mechanisms, such as solenoid valves, are required to regulate fuel and control flow to each bank, increasing manufacturing and maintenance costs. Tankless water heaters that are comparable in price to mid-range storage water heaters can only support low flow hot water draws due to burner range limitations. Until tankless water heaters are lifecycle cost effective

while meeting hot water demands, widespread installation is unlikely and many residential and commercial buildings will continue to use less energy efficient storage water heating systems.

Initiative Description and Purpose:

Tankless water heaters require a low-cost burner system that can reach a performance goal of 30:1 turndown and ultra-low emissions while meeting operational demands. Traditional high turndown burners are not capable of delivering ultra low emissions across their full turndown range. A Lawrence Berkeley National Lab developed technology, the Low Swirl Burner (LSB), is capable of meeting these performance requirements. The LSB burner needs to be developed for water heater appliances so that it can easily be integrated existing tankless water heater designs. By developing the burner to match current water heater specification tankless manufacturing costs of the tankless water heater will be significantly reduce as compared to redesigning the entire unit.

The primary challenge for this project is the design of a burner with low-pressure drop to minimize parasitic energy that delivers high combustion efficiency, rumble free, and single digit NO_x within 30:1 turndown. Applying the knowledge from adapting the LSB to industrial heaters and gas turbines, laboratory studies using laser diagnostics will be carried out to optimize the design and verify the operation of a low-drag LSB that affords one-thirtieth load operation by attaining flowfield similarity at low Reynolds numbers.

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 tankless water heaters 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 and reducing strain on the electric grid. 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:

This strategy will provide natural gas ratepayer benefits through:

- Enabling tankless water heaters to cost-effectively generate how water with lower emissions and higher efficiency than grid powered electric water heaters.
- This will alleviate strain on the CA electric grid.

- Maximum market potential will be attained through design on combustion systems that are compatible with currently installed tankless water heater configurations.
- This development is not being perused by private companies due to a lack of market drivers.

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

☒ Promote greater reliability

☒ Potential energy and cost savings

☒ Increased safety

☐ Societal benefits

☒ Environmental benefits – decreased emissions, higher 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

The LSB water heater burner system will reduce manufacturing costs of tankless water heater and enable transition from gas-fueled storage water heating to gas-fueled tankless water heating, thus reducing energy consumption while still meeting strict emissions requirements. This will all be done while producing less emissions and having an overall higher efficiency that the electric grid. With this system, tankless water heaters will penetrate the market, saving billions in fuel and energy, thus reducing the size and footprint of water heating systems. The savings from this burner are inline with government incentives (30% for 2012). Coupling the cost savings resulting form this proposal (15%) and government incentives will further expand market penetration of tankless water heaters.

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.