About the Gas Turbine Association (GTA)
The GTA is a membership organization established in 1995 and has a mission to serve as a unified voice for the Gas Turbine Industry. Today, Gas Turbines produce more than a quarter of our nation's electricity. They are a cornerstone energy conversion technology, providing electricity and heat for industries and communities, and powering the nation's network of energy distribution pipelines and other critical infrastructure. Largely through conversion to advanced gas turbine technologies, carbon dioxide emissions from the United States' power generation sector have fallen more than 25% since 2005, while overall generation capacity has increased over the same time period.

GTA would suggest that gas turbines are vital for energy resiliency and reliability – they are essential for responding to the impact of climate change. Research from the Electric Power Research Institute (EPRI) indicates that "The U.S. is responsible for 44% of global CO2 emission reductions since 2005, and 80% of that was from the electricity sector. Energy efficiency and cleaner generation have been the reason for these gains. Fuel blending can also help lower CO2 further." This is further supported by a review of the Power Sector Carbon Index, research performed by the Scott Institute for Energy Innovation at Carnegie Mellon University.

Gas turbines will play an increasingly important role in the achievement of national objectives related to energy and the environment and will play a key role as part of the Energy Mix moving forward.

To inquire about the Gas Turbine Association (GTA) please visit https://www.gasturbine.org or email Lynne Bellizzi at lynne@gasturbine.org.

Our Association also appreciates and reiterates many of the responses to the Committee's Request for Information that were provided by our colleagues at the American Gas Association (AGA) in its letter of November 22, 2019.

GTA responses are designated as:

> ***Gas Turbine Association***:

Sector-Specific Policies

1. What policies should Congress adopt to decarbonize the following sectors consistent with meeting or exceeding net-zero emissions by mid-century? Where possible, please provide analytical support that demonstrates that the recommended policies achieve the goal.

a. Transportation

b. Electric Power. The Select Committee would like policy ideas across the electricity sector but requests specific comment on two areas:

i. If you recommend a Clean Energy Standard, how should it be designed?
ii. How can Congress expedite the permitting and siting of high-voltage interstate transmission lines to carry renewable energy to load centers?

Gas Turbine Association: Congress should enact policies conducive to the construction of modern efficient natural gas burning power generation.

Natural gas-fired turbines produce less than half the amount of CO2 emissions per kilowatt-hour of power produced relative to coal-fired power facilities. Other air pollutants such as nitrogen oxide (NOx) and sulphur dioxide (SO2) are also drastically reduced through the use of natural gas resources for power generation.
According to IEA research, carbon dioxide emissions from power generation in the US fell by 27% between 2005 and 2017 while overall power generation increased, and the switch from coal to gas-fired power has provided 2/3rds of that reduction in emissions. Moreover, the switch from coal to gas has enabled CO2 emissions from US power generation to be lower than CO2 emissions from the US transportation sector for the first time in history – a strong demonstration of the impact that improving efficiency can have for our economy and our environment.

Gas turbines are also highly dispatchable power sources so they are a perfect complement for higher renewable portfolio standards. As a higher proportion of intermittent renewable sources comes online to the grid, there is a need for rapidly dispatchable high-volume sources of power generation to offset unexpected deficits in power production when renewable resources are not available, or when demand spikes at inopportune times relative to other sources of generation capacity. The cycles can vary hourly, daily or seasonally. Gas turbines are well-suited to provide sustained dispatchable power at volumes beyond the capacity of current power storage solutions.

Gas turbines also offer the opportunity to harness a carbon free fuel in hydrogen. Instead of "dumping" excess power generated by renewable energy sources during periods of relatively low demand, some are advocating for harnessing excess power from renewable sources such as wind or solar to create hydrogen through hydrolysis and then "storing" that resource for use as a highly efficient on-demand fuel source. In this model, the hydrogen can then be combusted via a gas turbine for on-demand zero-emission power generation.

