Perspektywy wykorzystania technologii wodorowych MHPS w energetyce

Mitsubishi Hitachi Power Systems Europe GmbH

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Konferencja Innowacje w obszarze energii w aspekcie zmian klimatycznych i poprawy jakości powietrza

12-13 grudnia 2019 roku, Warszawa

Innowacje w procesie wytwarzania, magazynowania i przesyłu

Perspektywy wykorzystania technologii wodorowej (energetyka wodorowa)

12.12.2019

Agenda

1. Introduction of Mitsubishi Heavy Industries Group
2. H2 in future world (energy sector)
3. H2 strategy by MHI / MHPS
4. MHPS H2 Gas Turbine development
5. MHPS opportunities in hydrogen energy sector in Poland

1. Introduction of Mitsubishi Heavy Industries Group

Mitsubishi Hitachi Power Systems, Ltd

MITSUBISHI HEAVY INDUSTRIES GROUP

Mitsubishi Heavy Industries Group

- 3 BUSINESS DOMAINS

Research & Innovation Center

Power Systems

- Nuclear Energy System

- Jet Engines
  (Mitsubishi Heavy Industries Aero Engines, Ltd.)
- Offshore Wind Turbines
  (MHI Vestas Offshore Wind A/S)
- Compressor
  (Mitsubishi Heavy Industries Compressor)

Industry & Infrastructure

Transportation systems

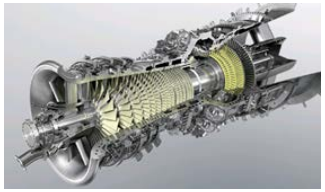
- Ammonia & Methanol Co-Production Plants
  (Mitsubishi Heavy Industries Engineering, Ltd.)
- Gas Carries
  (Mitsubishi Shipbuilding Co. ,Ltd.)
- Iron Making
  (Primetals Technologies, Ltd.)

Aircraft, Defense & Space

Aircraft - MRJ
(Mitsubishi Aircraft Corporation)

H-IIA Rocket

Mitsubishi Hitachi Power Systems, Ltd. (*MHPS*)



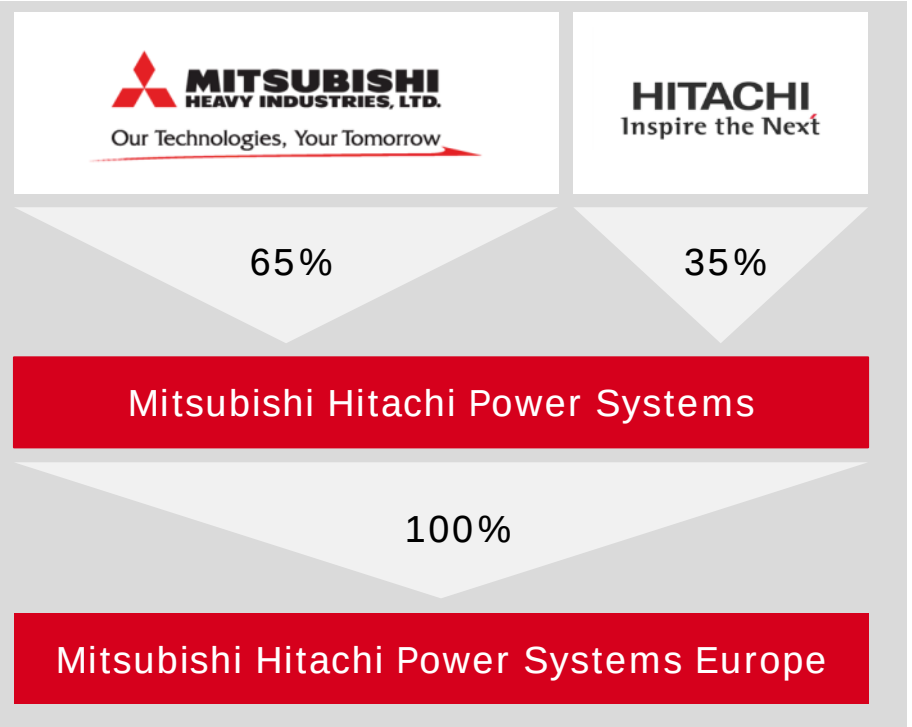
Large Frame Gas turbine (F, G, J –series)

Middle & small Gas turbine (H-100)

