






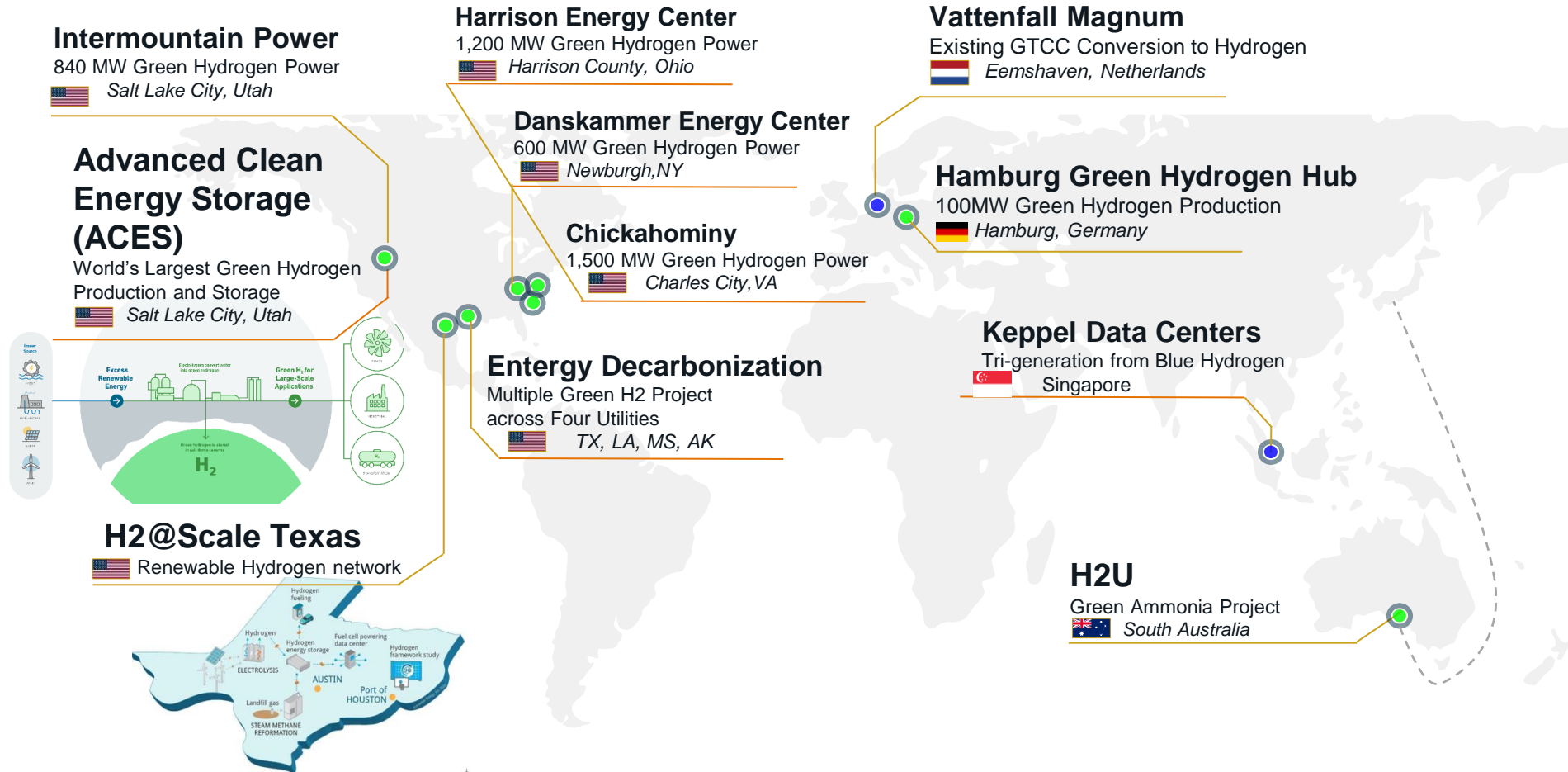
“Powerfuels Technology and Components from MHI – Supported by Japan Hydrogen Strategy”

15 September 2021

Research & Innovation Centre		
Energy Systems	Plants and Infrastructure	Integrated Defense and Space Systems
		
