



Capstone Positioning Itself for The Hydrogen Economy

Don Ayers
Senior Director of Engineering and Quality

Water Tower Research
Webcast | October 21, 2020

NASDAQ: **CPST**



*Saving Money and the Environment –
One Turbine at a Time*

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Don Ayers – Capstone Turbine Sr. Dir, Engineer and Quality



Mr. Ayers has been serving Capstone Turbines as a Senior Director of Engineering and Quality since 2014.

Prior to joining Capstone, Don held program and project manager positions at L-3 Communications, Technicolor and Kavlico.

He holds a Masters in Business Administration from Pepperdine Graziadio Business School and a Bachelors in Mechanical Engineering from Purdue University.



Hydrogen – The Opportunities



- The hydrogen economy has gained momentum over the past 12 months.
- Hydrogen is frequently used as a fuel in fuel cells, but can also be used a fuel for combustion-based energy systems.
- Capstone updated and modified its energy systems to add fuel flexibility.
- As hydrogen becomes more widely available, energy systems will need to have flexibility to use hydrogen as a fuel.
- Hydrogen and especially “green hydrogen” are positioned for meaningful growth.
- Capstone will have a solution to capitalize on this trend.
- Capstone has demonstrated that it can run on a 20% hydrogen mix, but recently announced new a Research & Development partnership with Argonne National Laboratory and ran a 70% hydrogen - 30% natural gas.
- This is a promising milestone toward a goal of 100% hydrogen.
- The real value sits in the broader context of fuel flexibility and providing a customer with options.



Hydrogen – The Obstacles



“Hydrogen has received significant press recently, but there is still a long way to go for broad-based commercial availability of hydrogen, so we do not expect this to be a major factor anytime soon. Nonetheless having this as an option expands fuel flexibility and is a high-profile addition to the platform.”
- Don Ayers, Capstone Turbine



