MOMENTUM

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Notice of Funding Opportunity

Title: University Turbine Systems Research (UTSR) - Focus on Hydrogen Fuels
Website: https://www.grants.gov/web/grants/view-opportunity.html?oppId=330129
Funding: Total: $6,400,000. Maximum awards: $1M.
Dates: Application Submission Deadline: Feb 01, 2021

Summary: The University Turbine Systems Research (UTSR) Program encompasses a portfolio of gas turbine-focused university projects, which address a wide variety of technical topics (including combustion, aerodynamics/heat transfer, and advanced materials topics) by conducting cutting edge R&D. Technical topics are relevant to research goals of the US DOE and the gas turbine industry and support advanced technologies that can increase energy efficiency, reduce emissions, and provide additional performance benefits. Given this extensive interest in hydrogen-based electricity generation, topics in this FOA focus on fundamental and applied research to enable the use of hydrogen as a gas turbine fuel.

Project Topic Areas:
The objective of this FOA is to solicit and competitively award university-based R&D projects that address and resolve fundamental scientific challenges and applied engineering technology issues associated with advancing the performance and efficiency of combustion turbines fueled with pure hydrogen, hydrogen and natural gas mixtures, and other carbon-free hydrogen containing fuels (e.g., ammonia) in combined and simple cycle applications. The FOA is soliciting with the intent to competitively award laboratory/bench-scale R&D in the following three areas of interest (AOIs):

AOI 1: Hydrogen Combustion Fundamentals for Gas Turbines
AOI 1 seeks to further the technical understanding of fundamental combustion phenomena of hydrogen containing fuels over a broad range of fuel compositions and combustion conditions. The goal of AOI 1 is to enable improved computational modeling of combustion phenomena and enable applied research of hydrogen containing fuels under gas turbine conditions. R&D subjects of interest for AOI 1 include: Assessment of ignition energy and delay times; Assessment of autoignition characteristics; Assessment of laminar and turbulent flame speeds; Assessment of extinction strain rates; Collection of chemical reaction kinetic data and development of reaction mechanisms; Evaluation of pollutant (Oxides of nitrogen (NOx), CO, and particulate matter) formation and formation pathways, including the impact of ammonia and diluents on pollutant formation; Development of computational fluid dynamic (CFD) models, computational reaction models, and other design tools to support applied hydrogen containing fuel combustion experiments; and Assessment of fuel mixing characteristics.

AOI 2: Hydrogen Combustion Applications for Gas Turbines
Successful projects under AOI 2 will develop a technical understanding of applied hydrogen containing fuel combustion phenomena under gas turbine conditions with the goal that the knowledge, data and understanding produced from the project could be used as design information for stable, high temperature and low NOx gas turbine combustors capable of utilizing hydrogen containing fuels in both new and retrofit applications. Under AOI 2, the R&D subject of interest is the assessment and mapping of hydrogen containing fuel combustion phenomena over a range of relevant gas turbine conditions and physical features, with the goal that the applied understanding would support the design of high temperature and stable hydrogen fueled gas turbine combustion systems with low NOx emissions. Accordingly, applications must consider the following: Fuels of interest include 100% hydrogen, carbon free hydrogen carrying fuels (i.e., ammonia), and mixtures of these fuels with each other and as appropriate with natural gas. Applications should specify these blends to extend and complete, where needed, the known hydrogen-natural gas mixture data set for the relevant gas turbine conditions. Hydrogen and natural gas percent-byvolume mixtures suggested for study should support, but not be limited to, likely gas turbine deployment scenarios with hydrogen fuels; The hydrogen containing fuels combustion assessment must consider test conditions and physical features (injectors, injector interactions, burners, swirlers, bluff bodies, vanes, etc.) representative of existing combustor designs, new combustor designs, and retrofit applications. Unique and novel approaches for purpose-built features made possible through advanced manufacturing to realize the goal of AOI 2 are encouraged; Diluents available for air-breathing, open combustion Brayton cycles in simple and combined-cycle applications should be used in testing, and the impact of diluents should be assessed. Nitrogen may be used as a diluent when assessing ammonia or ammonia-mixtures as a fuel. Nitrogen may be used to assess combustion phenomena; however, nitrogen is not considered to be a diluent that is readily available in most simple and combined-cycle applications for AOI 2; Several hydrogen-fueled gas turbine flame phenomena of interest include lean blow off, flame extinction limit, flammability limits, combustion instability, flash back, flame holding, flame speed, hot spots, etc.; Assessment of hydrogen fuel air