Policies that discourage construction of new natural gas combined cycle plants will inhibit near-term opportunities to significantly reduce emissions through installation of modern and highly efficiency gas turbines while maintaining the reliability, resilience, and operational flexibility required to stabilize the nation's power grid as renewable power generation continues to grow.

c. Industry

> ***Gas Turbine Association***: Gas turbines provide a number of critical services for the nation's industrial sector, including providing a substantial source of mechanical drive capability to support large-scale industrial equipment, pumps or compressors for pipelines or industrial gas production and distribution, and as a highly efficient source of co-generation capacity, steam, heat and auxiliary power for plant operations or heating and cooling systems. Furthermore, gas turbine manufacturing, operation, maintenance and repair is a major industrial sector and job creator in its own right, employing hundreds of thousands of Americans in high-value advanced manufacturing jobs throughout our country.

d. Buildings

> ***Gas Turbine Association***: Modern efficient gas turbines underpin many microgrid installations, as the quick ramp rates and on-demand provision of power provided by gas turbines can help offset variability in other systems. These attributes of gas turbine systems enable these installations to provide voltage and frequency regulation capabilities that are critical for the ongoing operation and resiliency of our power infrastructure, whether that is delivered across the nation or a neighborhood. Modern combined heat and power (CHP) or combined cooling heat and power (CCHP) systems based on gas turbine technologies contribute to resilient institutions and communities, protect critical infrastructure and deliver reliable energy and auxiliary services at effective rates of efficiency approaching 80% to 90%. They are a great success story in energy transition and combined with new energy storage solutions and renewable resources, worth replicating across the country. The reliability and dispatchable capacity afforded by the gas turbine cores upon which these systems are based are essential to their effective operation as an integrated and resilient system.

2. What policies should Congress adopt to ensure that the United States is a leader in innovative manufacturing clean technologies; creating new, family-sustaining jobs in these sectors; and supporting workers during the decarbonization transition?

> ***Gas Turbine Association***: The association encourages Congress to make policies including appropriations to R&D that acknowledge gas turbines as an integral part of the energy sector. Advanced gas turbines are a major source of American industrial strength, and design, engineering and manufacturing as well as ongoing operation, maintenance and repair provide hundreds of thousands of high-paying US jobs across the country. The materials, technologies

> and processes that underpin success in advanced gas turbines for power generation also support the United States' strength in aviation engines, military aircraft and weapons systems and even in commercial space applications. These represent tens of billions of high-value US exports each year, and help support a strong and vibrant advanced manufacturing industry across the U.S.

3. What policies should Congress adopt to ensure that environmental justice is integral to any plan to decarbonize these sectors?

> ***Gas Turbine Association***: Policies that dramatically increase the cost of electricity will likely have an outsized impact on lower income Americans and could have a suppressive effect on the US economy. Moving to 100% clean (i.e. carbon free) through use of renewables, energy storage, hydrogen production and carbon capture will likely result in the cost of energy increasing to many multiples of today's levels with the supply of energy likely being less reliable. This would likely result in downward pressure on US economic activity. The committee is requested to consider the economic burden of such a goal. The most promising climate policy design must strike a reasonable balance between several requirements. The energy sector landscape is immensely complex and connected. Setting absolute targets based solely on emissions will leave out several other criteria that are important to the United States and its citizens. When crafting policy in the energy sector, we believe the Committee should consider environmental impact, reliability and resiliency of the power grid, and cost effectiveness.

Cross-Cutting Policies

4. Carbon Pricing:

a. What role should carbon pricing play in any national climate action plan to meet or exceed net zero by mid-century, while also minimizing impacts to low- and middle-income families, creating family-sustaining jobs, and advancing environmental justice? Where possible, please provide analytical support to show that the recommended policies achieve these goals.
b. How could sectoral-specific policies, outlined in questions 1-3, complement a carbon pricing program?

> ***Gas Turbine Association:*** Carbon pricing is one method to incentivize transition toward a cleaner and less carbon-intensive energy system without making prescriptive decisions about the technologies and modalities of achieving those overall goals. Furthermore, carbon pricing policies engender broad-based changes across the sectors of the economy that they impact,

and are therefore much more effective at developing broader based changes than more narrowly-focused regulatory efforts. For example, a broad-based carbon price structure could be more effective in reducing the carbon intensity of the economy at a lower cost of carbon relative to the US EPA's recent Clean Power Plan, which was relatively narrowly targeted on regulation of new power generation facilities.