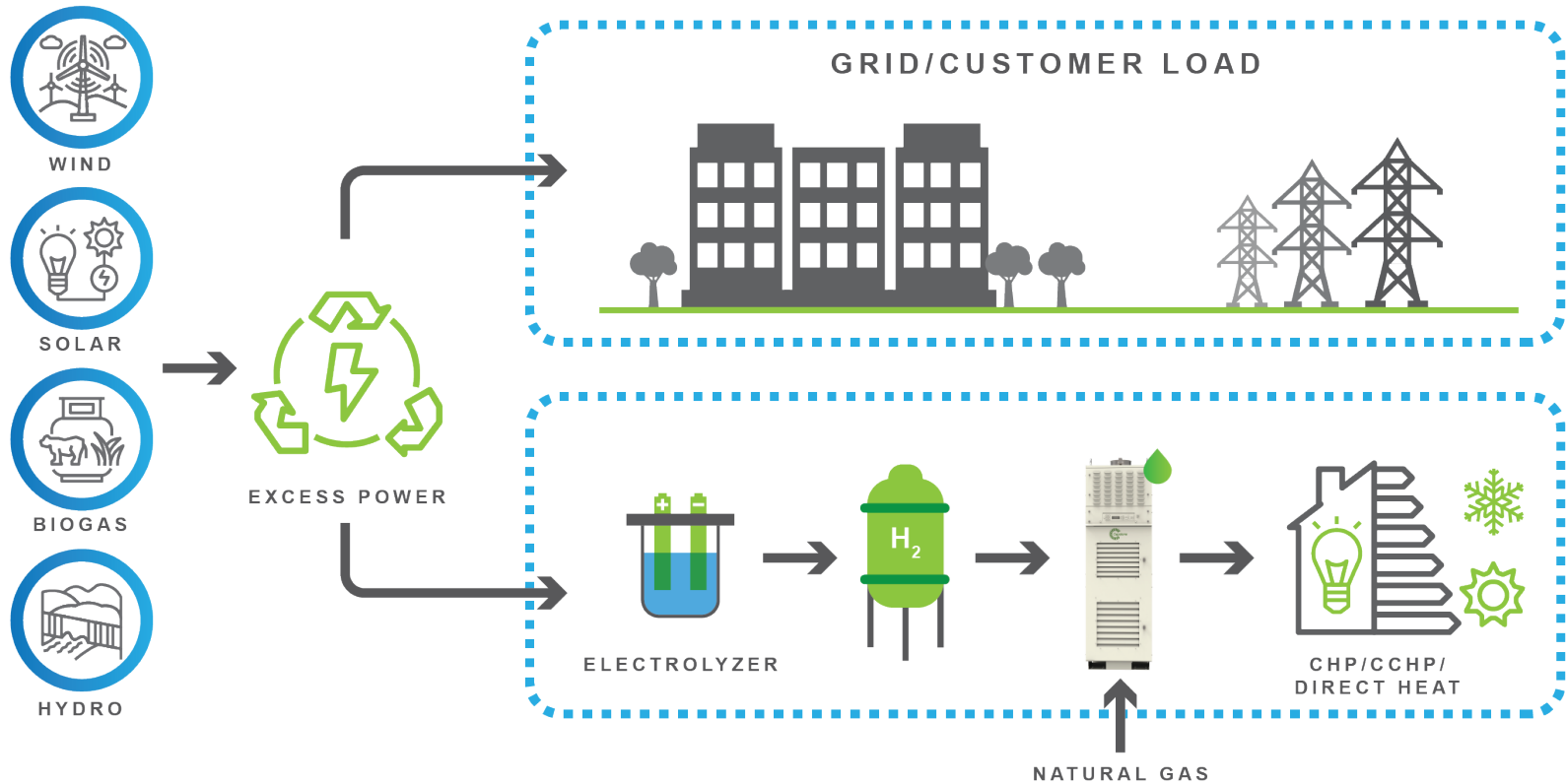
Hydrogen – Key Topics



- ✓ Capstone Turbine's flexible core engine and sophisticated controls technology is the perfect platform for development into new markets, applications, and fuels
- ✓ Hydrogen brings several challenges to turbomachinery in gas compression, storage, transmission, combustion, and associated safety controls
- ✓ Hydrogen and natural gas blends will provide the transition fuel for industry to achieve intermediate carbon emission goals, until such time as other technologies become hydrogen ready
- ✓ Capstone Turbine's fuel technology roadmap planned measured progress towards understanding existing capabilities with hydrogen while forwarding product development in more aggressive fuels



Hydrogen – System Architecture



Hydrogen – New Products

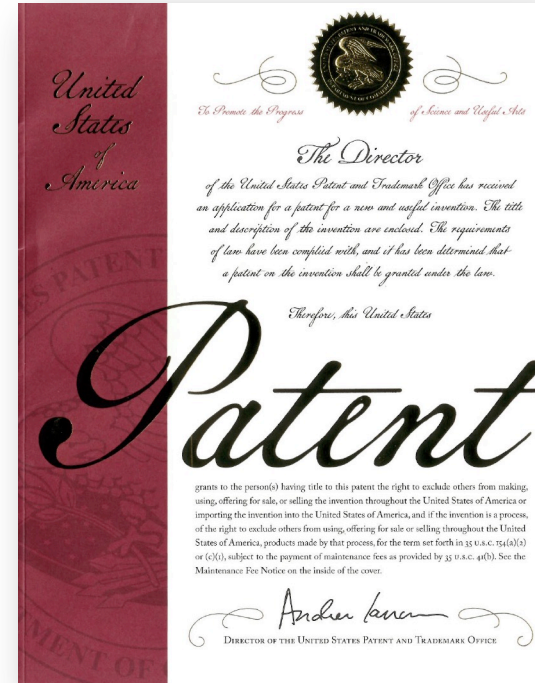


HYDROGEN •



Capstone now offers renewable power with the use of up to 20% Hydrogen in our product line of microturbines as a fuel source. Today we have successfully operated on a blend of natural gas and hydrogen and a newly patented injector.

• HYDROGEN



New Patent 10,184,664, is for a multiple-fuel capable, pre-mixed, low emission injector for high flame speed fuel combustion for Hydrogen and Renewable Natural Gas (RNG). Plans are in place to release a commercial 100% hydrogen fuel capable microturbine over the next couple of years.

Hydrogen – New Brochures

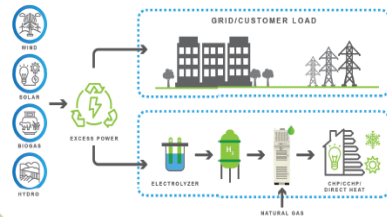
ZERO CARBON ROADMAP

CAPSTONE TURBINE HYDROGEN MICROTURBINES

As a thought-leader in the energy sector, Capstone recognized years ago that hydrogen would play an important role as a key part of the future of renewable, green energy landscape.

Hydrogen microturbines are the perfect complement for the intermittent nature of wind and solar power, making them an ideal component of the modern clean and green microgrid. When renewable energy production exceeds demand, excess energy can be used to power the production of storable, renewable hydrogen energy. Stored hydrogen provides a convenient, high-density fuel source that can be used as carbon-free fuel for Capstone's microturbines. As a decentralized energy source, microturbines can be located on-site where hydrogen can be produced and stored locally, in advance of the need for costly distribution, which may take many years to develop.

