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## Notice of Funding Opportunity

**Title:** Developing and Demonstrating Advanced Combustion Systems for the Industrial Sector  
**Website:** <https://www.energy.ca.gov/solicitations/2020-10/qfo-20-501-developing-and-demonstrating-advanced-combustion-systems>  
**Funding:** Total: \$10,000,000. Maximum awards: \$1.5M-\$8.5M, depending on group.  
**Dates:** Pre-Application Workshop: October 22, 2020  
Deadline for Written Questions: October 27, 2020  
Submission Deadline: December 09, 2020

**Summary:** The development of this solicitation is guided by the California Energy Commission's Natural Gas Research and Development Program Plan for fiscal year 2019-2020. This solicitation pertains to the Energy Efficiency program area under the plan. The purpose of this solicitation is to fund projects that will demonstrate increased efficiency of the oxygen-enriched combustion for industrial applications, or improve economics of equipment for oxygen production.

### Project Topic Areas:

#### Group 1: Demonstration of oxygen-enriched combustion for industrial applications

This group seeks projects to demonstrate at an industrial facility economically viable advanced combustion systems that have the potential to improve efficiency, reduce costs, and reduce environmental impact compared to conventional combustion systems. This group seeks Technology Demonstration and Deployment projects within TRL 7-8.

Specific research areas for this solicitation may include, but is not limited to: Chemical looping combustion for industrial processes. These are technologies that generate oxygen for combustion in situ and eliminate the need for conventional oxygen production; Oxy-fuel combustion (including pressurized) for industrial applications in which the combustion processes use pure oxygen instead of air to improve energy efficiency, reduce NO<sub>x</sub>, and enable CO<sub>2</sub> capture in the future; Methods to increase oxygen concentration. Higher oxygen concentration allows use of low-calorific fuels, such as biofuels. High-purity oxygen is required to eliminate NO<sub>x</sub>, but even moderate levels of oxygen enrichment provide efficiency improvements; and Identification and use of by-products, such as inert nitrogen (extracted at temperatures below -300°F) that could enhance project cost effectiveness. However, the research in these areas is secondary and not the primary focus of the project.

The solicitation seeks proposals that will do all of the following: Develop and demonstrate the advanced combustion technology to determine potential of meeting research goals at an industrial facility. This can include evaluation of enhancements such as use of advanced membranes or cryogenic technology to reduce cost; Perform a thorough technoeconomic analysis to evaluate the technology and measure and verify energy savings, improvements in efficiency, cost reduction, and environmental impact compared to conventional combustion systems; Identify and reach out to potential market and end-users where the technology is most applicable to determine specifications and requirements that would direct the technoeconomic analysis efforts and facilitate market adoption; Be applicable to the industries that are major users of natural gas, including food processing, petroleum refineries, chemicals, glass, cement, and metals; Demonstrate developed advanced combustion system at an actual industrial facility with potential for adoption in other industries; and Analyze results of the demonstration and prepare recommendations to improve system's characteristics and overcome barriers for broad market adoption.

#### Group 2: Test advanced oxygen production with improved economics

This group seeks projects that would improve economics of oxygen production for the application in industrial oxygen-enriched combustion systems. Currently available cryogenic systems are capable of producing high-purity oxygen at a large scale applicable to power generation plants. Alternative technologies, such as pressure swing absorption and ion transport membranes may be more suitable for medium-scale industrial applications, but the cost of oxygen production is still prohibitive for wide adoption of oxygen-enriched combustion. The technology focus of this group is not ready for a full-scale demonstration, but can be tested at laboratory/pilot scale to meet the research goals and lay the



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foundation to justify future research. This group seeks Applied Research and Development projects within TRL 4-6.

Specific research for this solicitation may include, but is not limited to: Advanced materials and/or systems for pressure or temperature swing absorption units, or ion transport membranes that could reduce the price of oxygen production to the levels competitive with cryogenic separation units; Electrostatic or electrochemical separation units scalable for industrial applications; and Other technologies capable of producing oxygen of at least 90 percent purity, at a price competitive with cryogenic separation units, and at oxygen production rates applicable to industrial boilers and furnaces (approximately 1-100 metric tons per day).

The solicitation seeks proposals that will include all of the following: Develop the advanced oxygen production technology and test the prototype in a laboratory environment to determine potential of meeting research goals; Perform a thorough technoeconomic analysis to evaluate the technology and measure and verify energy savings and improvements in efficiency and cost reduction; Identify and reach out to potential market and end-users where the technology is applicable to determine specifications and requirements that would direct the technoeconomic analysis efforts and facilitate future market adoption; and Be applicable for future full-scale demonstration at an actual industrial facility with potential for adoption in other industries.

**Funding:**

There is up to \$10.0 million available for grants awarded under this solicitation. Match funding for projects within Group 1 is required in the amount of at least 20% minimum of the requested project funds. Match funding for projects within Group 2 is not required for this solicitation. However, applications that include match funding will receive additional points during the scoring phase.

Project Group	Available funding	Minimum award amount	Maximum award amount	Minimum match funding (% of Natural Gas Funds Requested)
Group 1: Demonstration of oxygen-enriched combustion for industrial applications	\$8.5 million	\$2.0 million	\$8.5 million	20%
Group 2: Test advanced oxygen production with improved economics	\$1.5 million	\$0.5 million	\$1.5 million	No match funding required

**Project Requirements:**

Research Goals for Projects under Group 1 include: Increased combustion efficiency; Improvements over the best-in-class commercially available equipment in terms of: (a) lower capital and installation costs, (b) lower operational and maintenance costs, or (c) both; and Estimated payback period based on energy cost savings and installed technology cost.

The research goals for the projects within Group 2 include: Potential to reducing energy requirements for oxygen separation by 20% compared to current best-in-class conventional swing absorption systems; and Potential to produce oxygen at over 90% purity with costs at or lower than large-scale cryogenic separation systems (over 200 tons per day) at production rates typical to industrial boilers (approximately 10 MW or 34 MMBTU/hr which translates to less than 180 tons of oxygen per day) and furnaces.

**Eligible Applicants:**

This solicitation is open to all public and private entities. Demonstration projects in this solicitation must be located in the service territory of a California natural gas Investor Owned Utility (NG IOU), which includes Pacific Gas and Electric Company, San Diego Gas & Electric Company, and Southern California Gas Company. All projects in this solicitation must benefit natural gas IOU ratepayers.