<p>Jet Engines (Mitsubishi Heavy Industries Aero Engines, Ltd.)</p> <p>Compressors (Mitsubishi Heavy Industries Compressor Corp.)</p> 	<p>Iron Making  Ammonia & Methanol Co-Production Plants CO₂ Capture Plants (Mitsubishi Heavy Industries Engineering, Ltd.)</p> <p>Gas Carriers (Mitsubishi Shipbuilding Co., Ltd.)</p>	<p>Aircraft (Mitsubishi Aircraft Corporation)</p> <p>H-IIA Rocket</p>

Case Studies

MHI's Global Hydrogen Projects : Developing H2 hubs as starting points

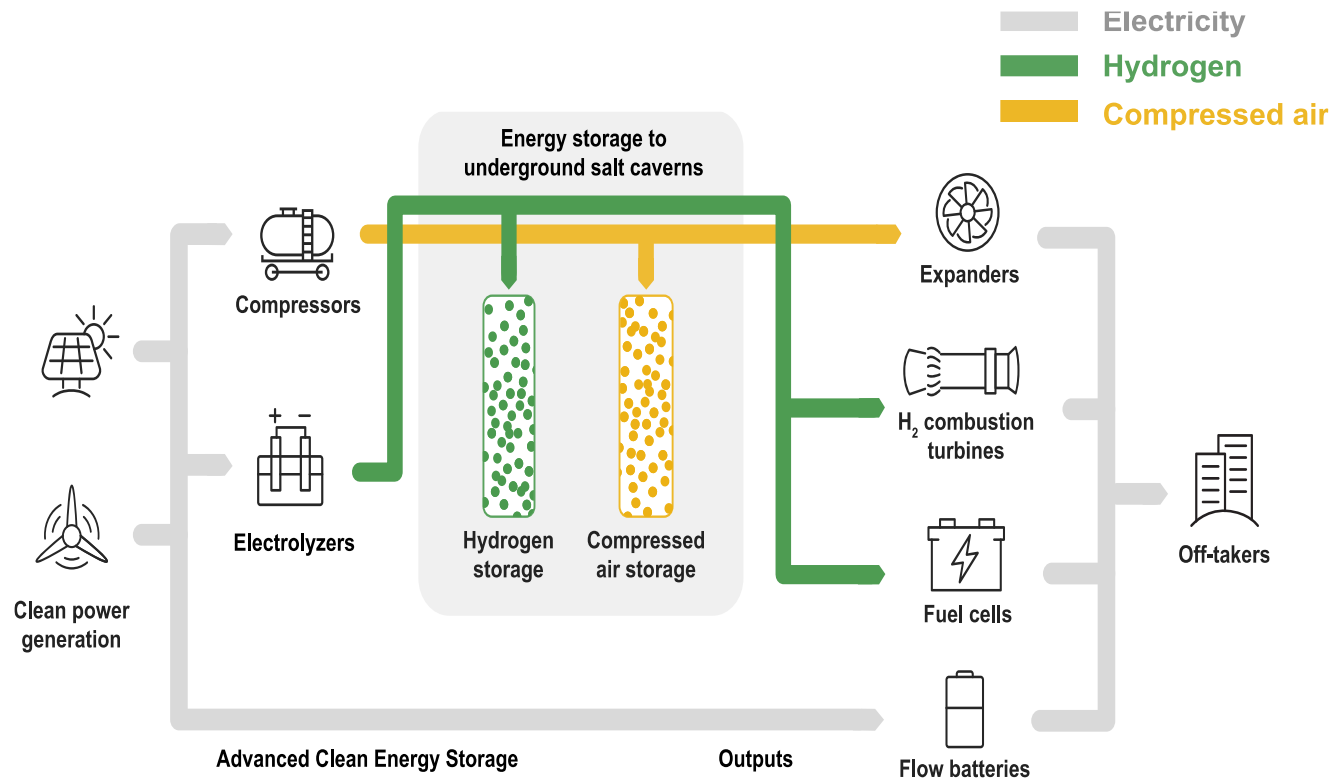


Advanced Clean Energy Storage Project (USA)

The Advanced Clean Energy Storage Project is the world's largest renewable energy storage project

Storage Capacity 1, 000 MW

Location Utah, USA



- Project launched in May 2019 by Mitsubishi Power, Magnum Development and the Governor of Utah
- Different storage technologies in use: renewable hydrogen, compressed air, large scale flow batteries and solid oxide fuel cells.
 - Plan to store hydrogen and/or compressed air in underground salt caverns in Utah
- Replicability potential in Europe

Intermountain Power Agency orders Mitsubishi Power's Hydrogen JAC Gas Turbines for Renewable Hydrogen Hub, a utility-scale project aiming to show a path towards 100% renewable power no later than 2045.