Capstone's hydrogen microturbine product will offer a more cost competitive 100% hydrogen solution with as good or better performance and superior lifecycle costs. In addition, Capstone's industry-leading combined heat and power (CHP) capability provides further advantages compared to electric-only fuel cells as microturbines offer a source of on-site thermal energy, optimizing the return on investment (ROI) for customers. A green energy solution that provides a real return financially is a very attractive offering in today's increasingly ESG-focused world.



HYDROGEN FAQ

• What hydrogen blended fuels can Capstone microturbines use?

Currently, Capstone microturbines can be operated on hydrogen / natural gas blends. The current limit in the fuel specification is 1%, however, Capstone has been permitting up to 10% hydrogen volume blended with natural gas. Capstone has been working with the DOE Argonne National Lab (ANL) and University of California Irvine (UCI) to advance system testing. At ANL, the C65 has been able to operate on up to 70% hydrogen without modification. Additional work is scheduled to evaluate the C200, and to validate performance over a variety of environmental conditions, operating profiles, and system configurations. SynGas, which is typically a blend of hydrogen, CO, and CO₂, will also be considered as Capstone progresses to 100% hydrogen operation.

• What is the fuel consumption rate for hydrogen to reach rated power outputs?

Fuel consumption for a C200 system will continue to be 2400 MWhour as this is what is needed to produce the power. The difference will be in the mass and volumetric flow rates of hydrogen, which will govern the size of fuel delivery equipment and storage requirements, if necessary. As a rule of thumb, the mass flow rate of hydrogen will be a third of that natural gas, while the volumetric flow rate will be higher, typically at 3 times natural gas.

• What safety measures are in place when hydrogen is all or part of the fuel composition?

For hydrogen blends up to 10% by volume, there are no expected changes required and the system may be used as currently manufactured by Capstone. As we work with higher levels of hydrogen, we have to be conscientious of the safety aspects, reviewing fuel inlet hardware, system controls, and package ventilation. Our work with national and university research partners will provide valuable insight as industry standards and best practices are developed.

• How does the use of hydrogen impact maintenance schedules?

There are no anticipated changes to maintenance schedules for systems operating on hydrogen and natural gas blends. For full hydrogen operation, scheduled maintenance will be defined as part of the validation and field trial stages. To keep Capstone equipment as consistent as possible, the objective will always be to minimize the number of new components, as well as maintaining our already very minimal service schedules. However, we do recognize the challenges hydrogen presents when used in a system that operates in the many different global applications available.

• What is the cost of the hydrogen fueled product?

100% hydrogen systems pricing will be based on the necessary changes we determine during final design for manufacturing, but is expected to only be nominally higher due to increased need for safety and monitoring required. Hydrogen/natural gas blend systems will be built as Capstone's standard, high pressure natural gas systems. Pricing is expected to be consistent with that product line.

• When will the 100% hydrogen C65/200/1000 be available?

Further testing is already planned with our patented hydrogen injectors after which we expect to continue testing with greater levels of hydrogen up to 100%. The current plan has a 100% hydrogen product available for sale in the latter half of calendar year 2022.



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Distributor Education



C65 Microturbine High-pressure Pure Hydrogen



Achieve ultra-low emissions and reliable electrical generation from pure hydrogen.

- One moving part – minimal maintenance and downtime
- Patented air bearings – no lubricating oil or coolant
- Integrated utility synchronization – no external switchgear
- Compact modular design allows for easy, low-cost installation
- Multiple units easily combined – act as single generating source
- Remote monitoring and diagnostic capabilities
- Proven technology with tens of millions of operating hours
- Various Factory Protection Plans available



C65 Microturbine

Electrical Performance¹

Electrical Power Output	65kW
Voltage	400/480 VAC
Electrical Service	
Frequency	
Electrical Efficiency LHV	

Fuel/Engine Characteristics¹

Pure Hydrogen	
Inlet Pressure	
Fuel Flow HHV	
Net Heat Rate LHV	

Exhaust Characteristics¹

NOx Emissions @ 15% O ₂	
Exhaust Mass Flow	
Exhaust Gas Temperature	

Dimensions & Weight¹

Width x Depth x Height	
Weight - Grid Connect Model	
Weight - Dual Mode Model	

Reliable power

C1000S Megawatt Power Package Hydrogen



The Signature Series Microturbine provides 1MW of reliable electrical power in one small, ultra-low emission, and highly efficient package.