1. Introduction of Mitsubishi Heavy Industries Group

MHPS Overview

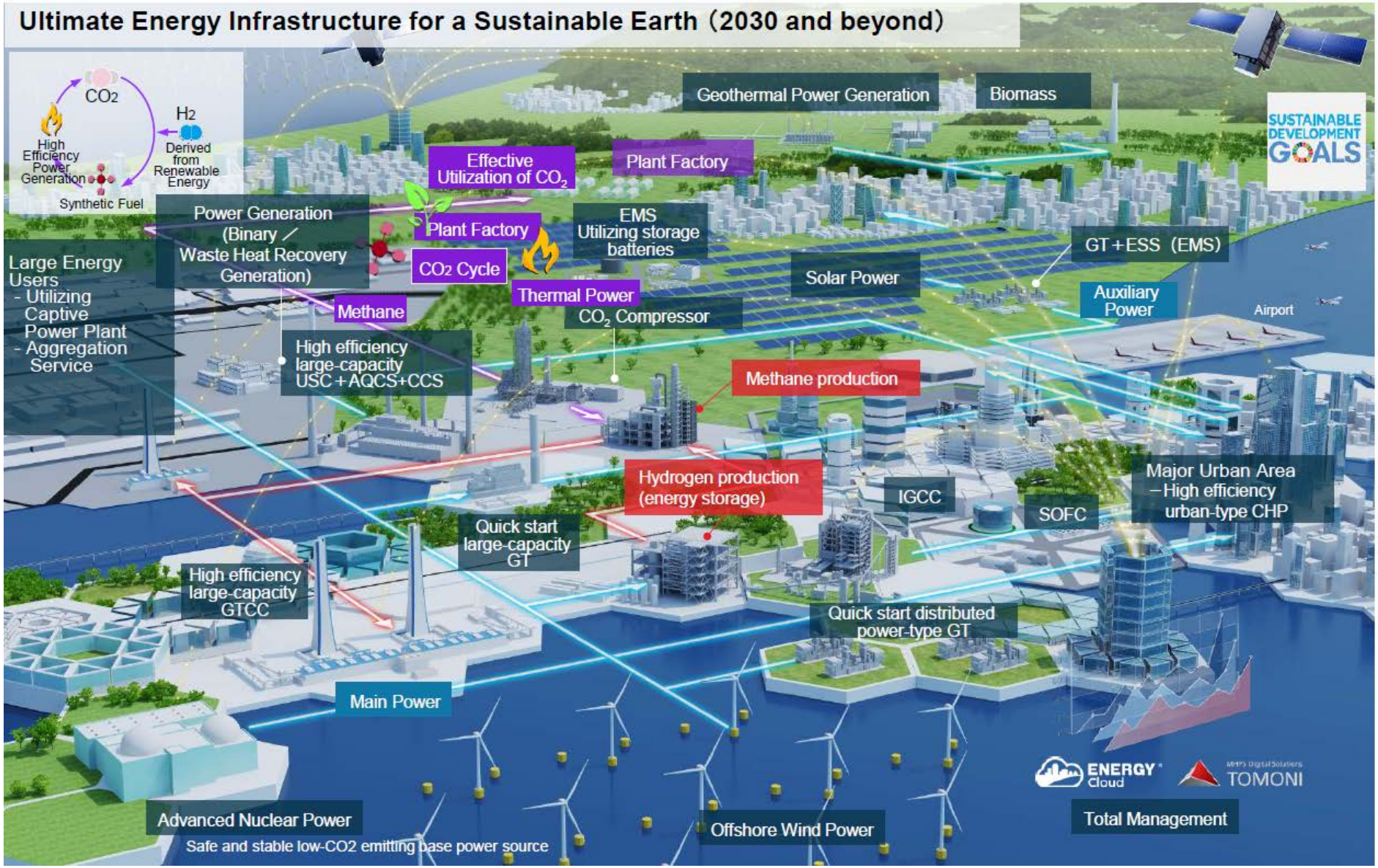
- Start of joint venture: 1 February 2014
- HQ Location: Yokohama, Japan
- Number of MHPS Group companies: 65
- Total workforce: approx. 19,500
- Major operations / businesses:
  - Thermal Power Generation Systems
  - Geothermal Power Generation Systems
  - Environmental Systems
  - Fuel Cells
- Capital: ¥100b / $892m *(USD/JPY: 112)*



- HQ Location in Europe: Duisburg (New plant business), London (Service),
- Market Region: Europe, Middle East, Africa (EMEA)