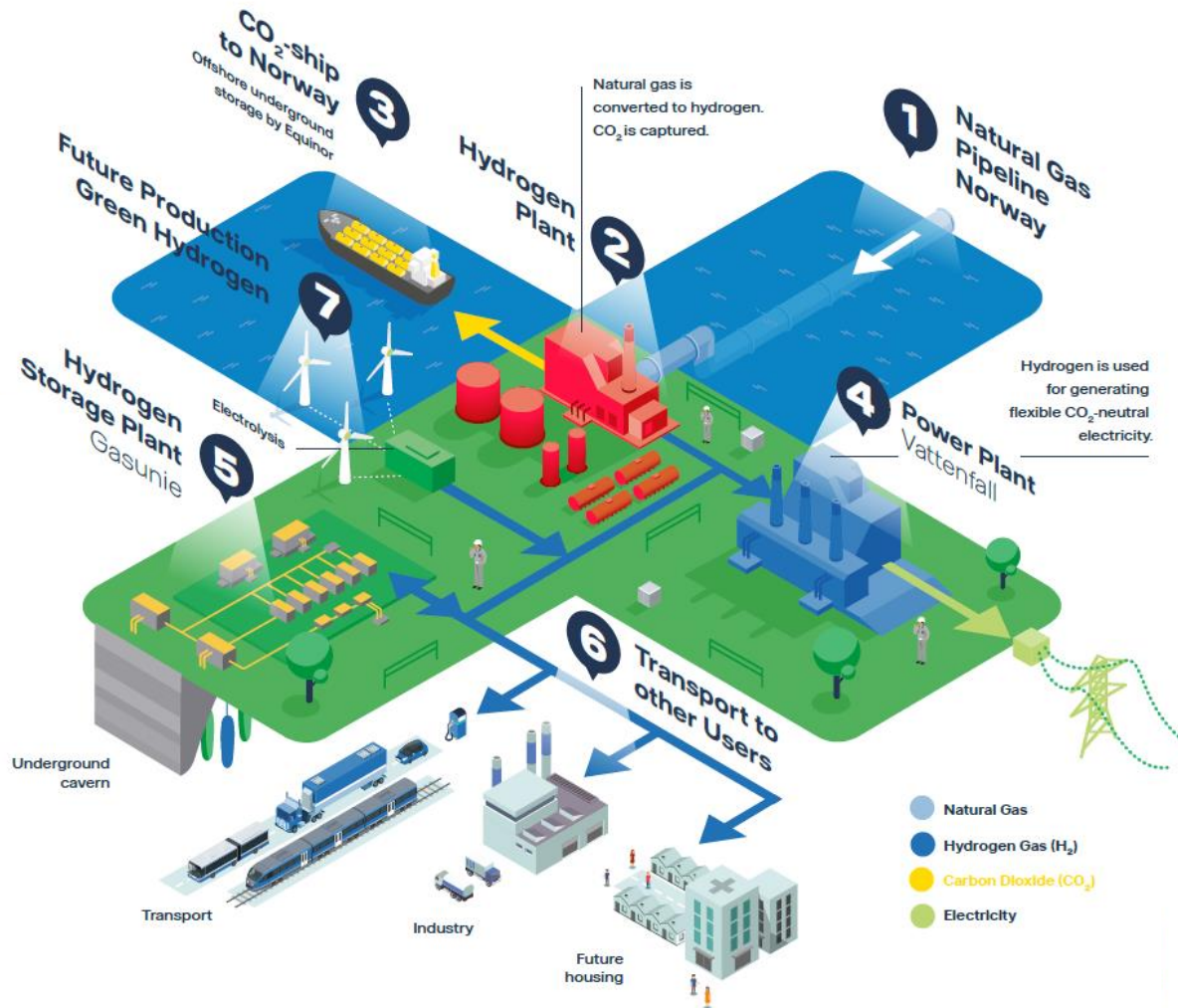


Gas Turbine Model	M501JAC
Power Output	840 MW (by 2 CCGT)
Location	Utah, USA

- Mitsubishi Power's Hydrogen Gas Turbines is central to Utah's comprehensive decarbonisation plan: 1) fuel switch from coal to natural gas and 2) from natural gas to renewable hydrogen.
- Transition will start in 2025 using a mix of 30% hydrogen and 70% natural gas. This mixture will reduce carbon emissions by more than 75% compared to the retiring coal-fired technology.
- Between 2025 and 2045, the hydrogen capability will be systematically increased to 100% renewable hydrogen, enabling carbon-free utility-scale power generation.