- Ultra-low emissions
- One moving part – minimal maintenance and downtime
- Patented air bearings – no lubricating oil or coolant
- Integrated utility synchronization – no external switchgear
- Compact modular design allows for easy, low-cost installation
- High electrical efficiency over a very wide operating range
- High availability – part load redundancy
- Remote monitoring and diagnostic capabilities
- Proven technology with tens of millions of operating hours
- Various Factory Protection Plans available



C1000S Power Package

Electrical Performance¹

Electrical Power Output	1000kW
Voltage	400/480 VAC
Electrical Service	3-Phase, 4 Wire Wye
Frequency	50/60 Hz
Electrical Efficiency LHV	33%

Fuel/Engine Characteristics¹

Hydrogen HHV	12.1 MJ/m ³ (24 BTU/ft ³) nominal
Inlet Pressure	517-551 kPa gauge (75-80 psig)
Fuel Flow HHV	12,000 MJ/hr (11,400,000 BTU/hr)
Net Heat Rate LHV	10.9 MJ/kWh (10,300 BTU/kWh)

Exhaust Characteristics¹

Exhaust Mass Flow	6.7 kg/s (14.7 lbm/s)
Exhaust Gas Temperature	280°C (533°F)

Dimensions & Weight¹

Width x Depth x Height	3.0 x 9.1 x 3.0 m (117 x 360 x 119 in)
Weight - Grid Connect Model	17,100 kg (37,700 lbs)
Weight - Dual Mode Model	20,650 kg (45,500 lbs)

Reliable power when and where you need it. Clean and simple.

Hydrogen – New Press Releases



Capstone Turbine Issued Two New Patents for Multiple Fuel Applications – Including Hydrogen and Liquid Fuel Ultra-Low Emissions Capabilities

VAN NUYS, Calif., May 20, 2019 (GLOBE NEWSWIRE) – Capstone Turbine Corporation (www.capstoneturbine.com) (NASDAQ: CPST), the world's leading clean technology manufacturer of microturbine energy systems announced today that the U.S. Patent and Trademark Office has issued two new patents to Capstone. The patents support Capstone's initiatives targeting the expansion of multiple fuels for operation, including high flame speed fuels such as hydrogen, while also maintaining Capstone's industry-leading low emissions.

Patent 10,184,664 is for a multiple-fuel capable, pre-mixed, low emission injector for high flame speed fuel combustion. This patent is the foundation for continued development in achieving high reliability and performance with hydrogen content fuels.

Patent 10,197,292 is for a multi-stage, lean pre-vaporizing, pre-mixing fuel injector providing ultra-low emissions that meet EPA Tier 4 requirements for power generation. Under this new program, exhaust emissions from these engines will be required to decrease by more than 90%.

"Both patents use a similar design architecture but with differences for each application. One being for liquid fuels, and the other for hydrogen and hydrogen blend fuels," explains Don Ayers, Capstone's Director of Product Engineering. "They each seek to control fuel to air mixing to achieve higher performance and combustion efficiencies through flame stability, flashback prevention, and ultra-low emissions," added Mr. Ayers.

"Designing multiple fuel capability into our injectors reduces service costs and extends service life. It's a win-win situation for Capstone and our customers," said Jeff Foster, Capstone's Senior Vice President of Customer Service and Product Development.

Capstone's technology roadmap, announced in October 2018, includes the development of not only new fuel capabilities enabled by these patents, but also integrating these advancements into our future C65 Signature Series product line, and validated as part of our organic technology growth strategy.

"Our technology roadmap supports a variety of global advances that will ensure Capstone's products continue to become an essential behind the meter microgrid asset as part of the new clean and green energy economy," said Darren Jamison, Capstone's President and Chief Executive Officer. "Microturbines operating on alternative fuels like hydrogen, biogas, butane, and renewable natural gas showcases how Capstone's innovative and adaptable microturbine technology can continue to grow into new segments of the expanding green energy economy," concluded Mr. Jamison.

About Capstone Turbine Corporation

Capstone Turbine Corporation (www.capstoneturbine.com) (NASDAQ: CPST) is the world's leading producer of highly efficient, low-emission, resilient microturbine energy systems. Capstone microturbines serve multiple vertical markets worldwide, including natural resources, energy efficiency, renewable energy, critical power supply, transportation and microgrids.

Capstone offers a comprehensive product lineup, providing scalable systems focusing on 30 kW to 10 MWs that operate on a variety of gaseous or liquid fuels and are the ideal solution for today's distributed power generation needs. To date, Capstone has shipped over 9,000 units to 73 countries and have saved customers an estimated \$253 million in annual energy costs and 350,000 tons of carbon.