premixing and hydrogen fuel staging particularly for NOx control under relevant conditions and geometries; and Where pertinent, assess conditions relevant to turn-down range, dynamics, and load following transients.

AOI 3: Hydrogen-Air Rotating Detonation Engines
Successful projects under AOI 3 will develop a fundamental understanding of various loss mechanisms (such as secondary deflagration or non-detonative shock waves) and wave mode / number on the potential work output from an RDE-Turbine system and build upon the existing knowledge base in order to demonstrate (experimentally or through a combination of experimental and computational study) the ability to transition the high-speed, unsteady flow from the RDE exit to a downstream turbine through the actual integration of the RDE in a small-scale gas turbine, or through a combination of experimental and computational lab-scale studies. Under AOI 3, R&D subjects of interest include: Assessment of the impact of concurrent deflagration in hydrogen-air (or hydrogen blended fuels) RDE's to produce useful work when integrated into a gas turbine system; Assessment of wave mode and wave number of hydrogen-air (or hydrogen blended fuels) RDE's/RDC's potential to produce useful work when integrated into a gas turbine system; Development of computational studies in support of integrating RDE's and gas turbine systems operating on hydrogen containing fuels and air; Demonstration of coupling of RDE/RDC with flow transition elements (i.e., diffuser) and turbine; Demonstration of methodology for quantifying the impact of RDE, transition element(s) and turbine on individual component performance and ability to produce useful work in a gas turbine system; and Suggested methodology for scaling lab-scale experimental and computational studies to F-class and aeroderivative class RDE-gas turbine integrated systems.

Funding:
Total funding under this solicitation is $6,400,000. The cost share must be at least 20% of the total allowable costs for research and development projects and must come from non-Federal sources unless otherwise allowed by law.

Area of Interest	Estimated Federal Funding	Anticipated No. of Awards	Anticipated Individual Award Size			Maximum DOE Share of Award
			DOE Share $/%	Cost Share * $/%	Total $	
1	$2,400,000	Up to 3	$800,000 / 80%	$200,000 / 20%	$1,000,000	$800,000
2	$2,400,000	Up to 3	$800,000 / 80%	$200,000 / 20%	$1,000,000	$800,000
3	$1,600,000	Up to 2	$800,000 / 80%	$200,000 / 20%	$1,000,000	$800,000
Total	**$6,400,000**	**Up to 8**				

*Applicants may propose cost share in excess of 20% which could result in higher total award values than those stated above.

Project Requirements:
Strategic leveraging and collaboration with an applicable OEM, turbine OEM, or other government agency (e.g., DOD and NASA) is encouraged. If an applicant proposes an applicable OEM, turbine OEM, or other government agency as a subrecipient on the award, a letter of commitment from each proposed team member is required and must be signed by the person authorized to commit resources on behalf of the organization. Letters should clearly state the nature of the partnering organization's commitment to the project, such as host site access, data access, advisory services, etc.

AOI 1: Hydrogen Combustion Fundamentals for Gas Turbines
Successful applications must address fundamental knowledge gaps associated with combustion of hydrogen containing fuels and should propose to evaluate these phenomena using a range of relevant fuel compositions, some of which should include potential diluents such as nitrogen and steam. Efforts that utilize both high fidelity computational models and experiments in a complementary fashion are encouraged. Applications should present a strong technical understanding of existing information related to combustion of hydrogen containing fuels in order to focus work and build upon the existing knowledge base. Applications should clearly explain the fuel compositions, combustion phenomena, and combustion conditions that will be evaluated during the project and justify why these fuel compositions, combustion phenomena, and combustion conditions were selected.

