Hydrogen Overview

TAKEAWAY: 01

GE supports customers in their decarbonization* journey, including hydrogen, carbon capture, coal-to-gas switching or other approaches.

TAKEAWAY: 02

GE has more than 100 gas turbines operating on hydrogen fuel blends that have accumulated more than 8 million hours of operation.

TAKEAWAY: 03

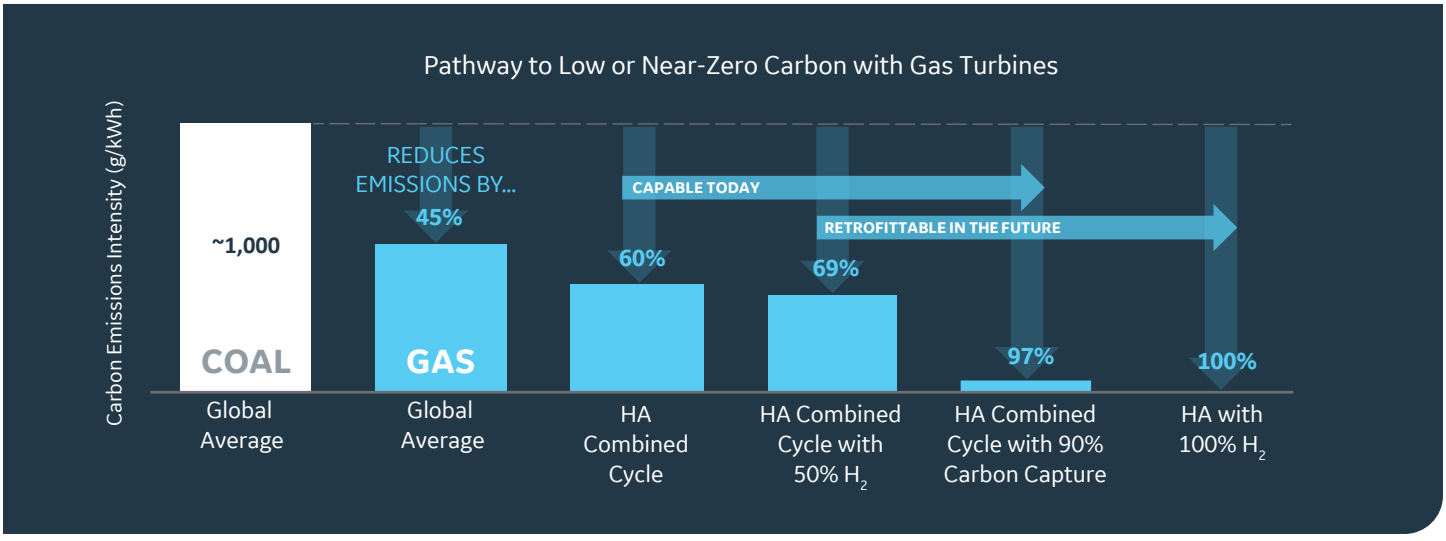
GE is partnering with customers on both hydrogen demonstration and commercial projects across the globe.

ENERGY TRANSITION: A DECADE OF ACTION

- The energy transition remains the greatest uncertainty for the power sector today. While the sense of urgency to address climate-change has never been higher, the pace and scale of investments must increase significantly in order to meet decarbonization goals.
- More work needs to be done to reduce the cost of hydrogen and carbon capture and sequestration technologies to accelerate their deployment. These technologies have the potential to significantly enable near-zero-carbon power generation and some governments are offering incentives to foster adoption.

HYDROGEN AS A FUEL FOR GAS TURBINES

- Burning hydrogen is a potential pathway to decarbonize gas turbines by replacing natural gas fuel with hydrogen, which has no carbon, and therefore, no CO_2 in the exhaust. One area to consider when burning hydrogen is that more NO_x may be produced compared to natural gas.
- Most (~95%) of the hydrogen produced today is produced using natural gas via the Steam Methane Reforming process, with the resultant CO_2 released to the atmosphere. This is called **“grey” hydrogen.**
- Adding a carbon capture system to this process results in **“blue” hydrogen.**
- So-called **“green” hydrogen** is produced by electrolyzing water into hydrogen and oxygen using renewable energy as the power source.
- **A gas turbine does not care which “color” hydrogen is used as fuel.**



OVER

CHALLENGING HYDROGEN ECONOMY

- Low carbon hydrogen fuel costs are trending lower, but are expected to remain 2–10X more expensive than natural gas at least through the end of the decade.
- Carbon taxes or other incentives may improve the economics of hydrogen compared to fossil fuels, but we anticipate that hydrogen will be used in long-haul transportation, maritime shipping, and industry before it is broadly adopted in the power sector.