For more information about the company, please visit www.capstoneturbine.com. Follow Capstone Turbine on [Twitter](#), [LinkedIn](#) and [YouTube](#).

Forward-Looking Statements

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Capstone Turbine Corporation Announces Significant Progress in Microturbine Hydrogen Testing

Development Testing Demonstrates up to 70% Hydrogen to Natural Gas Mix

VAN NUYS, CA / ACCESSWIRE / August 24, 2020 / Capstone Turbine Corporation (www.capstoneturbine.com) (NASDAQ: CPST), the world's leading clean technology manufacturer of microturbine energy systems, announced today that through a collaboration with the U.S. Department of Energy's Argonne National Laboratory, it has achieved significant progress in the development of a hydrogen operable microturbine product.

Development testing performed at Argonne demonstrates that a blend of up to 70% hydrogen to natural gas can be successfully operated in an off-the-shelf Capstone microturbine, before the addition of specialized hardware or software. The next stage in the testing will be to replace injectors with Capstone's patented hydrogen compatible design, which is intended to ensure combustion stability and flashback margin. The testing will proceed to higher hydrogen levels until the program's goal of 100% is reached.

[See Capstone Turbine Issued Two New Patents For Multiple Fuel Applications – Including Hydrogen And Liquid Fuel Ultra-Low Emissions Capabilities; <https://ir.capstoneturbine.com/press-releases/detail/3688/>]

"The initial goal of the testing is to establish the capabilities of our current off-the-shelf production systems," commented Don Ayers, Capstone Turbine's Senior Director for Engineering and Quality. "There is a broad global initiative to decarbonize electricity generation through renewable natural gas or RNG by blending natural gas and hydrogen in existing pipelines. The Argonne Lab tests are showing that we have a significant margin in our standard product because of our robust designs and existing design margin. Our microturbines, unmodified, can handle any of the blends currently being discussed for pipeline injection around the world," added Mr. Ayers.

"The old adage that hydrogen will always be the fuel of the future is slowly losing steam thanks to environmental and political factors pushing carbon-free economies," said Muni Biruduganti, Principal Research Engineer at Argonne National Labs. "The recent experiments at Argonne demonstrated the resiliency of existing Capstone power generators to bridge the gap between grey-hydrogen and green-hydrogen use," added Mr. Biruduganti.

Hydrogen technology is advancing to the forefront of not just carbon neutrality, but a completely carbon-free society. Microturbines are uniquely positioned as a distributed energy source to be located at the source of hydrogen generation. The technology can be deployed immediately, without the need to wait for extensive infrastructure modernization and hydrogen specific upgrades. This unique advantage means customers will be able to operate carbon-free sooner, while also providing a flexible, resilient energy source that provides both power and thermal energy all day, every day of the year. This can be particularly advantageous in highly efficient combined heat and power systems (CHP) as a part of a microgrid, with excess renewable generation used to produce green hydrogen through electrolysis.

"As a thought-leader in the energy sector, Capstone recognized years ago that hydrogen would play an important role as a key part of the future of renewable, green energy landscape," said Darren Jamison, Capstone's President and Chief Executive Officer. "Microturbines are a proven technology on alternative fuels like biogas and butane. Renewable Natural Gas showcases how Capstone's innovative and adaptable microturbine technology can continue to grow into new segments of the expanding green energy economy. Hydrogen microturbines are the perfect complement for the intermittent nature of wind and solar power, making them an ideal component of the modern, clean and green microgrid," concluded Mr. Jamison.

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For customers with limited capital or short-term needs, Capstone offers rental systems, for more information, contact rentals@capstoneturbine.com. To date, Capstone has shipped nearly 10,000 units to 83 countries and in FY20, saved customers an estimated \$219 million in annual energy costs and 368,000 tons of carbon.

For more information about the company, please visit www.capstoneturbine.com. Follow Capstone Turbine on [Twitter](#), [LinkedIn](#), [Instagram](#), [Facebook](#) and [YouTube](#).

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CONTACT: Capstone Turbine Corporation
Investor and investment media inquiries:

Hydrogen – Key Takeaways



- ✓ Microturbines are an economically viable, highly reliable, and low emission technology providing immediate electrical and thermal energy to many customers around the world, in thousands of applications
- ✓ Initial interest has been from sites producing hydrogen as a byproduct, regions with blended hydrogen/natural gas, and in projects co-located with hydrogen generation capability
- ✓ Capstone will leverage relationships with technology partners, along with industry leaders, to enable accelerated product development, in the most cost effective and results driven manner





Q&A SESSION



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