2. H2 in future world (energy sector)

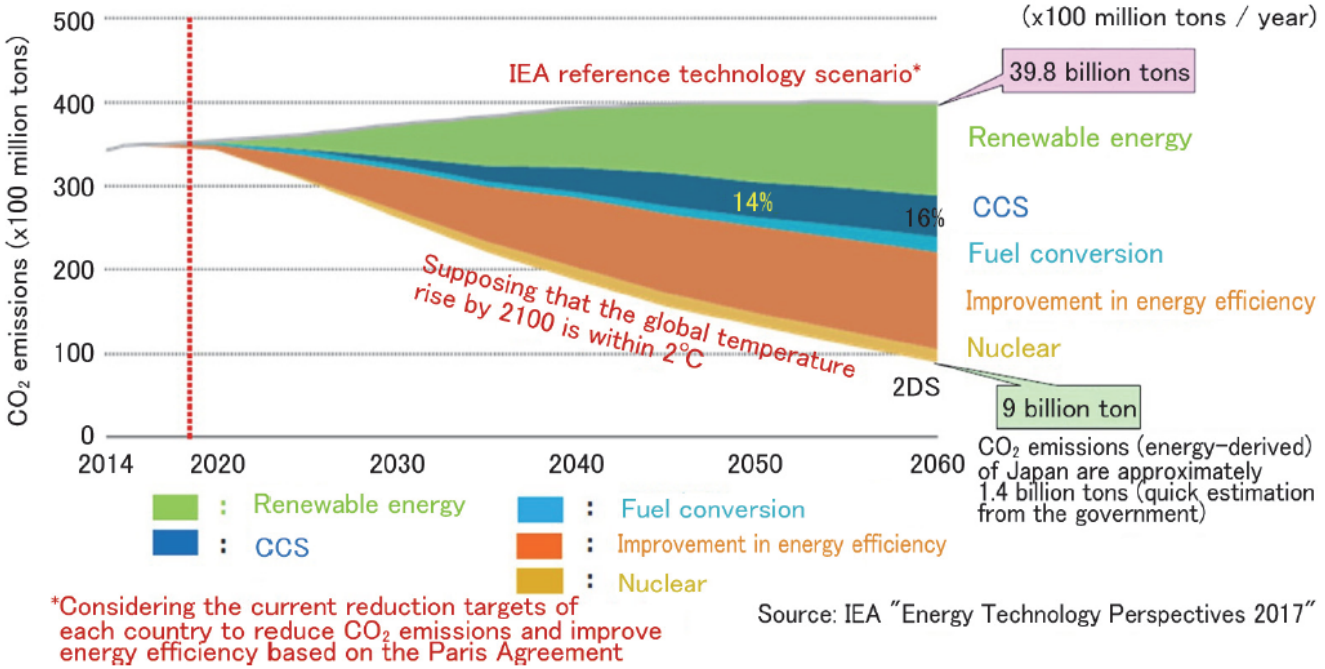
Ultimate Energy Infrastructure for Sustainable Earth (2030)



2. H2 in future world (energy sector)

International Energy Agency Report

Forecast of total global CO2 reduction amount from the present to 2060 is estimated around 30% of the total. Main players of those change will be renewable energy and energy efficiency improvement.