- Power plant is connected to the Los Angeles power grid by an existing high voltage direct-current (HVDC) transmission line.

H2M Project (The Netherlands) - Magnum

The H2M (Hydrogen to Magnum) project is a key first step in the development of a low-carbon H₂ economy.



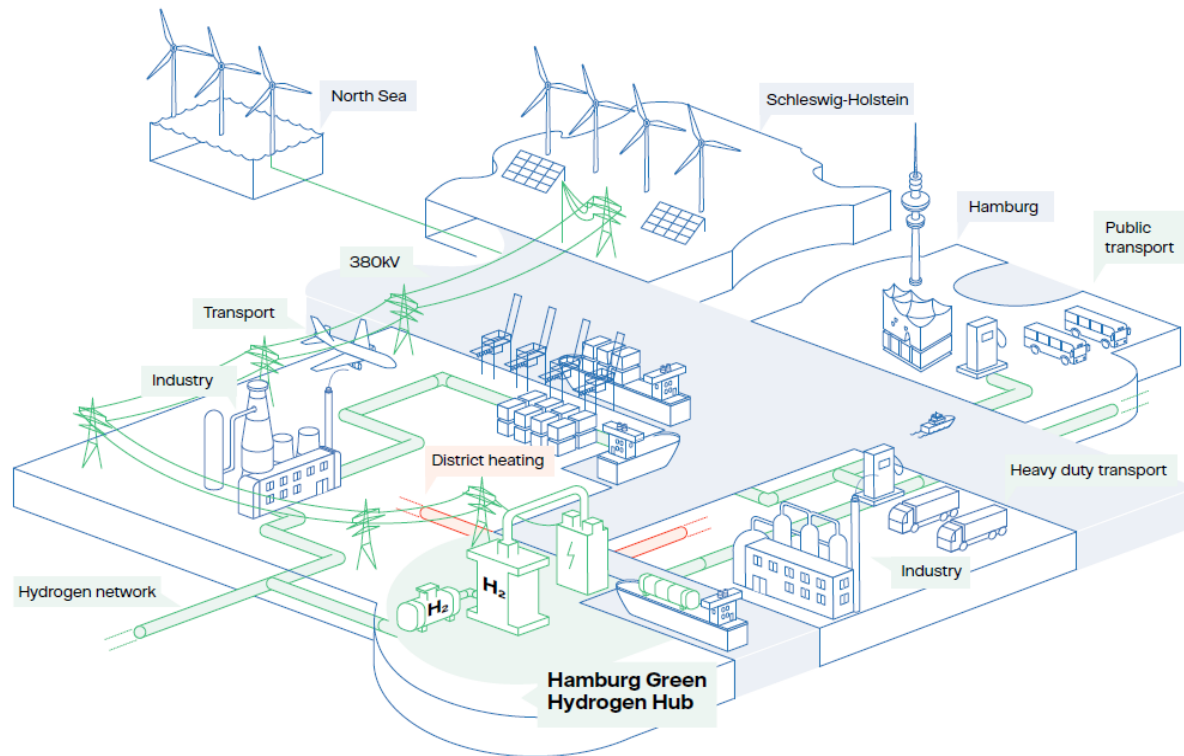
Gas Turbine Model	M701F
Power Output	440 MW
CO ₂ reduction	Up to 2 Mt/year*
Location	Eemshaven, The Netherlands

- The goal is to Kick-start H₂ economy by using Blue H₂ for Hydrogen (100%) firing in CCGT by 2025, and gradual transition to Green H₂.
- Development of hydrogen demand by H2M will assist realisation of hydrogen infrastructure.
- *Expected CO₂ emission reduction reaches up to 2Mt/year including use of Hydrogen in Transport, Industry and Housing.