That said, any effort to develop a carbon pricing structure should be implemented in a phased approach with clear market signals and analysis underpinning the construction and governance of that system. This structure and analytical rigor will enable the market time to adapt to identify and implement the most effective solutions within a reasonable timeline without significantly disrupting the financing and project development markets. Moving too quickly could cause costs of implementation to spike simply through overloading the existing systems set up to manage and finance these types of project developments. Economic impacts, especially for the most vulnerable elements of our society, should be considered as part of this dialogue.

5. Innovation:

a. Where should Congress focus an innovation agenda for climate solutions? Please identify specific areas for federal investment and, where possible, recommend the scale of investment needed to achieve results in research, development and deployment.
b. How can Congress incentivize more public-private partnerships and encourage more private investment in clean energy innovation?

Gas Turbine Association: Congress should enact policies that provide $50M per year to the Department of Energy R&D funding for advanced gas turbine technologies. While gas turbines generate approximately 30% of the power in the US, gas turbine technologies only receive about 3% of R&D funding within the DOE's Office of Fossil Energy. Technologies for ultra-high gas turbine combined cycle (GTCC) efficiency (65%+) will enable natural gas power generation to reduce emissions while maintaining the reliability and resiliency necessary to complement renewable energy sources.

Key technology areas include: high temperature materials, improved heat transfer capability, aerodynamic optimization, advanced manufacturing technology, combustion technology, advanced controls and systems integration, compressor technology, validation and testing, as well as new gas turbine architectures. Regarding relevant areas for future research, over the past 4 years the Association has helped sponsor the NIST Advance Manufacturing Consortium for Advanced Production and Engineering of Gas Turbines and Rotating Machinery (CAPE). The CAPE effort, through the collaboration of many leading members of the nation's turbine and aviation engine industry and the nation's academic community and national labs, has developed an Advanced Gas Turbine Manufacturing Technology Roadmap that outlines priorities for

investment in advanced materials, advanced production processes, digitization and advanced inspection, maintenance, repair and sustainment, and workforce training and safety that will help our nation retain its vital competitive edge in a very competitive global marketplace and strategic defense environment. More information regarding this roadmap and related recommendations and action plans is available at the Association's website www.gasturbine.org.

In particular, the Association calls for increased funding of the DOE's Fossil Energy Research & Development program called "Advanced Turbines". Funds provided through this program have contributed to advances in gas turbine technologies resulting in greater efficiencies and a cleaner burning reliable fuel source. Each percentage point increase in efficiency of the gas turbine combined cycle fleet results in emissions reductions equivalent to taking 2 million cars off the road. Improvements through these programs have also led to substantial improvements in performance and efficiency of aircraft engines, another prime mover of modern life that we will be hard-pressed to replace. Our nation needs to invest significantly in advanced turbine R&D to assist in technology and material development and demonstration across all segments of the gas turbine industry, encompassing aviation and industrial applications as well as power generation. We are concerned that the DOE's current focus on "Coal FIRST" coincides with a reduction in funding available for advanced gas turbine R&D, which is detrimental to progress that needs to be made across multiple modes of advanced turbines that will be critical to enabling our nation and our world's effective transition to a cleaner and less carbon-intensive energy and transportation system in the coming years.

Non-CO2 Greenhouse Gases

9. What policies should Congress adopt to reduce emissions of non-CO2 greenhouse gases, including methane, nitrous oxide, and fluorinated gases?

Gas Turbine Association: Gas Turbine technologies provide substantial benefits in decreasing emissions and improving efficiency for the power generation, heating and cooling and industrial applications. Highly efficient combined-cycle power generation and combined heat and power facilities allow the production of electricity, heat and steam with vastly reduced levels of nitrogen oxide (NOx), carbon monoxide (CO), un-combusted hydrocarbons and other ancillary emissions such as Volatile Organic Compounds (VOCs) and Sulphur Oxides (SOx). As the gas turbine industry enables the most efficient means of converting methane and many other more complex hydrocarbons into electrical, thermal and/or kinetic energy for a wide range of applications, our industry supports activities to reduce waste and improve the efficiency, effectiveness and emissions profile of the overall US power generation industry. The Association urges policymakers including Congress to design and enact policy tools that focus on broad goals and objectives and allow the market to find the most cost-effective and efficient means of meeting those objectives.

Respectfully,

Guy DeLeonardo
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December 4, 2019

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