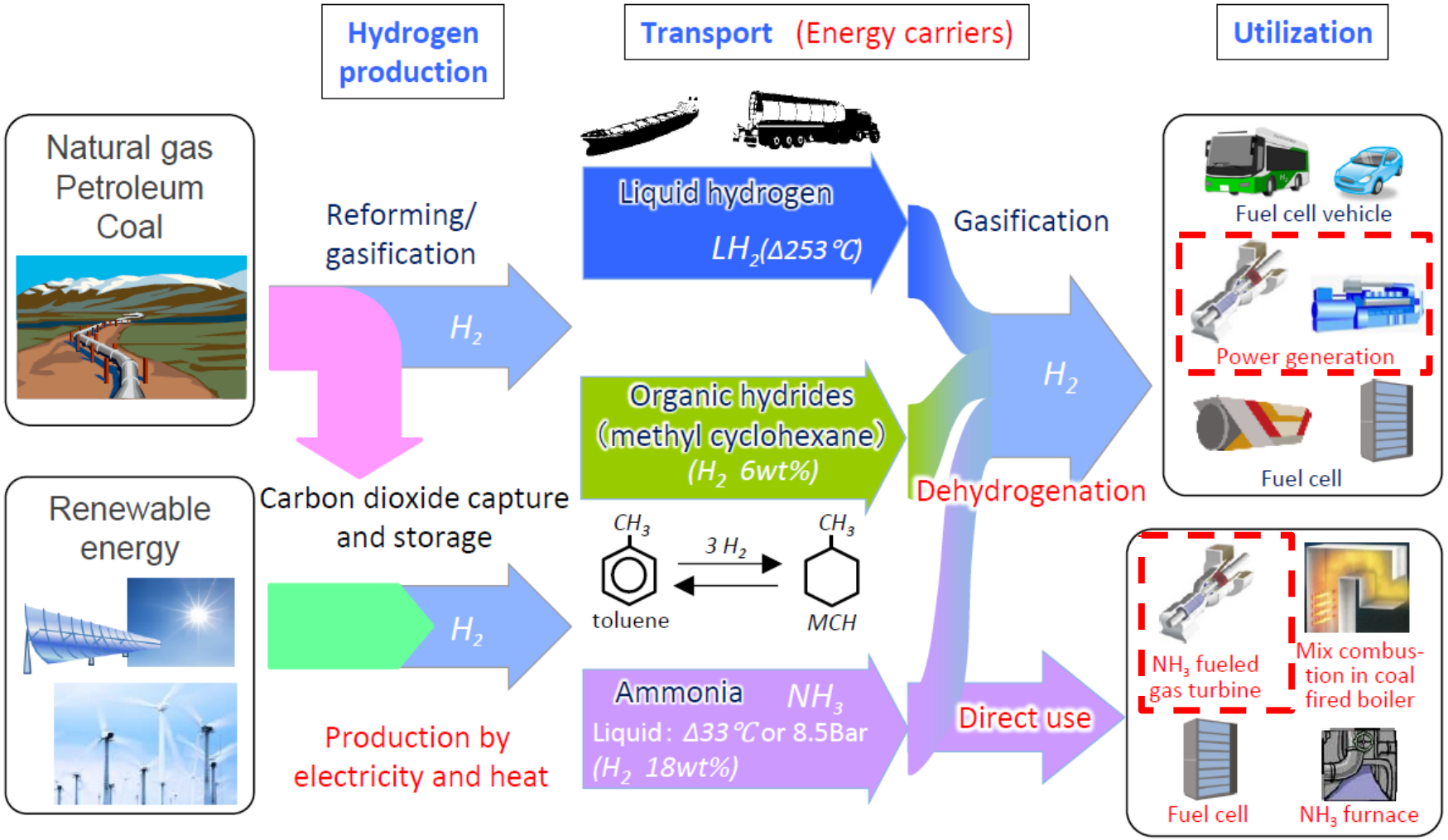


It is considered that converting renewable energy into hydrogen for storage, transportation, and usage is effective against energy fluctuations. It will be built hydrogen supply chain and it will be developed relevant hydrogen technologies.

It is expected that the use of hydrogen produced by reforming fossil fuels including natural gas will start to increase from around 2030 and will account for 14% of the cumulative CO2 reduction amount to 2050 with carbon dioxide capture and storage (CCS).

2. H2 in future world (energy sector)

Strategic Innovation Promotion Program (SIP)



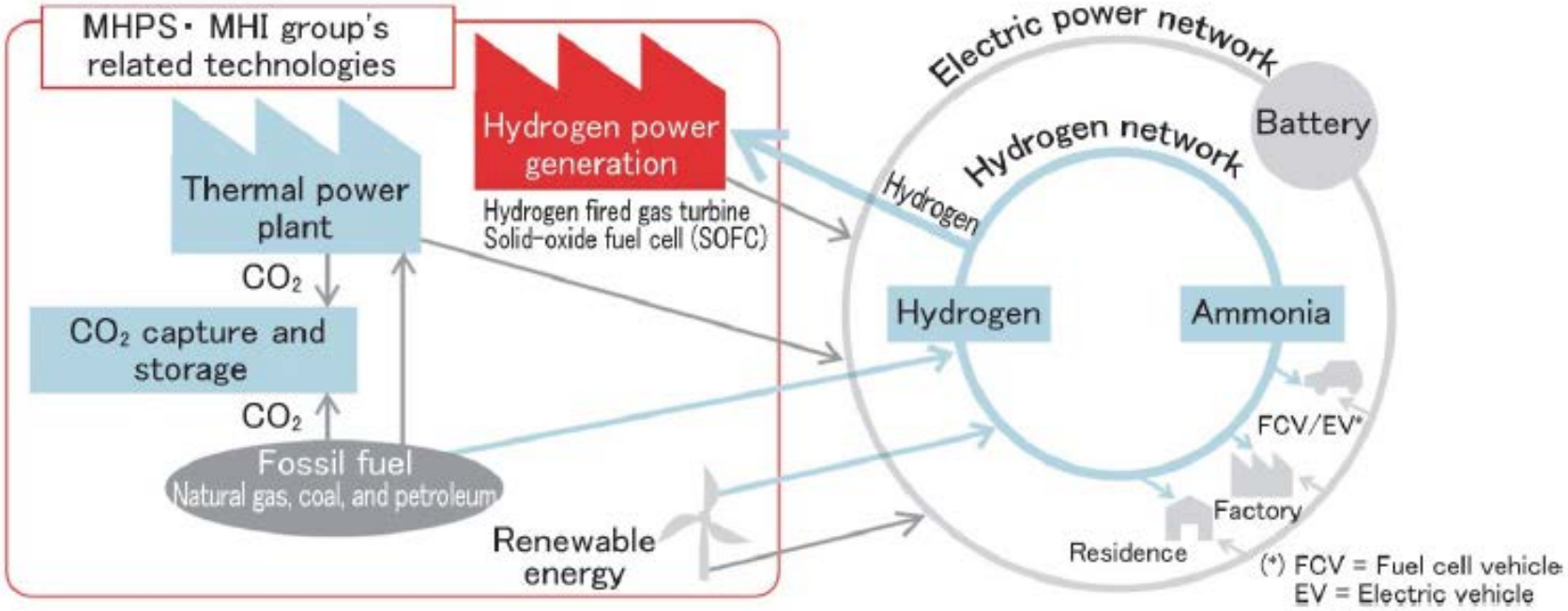
≪**Ammonia direct use**≫ 【Power generation sector】 Gas turbine, Coal fired boiler, Fuel Cell 【Industrial sector】 Industrial furnace 【Transportation sector】 Marine Engine

