



Hydrogen overview

Takeaway

- GE Vernova supports customers in their decarbonization* journey, including hydrogen, carbon capture, coal-to-gas switching, or other approaches.
- GE Vernova has more than 100 gas turbines operating on hydrogen fuel blends that have accumulated more than 8 million hours of operation.
- GE Vernova is partnering with customers on both hydrogen demonstration and commercial projects across the globe.

* Decarbonization in this paper is intended to mean the reduction of carbon emissions on a kilogram per megawatt hour basis.

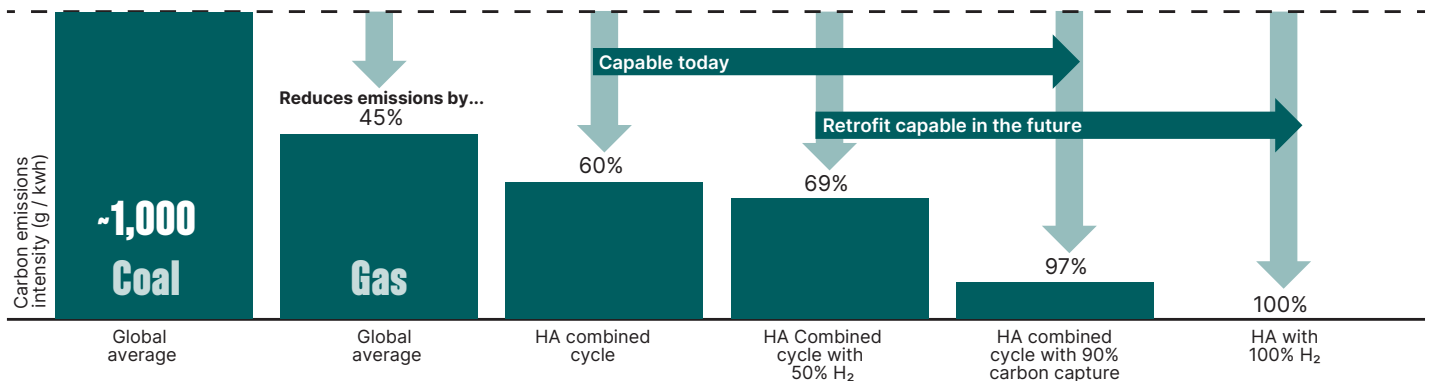
Energy transition: a decade of action

- 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 (CCS) technologies to accelerate their deployment. These technologies can help enable near-zero-carbon power generation, and some governments are offering incentives to foster adoption.

Hydrogen fueled 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 CO₂ in the exhaust. One area to consider when burning hydrogen is that more NO_x may be produced compared to natural gas.
- Most (~95%) hydrogen today is produced using natural gas via the Steam Methane Reforming process, with the resultant CO₂ 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.
- **A gas turbine operates independently of the hydrogen’s “color” classification.**

Pathway to low or near-zero carbon with gas turbines



Challenging hydrogen economy

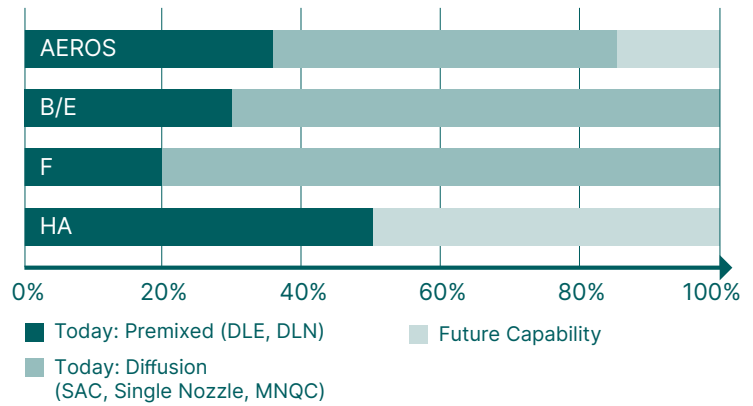
- Low-carbon hydrogen fuel costs are trending lower, but are expected to remain 2–10X more expensive than natural gas at least through the end of the decade.
- Carbon taxes or other incentives may improve the economics of hydrogen compared to fossil fuels, but we anticipate that hydrogen will be used in longhaul 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 Vernova 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 of using hydrogen as a gas turbine fuel.

GE Vernova's 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 turbines.
- Existing gas power plants can be retrofitted to burn higher volumes of hydrogen than originally configured for. These upgrades can be scheduled with planned outages to minimize plant downtime, and for new units these capabilities can be part of the initial plant configuration or phased in over time as hydrogen becomes available.



Recent demonstration and commercial projects that use or plan to use hydrogen



Debary Hydrogen Project (USA)

Duke Energy intends to operate their recently upgraded 7E gas turbine on up to 100% hydrogen by volume starting in 2025.



NYPA Brentwood (USA)

New York Power Authority demonstrated 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 began operating their new 9HA.01 gas turbines on a 10% blend of hydrogen and natural gas starting in 2023.

** GE Vernova H₂ statistics as of September 2021: inclusive of both heavy-duty and aeroderivative gas turbines.

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 Vernova’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.

For more information visit

<https://www.governova.com/gas-power/future-of-energy/hydrogen-fueled-gas-turbines>