AOI 2: Hydrogen Combustion Applications for Gas Turbines
Applications should emphasize and discuss the combustion phenomena that will be explored, describe how they will be explored, and justify why they are important to realizing stable, low NOx, and high temperature gas turbine combustion. Applications must present a relevant technical understanding of existing hydrogen containing fuel combustion information in order to focus potential work and build upon the existing knowledge base. Successful projects must include the mapping, scaling, and normalizing of test data and an explanation of combustion phenomena and trends over a relevant range of gas turbine conditions, combustor geometries, and physical features.

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Applications should present a plan that organizes and separates testing into logical and resource efficient test campaigns. Test campaigns should be organized and justified technically, and prioritized to meet the goal of AOI 2, which is to produce knowledge, data and understanding that could assist with, and enable, the design of stable, high temperature, and low NOx hydrogen fueled gas turbine combustors. Proposed concepts should have a Technology Readiness Level (TRL) of 1 to 3 at the beginning of the project and a TRL of 2 to 3 must be achieved at project end.

AOI 3: Hydrogen-Air Rotating Detonation Engines

Applicants should present a strong technical understanding of existing knowledge related to the design, operation and performance characterization of RDE's/RDC's on hydrogen-based fuels and air. Applicants should provide clear technical justification for the RDE configuration and how it relates to hardware and conditions relevant to F-class and aeroderivative class gas turbines. The research focus should be on experimental or complementary experimental-computational efforts at precombustion operating pressures above ambient. Applicants are responsible for identifying any activities that fall under the International Traffic in Arms Regulations (ITAR), and/or the Export Administration Regulations (EAR). If selected, prior to award, the applicant must provide a description of the initiation / implementation / maintenance of the ITAR/export control compliance systems or facilities in order to perform ITAR / export controlled research. Proposed concepts should have a Technology Readiness Level (TRL) of 2 to 3 at the beginning of the project and a TRL of 4 must be achieved at project end.

Eligible Applicants:

In accordance with 2 CFR 910.126, competition, eligibility for award is restricted to Domestic Institutions of Higher Education and University- Affiliated Research Institutions. DOE is restricting eligibility to support the performance of high quality research at Domestic Institutions of Higher Education and University-Affiliated Research Institutions, and to ensure that the results of the research benefit the public, it is recommended that applications may only be submitted by Domestic Institutions of Higher Education and University-Affiliated Research Institutions. Subrecipient and/or Subcontracting effort that is proposed for entities other than a Domestic Institution of Higher Education and/or University-Affiliated Research Institution is limited, in aggregate, to 20% of the total proposed project costs. The following are eligible to apply for funding as a Subrecipient but are not eligible to apply as a Prime Recipient: U.S. citizens and lawful permanent residents; For-profit entities and nonprofits that are incorporated (or otherwise formed) under the laws of a particular State or territory of the United States; State, local, and tribal government entities; DOE/National Nuclear Security Administration (NNSA) Federally Funded Research and Development Centers (FFRDCs) and National Laboratories (NL); Non-DOE/NNSA FFRDCs and National Laboratories; Federal agencies and instrumentalities (other than DOE); Foreign entities, whether for-profit or otherwise; Incorporated and Unincorporated consortia, which may include domestic and/or foreign entities. Unincorporated Consortia must designate one member of the consortium to serve as the consortium representative. The consortium representative must be incorporated (or otherwise formed) under the laws of a State or territory of the United States. NETL is not eligible for award under this announcement and may not be proposed as a sub-recipient on another entity's application. Nonprofit organizations described in section 501(c)(4) of the Internal Revenue Code of 1986 that engaged in lobbying activities after December 31, 1995, are not eligible to apply for funding.