Source: SIP Energy Carriers, Nov 2018

3. H2 strategy by MHI / MHPS

In Japan, as a basic hydrogen strategy for a low carbon society, the commercialization of hydrogen power generation around 2030 has been targeted.

Currently MHPS is developing under NEDO (New Energy and Industrial Technology Development Organization) new type of combustors that can use 30% hydrogen mixed with LNG fuel for large power generation gas turbines. This technology can handle output equivalent to **700 MW** (GTCC power generation with a turbine inlet temperature of 1,600°C), and the CO2 emissions during power generation can be reduced by approximately 10% in comparison with conventional GTCC power generation.

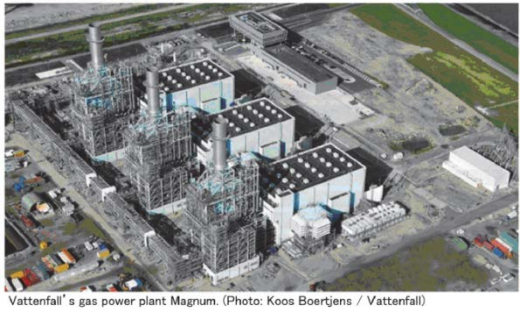


Source: Mitsubishi Heavy Industries Technical Review Vol. 55 No. 4 (Dec. 2018)