Source and courtesy Vattenfall

Hamburg Green Hydrogen Hub (Germany)

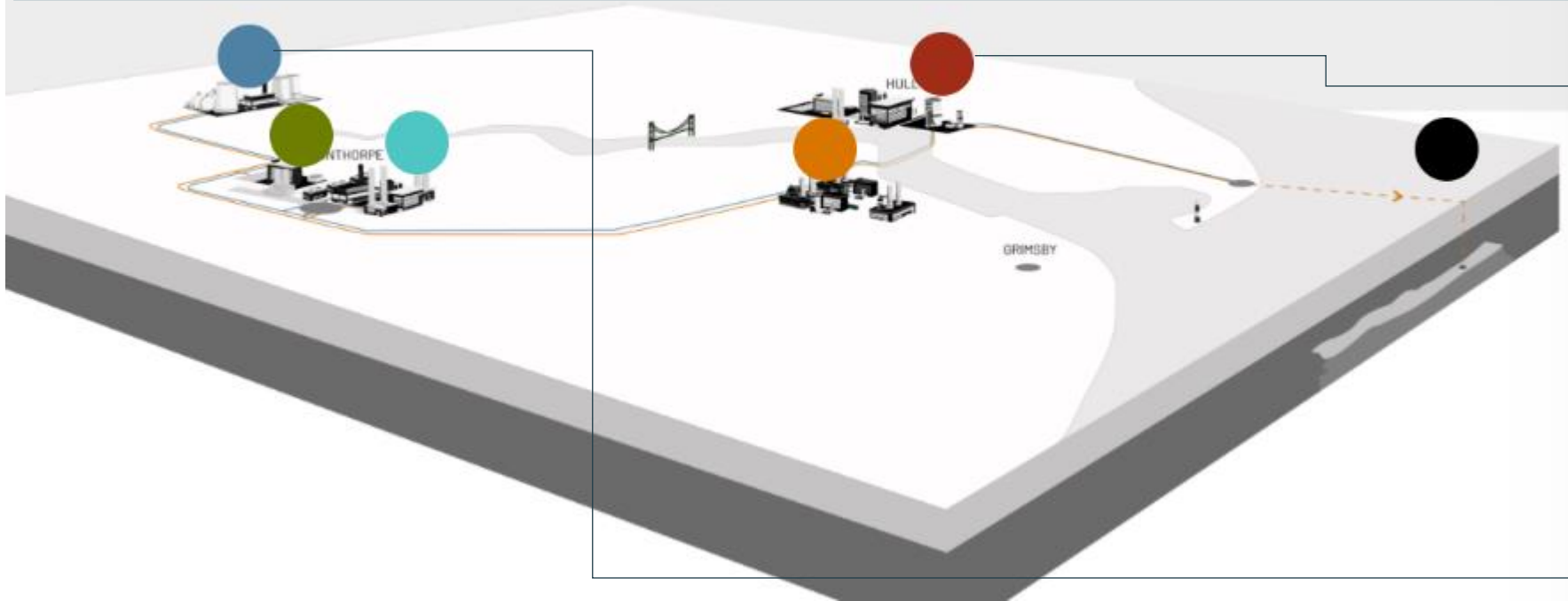
Hamburg Green Hydrogen Hub envisages transformation of former site of coal plant into green hydrogen production site with initial output of 100 MW and further development of site into a “Green Energy Hub”



Electrolyzer Capacity	100 MW
Grid connection	380 kV (TSO 50Hertz)
Location	Hamburg, Germany

- Production of green hydrogen to be utilized mainly in industrial applications (steel and refining; backed by long-term Carbon CfD and REDII), but also heavy transport;
- Direct matching of renewables assets and electrolyser (24hrs storage in 6km pipeline)
- Optimal utilization of electrolyser ,waste‘ streams: oxygen for industry and waste heat for the Hamburg district heating grid (80°C, with HP increased to 180°C)
- Joint project with Vattenfall, Shell, Wärme Hamburg

MHI Group is a key technology provider to one of the UK's flagship industrial cluster decarbonisation projects, which could reduce the UK's annual emissions by 15%.