DELIVERING VALUE FOR ITS CUSTOMERS

- Power plant operators are increasingly exploring the option to use hydrogen as a fuel and requesting OEMs to identify their specific capability.
- GE has more experience burning hydrogen than any other OEM. This experience goes back to the mid-1990s and includes more than 100 gas turbines that have accumulated more than 8 million** hours of operation. This experience enables us to understand the unique challenges using hydrogen as a gas turbine fuel.

RECENT DEMONSTRATION AND COMMERCIAL PROJECTS THAT USE OR PLAN TO USE HYDROGEN

Long Ridge Energy (USA)
Long Ridge Energy intends to begin blending hydrogen in their *new 7HA.02* gas turbine later this year. The owner's plan is to transition the plant to 100% hydrogen in 10 years.

NYPA Brentwood (USA)
New York Power Authority intends to demonstrate blending hydrogen and natural gas in an existing *LM6000* gas turbine in 2022.

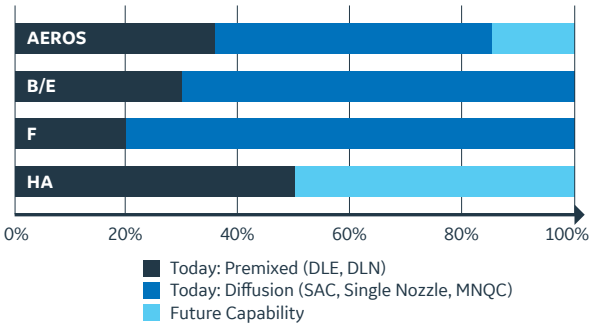
Tallawarra B (Australia)
EnergyAustralia intends to begin blending hydrogen in their *new 9F.05* gas turbine starting in 2025. This will be the first 9F gas turbine to operate on blends of hydrogen and natural gas.

Guangdong Huizhou (China)
Guangdong Energy Group intends to operate their new 9HA.01 gas turbines on a 10% blend of hydrogen and natural gas starting in 2023.

For more information, visit our website:
gepower.com/hydrogen

GE GAS TURBINE HYDROGEN CAPABILITY

- Each gas turbine model has specific capability for burning hydrogen, dictated primarily by the combustion system. Some are capable of burning 100% today.
- Our most advanced gas turbines, the 7HAs and 9HAs, are capable of burning as much as a 50/50 hydrogen/natural gas blend when using the DLN2.6e combustor.
- Work is underway to increase hydrogen burning capability across the portfolio, with a specific goal of achieving 100% capability for the HA machines.
- Existing gas power plants can be retrofitted to burn higher volumes of hydrogen than originally contemplated. These upgrades can be scheduled with planned outages to minimize the time the plant is not generating power, and for new units these capabilities can be part of the initial plant configuration or phased in over time as hydrogen becomes available.



CONCLUSION

- There is tremendous industry "buzz" around hydrogen, and it holds promise for decarbonizing the energy sector.
- However, because of the huge quantities of fuel needed for a gas power plant, questions remain about the timing of sufficient quantities of cost-competitive hydrogen for the power sector.
- Regardless of what challenges there are for building a hydrogen economy, our purpose is to support our customers on their hydrogen journey.
- Pilot projects are already demonstrating GE's technical leadership and innovation in decarbonization technology and we continue to build partnerships to deliver decarbonization solutions today, and at the same time build a more differentiated offering for our customers.

*Decarbonization in this paper is intended to mean the reduction of carbon emissions on a kilogram per megawatt hour basis.
**GE H_2 statistics as of September 2021: inclusive of both heavy-duty and aeroderivative gas turbines.