3. H2 strategy by MHI / MHPS

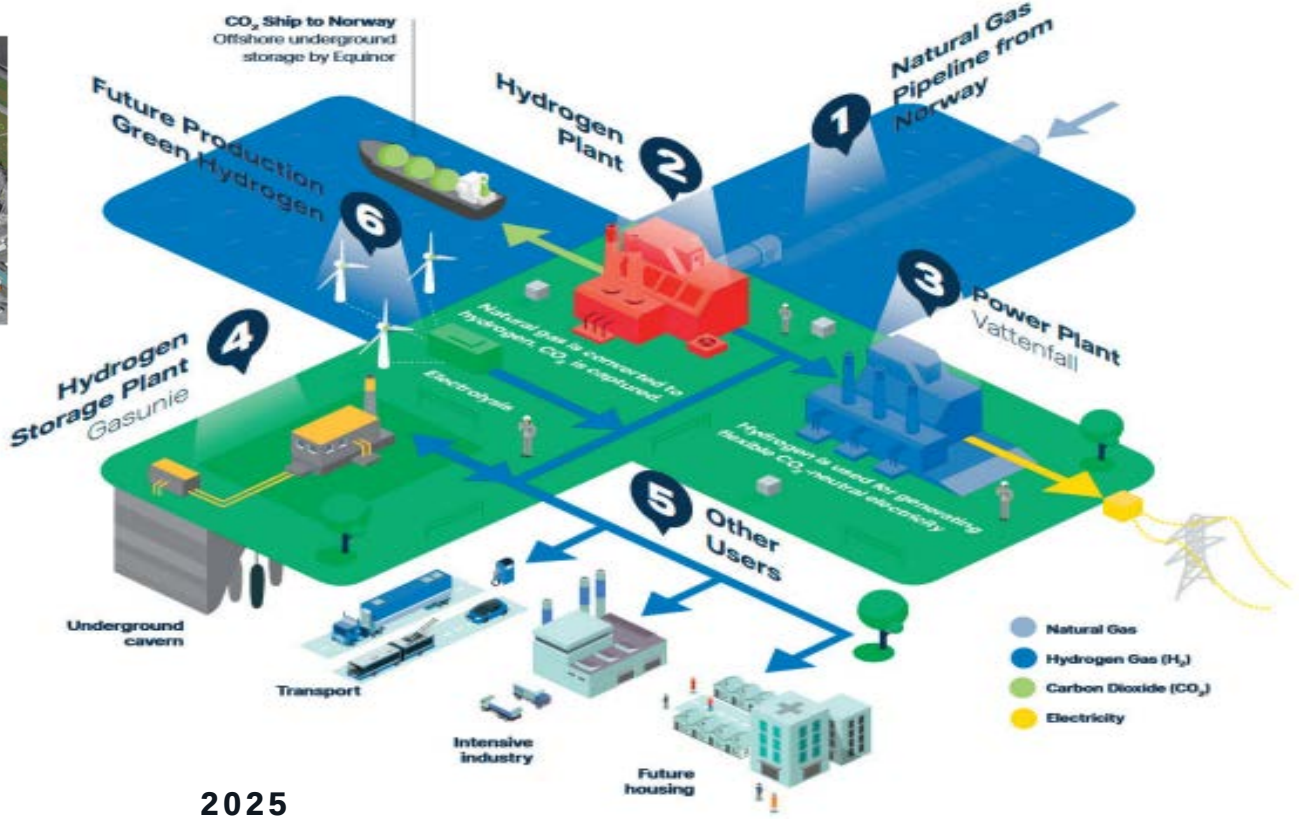
Ammonia cracking GTCC Plant

We are participating in a project to convert a natural gas-fired gas turbine combined cycle (GTCC) power generation plant with 1.32 million kW-class output operated by N.V. Nuon to hydrogen-fired power generation. In 2023 year Nuon Magnum power plant will be 100% hydrogen-fired power generation plant



Vattenfall's gas power plant Magnum. (Photo: Koos Boertjens / Vattenfall)

This project calls for the conversion of one of the three units of the M701F **(440 MWe)** gas turbine power generation plant, which we delivered to the Nuon Magnum power plant.



1970 — **2025**

Cogen/IGCC
(31 units, ＞ 3 mil hours experience)

Magnum
H2 conversion

Source: Mangum Project

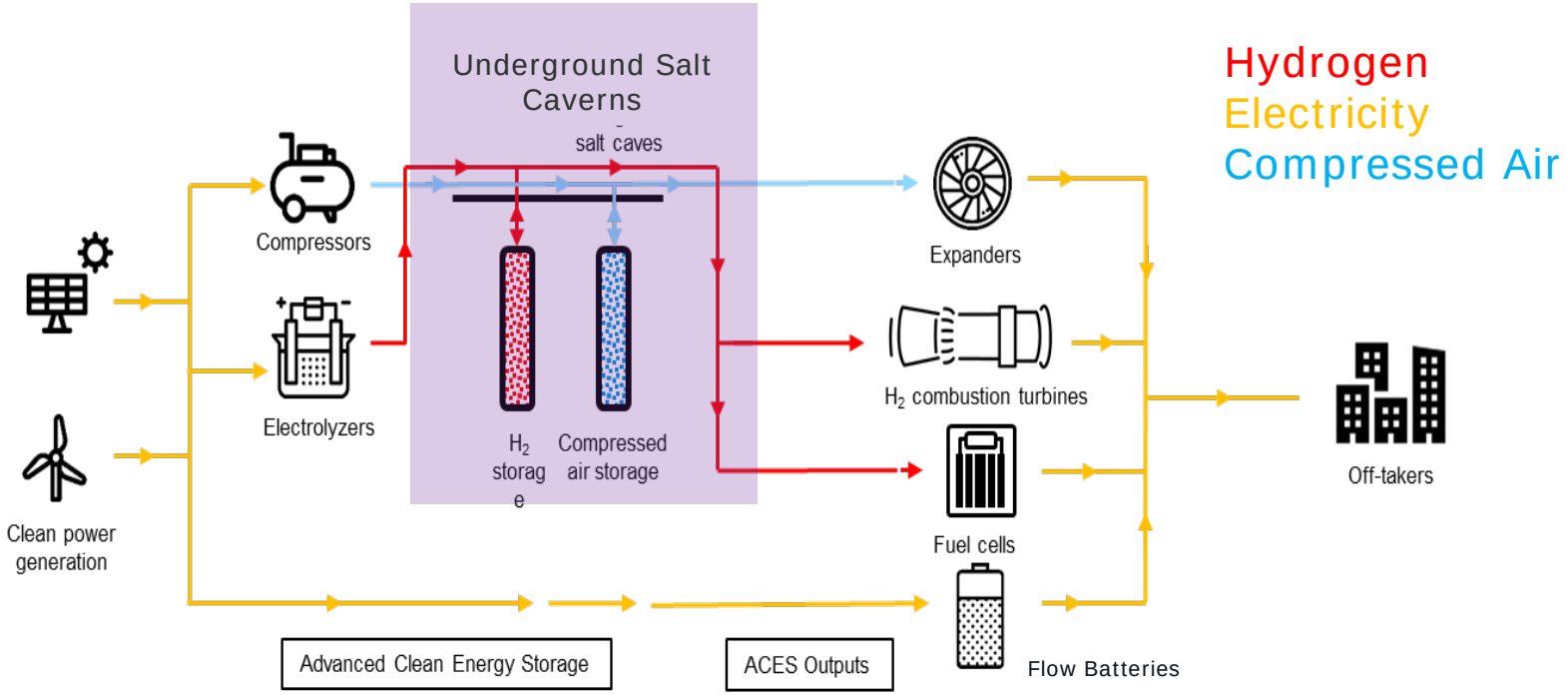
3. H2 strategy by MHI / MHPS

USA Advanced Clean Energy Storage

MHPS, Magnum Development and Governor of Utah announced an initiative to launch the Advanced Clean Energy Storage (ACES) project in May 30, 2019.