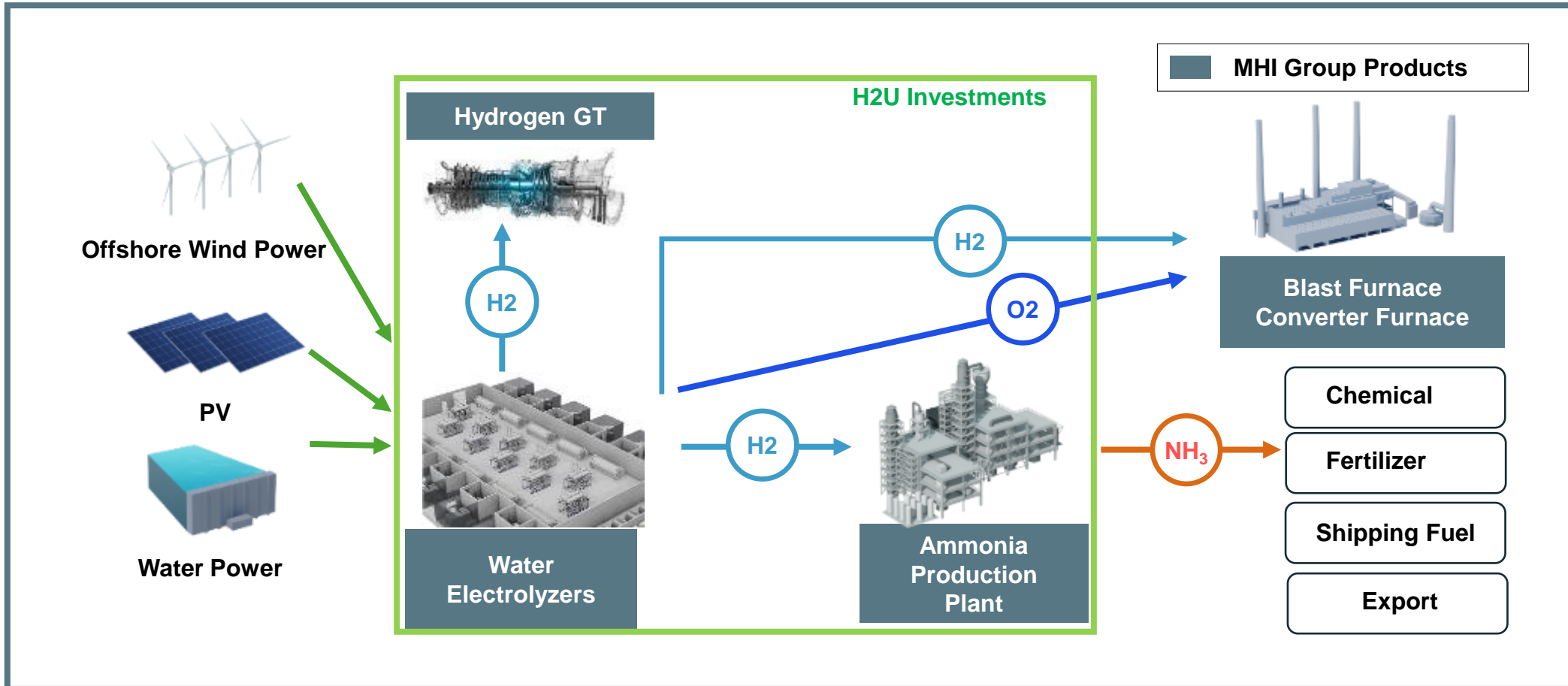
Mitsubishi Power will be converting 3 large scale gas turbines at Triton's Saltend Power Station to burn 30% hydrogen fuel mix.

