Gas Turbine Association

August 19, 2020

U.S. Department of Energy (DOE)
The Office of Fossil Energy
Re: RFI-DE-FOA-0002369

The Gas Turbine Association (GTA) is a membership organization established in 1995 with a goal of communicating the message that gas turbines are, and will continue to be, a vital source of power generation in the United States of America and around the globe. The GTA is comprised of the major gas turbine manufacturers and service providers in the energy market, with US gas power exports of $12B USD per year, with more than 200,000 high paying jobs across the country.

As the world transitions towards carbon neutrality, gas turbine technology will be essential for under-pinning and securing a sustainable, clean, efficient, and reliable generation mix. Today, gas turbines produce over one-third of our nation's electricity and power a substantial portion of our nation's pipeline infrastructure. They are a cornerstone energy conversion technology, providing electricity and heat for industries and communities. Today's dynamic, innovative, and competitive US energy market depends on clean and efficient gas turbine products coupled with growing renewable generation capabilities.

With this in mind, GTA wholly supports the Department of Energy's (DOE) Request for Information (RFI) to achieve future "Hydrogen Technologies." This response is focused on **Topic Area C** of the RFI. GTA believes gas turbines will continue to play an integral role in our nation's energy infrastructure today and in the future, and that they are an essential vehicle for reducing greenhouse gas emissions as the US transitions towards a decarbonized future. In particular, fuel flexible gas turbine engines with the capability to burn green hydrogen, generated from renewable sources of energy such as solar and wind, would provide proven and reliable electrical power to businesses, homes, and electrical vehicles without adversely impacting the climate. As the electrical energy infrastructure becomes more distributed via the usage of solar panels and wind farms and as electricity demand increases due to the proliferation of electrical vehicles, the excess energy from these sources may be stored as hydrogen, and then burned, as needed, by fuel-flexible gas turbine engines. Investments in gas turbine technologies that substantially enhance energy conversion efficiency, relative to today's state-of-the-art technology, and as recommended in a consensus study report published in January 2020 by the National Research Council, are critical to a future state and national green energy infrastructure.

Gas turbine technology provides the best attributes:

- Variation in offerings from small to large gas turbines – making it suitable for an extraordinarily broad array of applications.

- Operational flexibility – that will provide power security to the growing renewable portfolio.
- Achieve a significantly lower environmental impact when compared to other energy technologies.
- Substantial gain in plant efficiencies in Combined Heat and Power applications.

The key to success begins with a coherent technology development path that provides design opportunity for substantially higher levels of gas turbine simple cycle and combined cycle thermal efficiency by 2030. The enabling technologies include high temperature materials, advanced coatings, advanced turbomachinery, and advanced thermal management strategies, as recommended in a consensus study report published in January 2020 by the National Research Council.

Also, as the DOE may be aware, EUTurbines members, in support of EU's reducing greenhouse gas emissions initiative, declared in 2019 "*that by 2020 natural gas blended with up to 20% hydrogen can be utilized and that, by 2030, customers will be able to acquire turbines operating with hydrogen only. In addition, retrofit combustion system solutions for existing turbines shall be developed.*"

Many of the GTA members are also EUTurbines members, as the energy market is in fact both global and regional. GTA is advocating for DOE research and development funding that enables gas turbines to operate efficiently and cost effectively on hydrogen fuel. A national power-to-power hydrogen infrastructure will utilize gas turbines for both gas compression and electrical power generation. However, several key barriers must be overcome to drive the implementation of today's gas turbine fleet for hydrogen. These issues include:

1. The development of fuel flexible combustion systems, including retrofit combustion system solutions, that burn renewable fuels, such as natural gas with high hydrogen content (from a range of 0% up to 100%) and other Green Fuels.
2. The development of new gas turbine combustor technology that mitigates flashback and combustion dynamics while avoiding excess NOx emissions. As part of the hydrogen development path, GTA recommends engagement with EPA to ensure emissions regulations consider high H2 operation.
3. Infrastructure and/or chemical transport options to accommodate hydrogen's low energy density. These include methods for increasing compression capacity on existing pipelines as well as technology improvements in hydrogen-resistant seals, coatings, improved sensors and related ancillary technologies to effectively transport and manage high-hydrogen blended mixtures or pure hydrogen.
4. Gas turbine plants will require significant modifications and retrofits in order to incorporate hydrogen-compatible advanced materials and thermal-barrier coatings (TBC).
5. New safety standards and safety equipment will be essential. Hydrogen is highly explosive in confined spaces, even at low concentrations. New ventilation and purge standards must

address hydrogen accumulation in Heat Recovery Steam Generator (HRSG) attics, and safety procedures must be instilled at plants to prepare plant personnel and emergency responders for the nearly invisible flames of hydrogen combustion.

Gas turbine technology development is needed to reach the goal of safely and efficiently burning up to 100% hydrogen fuel. The points below highlight some of the necessary development topics that must be addressed:

- New materials development for improved life
- Combustion dynamics on H2 is required
- Consider and address "start up and shut down on H2"
- Address fuel blending with NG with variable fuel heating options
- Assess dual NG/H2 capability with fuel switching
- Development of HRSG with capability to operate safety on H2 in duct firing.
- Ensure fuel accessories development to address hazard gas protection, including inert purge and sensors
- Grid code compliance with H2
- How to maintain low NOx/CO including combustion premixing & staging as well as post combustion catalysts.
- Safe operation on H2 including need for new standards / certifications / guidelines, and continuous monitoring

GTA welcomes the opportunity to support a further technical dialogue with the DOE on this RFI. Our belief is that a continued dialogue would benefit both parties; constructively addressing value, timing, and investment. The GTA would also like to take this opportunity to extend our support/expertise for future consultation and collaboration on any other FOA that will have a reliance and a direct impact on Gas Turbines.

Please do not hesitate to contact me directly with any questions, comments or concerns at 704-806-0197 or dellavilla@spsinc.com.

Sincerely,

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Gas Turbine Association

Gas Turbine Association Membership

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