The ACES aims 1000 MW of 100% clean energy storage with using storage technology such as Renewable hydrogen (Green H2), Compressed air, Large scale flow batteries, Solid oxide fuel cells.

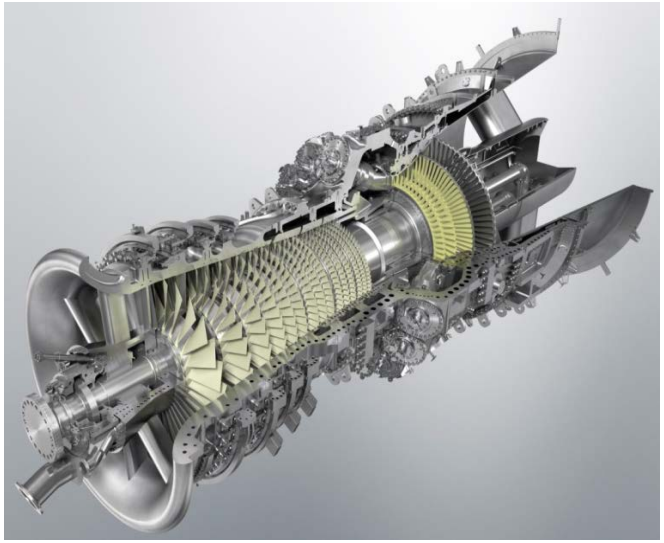
Renewable hydrogen and Compressed air will be considered for storage in Salt Caverns in Utah that owned by Magnum Development.



4. MHPS H2 Gas Turbine development

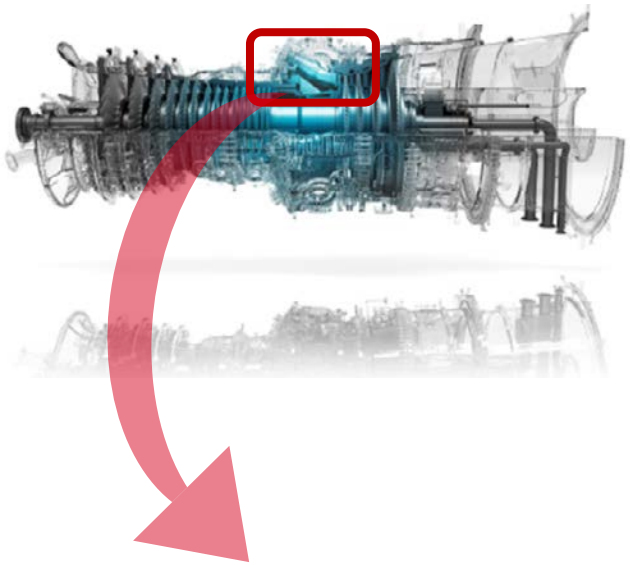
Existing Gas Turbine can burn hydrogen with limited modifications on combustion parts.

Advanced Class GT



MHPS “JAC”
Ultra high **64%+** GTCC thermal efficiency with 99.5% availability

Hydrogen Gas Turbine

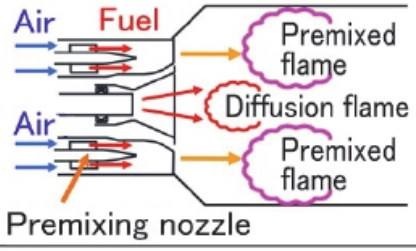
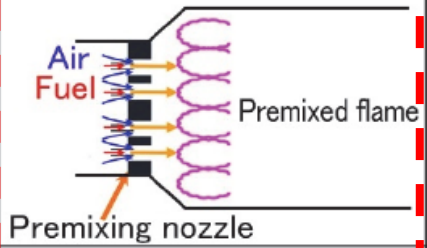
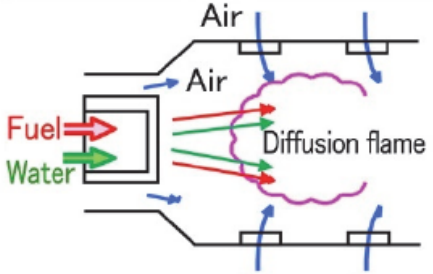


Limited modification to combustion parts

Gas Turbine combustion parts need to be modify to burn hydrogen as supplementary fuel and finally as main fuel. MHPS is working strongly to meet global expectation for energy sector transformation from conventional fuels to hydrogen. MHPS is going to meet expectations.