MHI Engineering's carbon capture technology will be utilized at a bioenergy with carbon capture and storage (BECCS) pilot project at Drax Power Station. Implementing BECCS at Drax could deliver 16 million tonnes of negative emissions a year.



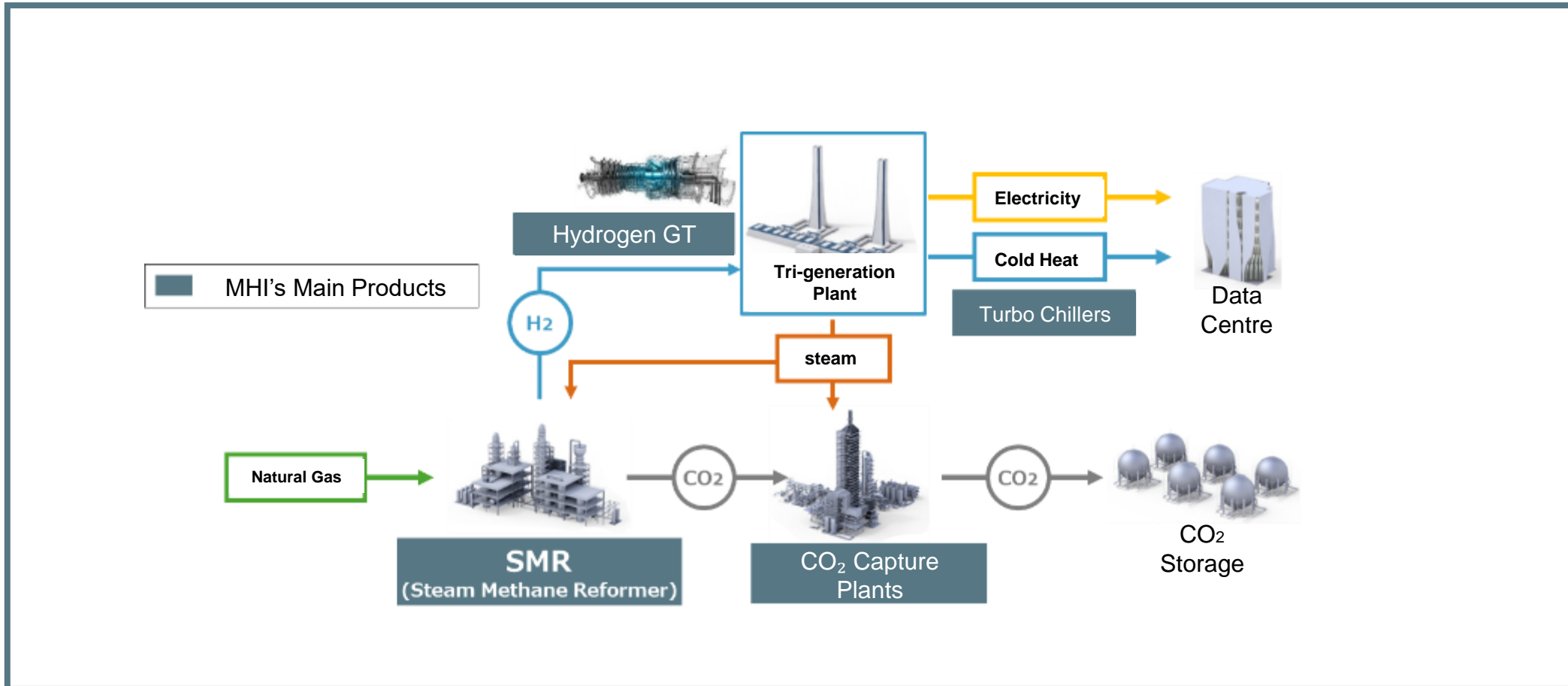
Carbon-free Ammonia Production (Australia)

Making use of abundant renewable energy in the area, MHI will produce hydrogen and ammonia. In addition to contributing to the region's industries such as nearby steel mills, we will try to export carbon-free ammonia



Tri-generation in Data Centers (Singapore)

MHI and Keppel Data Centres commenced a joint study focused on the whole process from production of carbon-free hydrogen to supply of electricity, cooling/heat and steam, aiming for carbon neutrality of data centers.



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