4. MHPS H2 Gas Turbine development

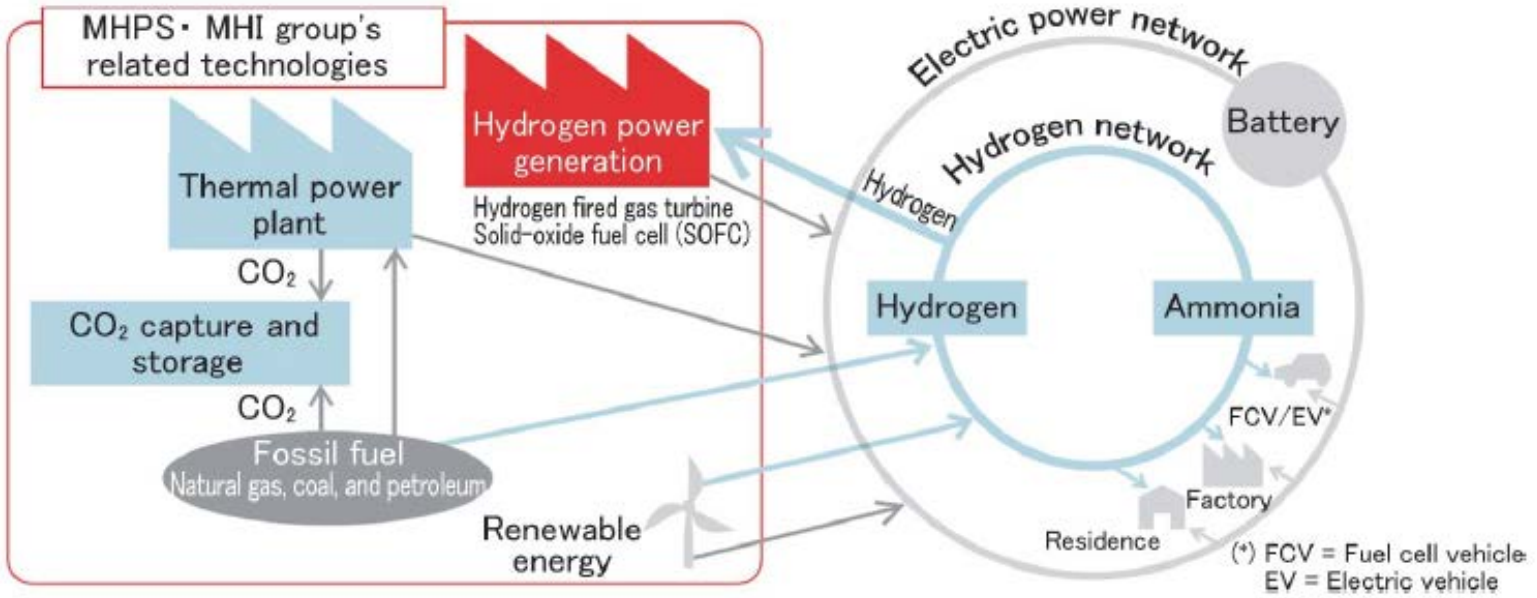
Combustion system for hydrogen-fired gas turbines must be developed for the co-firing and hydrogen firing. Hydrogen has a higher combustion speed in comparison with natural gas, so the risk of flashback phenomenon is higher than that in the case of natural gas firing.

Combustor	Multi-nozzle combustor	Multi-cluster combustor	Diffusion combustor
Combustion method	Premixed flame combustion	Premixed flame combustion	Diffusion flame combustion
Structure			
NOx	Low NOx due to flame temperature uniformed by premixing nozzle	Low NOx due to flame temperature uniformed by small premixing nozzle	Fuel is injected in to air. There is a high-flame temperature region and the NOx is high
Flashback	High flashback risk in the case of hydrogen mono-firing because of the large flame propagating area	Low flashback risk due to the narrow flame propagating area	No flashback risk because of diffusion flame
Cycle efficiency	No efficiency drop due to no steam or water injection	No efficiency drop due to no steam or water injection	Efficiency drop occurs because steam or water are injected to reduce NOx
Hydrogen co-firing ratio	Up to 30 vol%	Up to 100 vol% (under development)	Up to 100 vol%

5. MHPS opportunities in hydrogen energy sector in Poland

MHPS would like to start cooperate and develop **blue** or **green** hydrogen in Poland.

MHPS is ready to build blue or green hydrogen CCGT Plant in Poland.



Power for a Brighter Future

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Thank You