

Hydrogen Energy Supply Chain for Decarbonization

KAWASAKI HYDROGEN ROAD

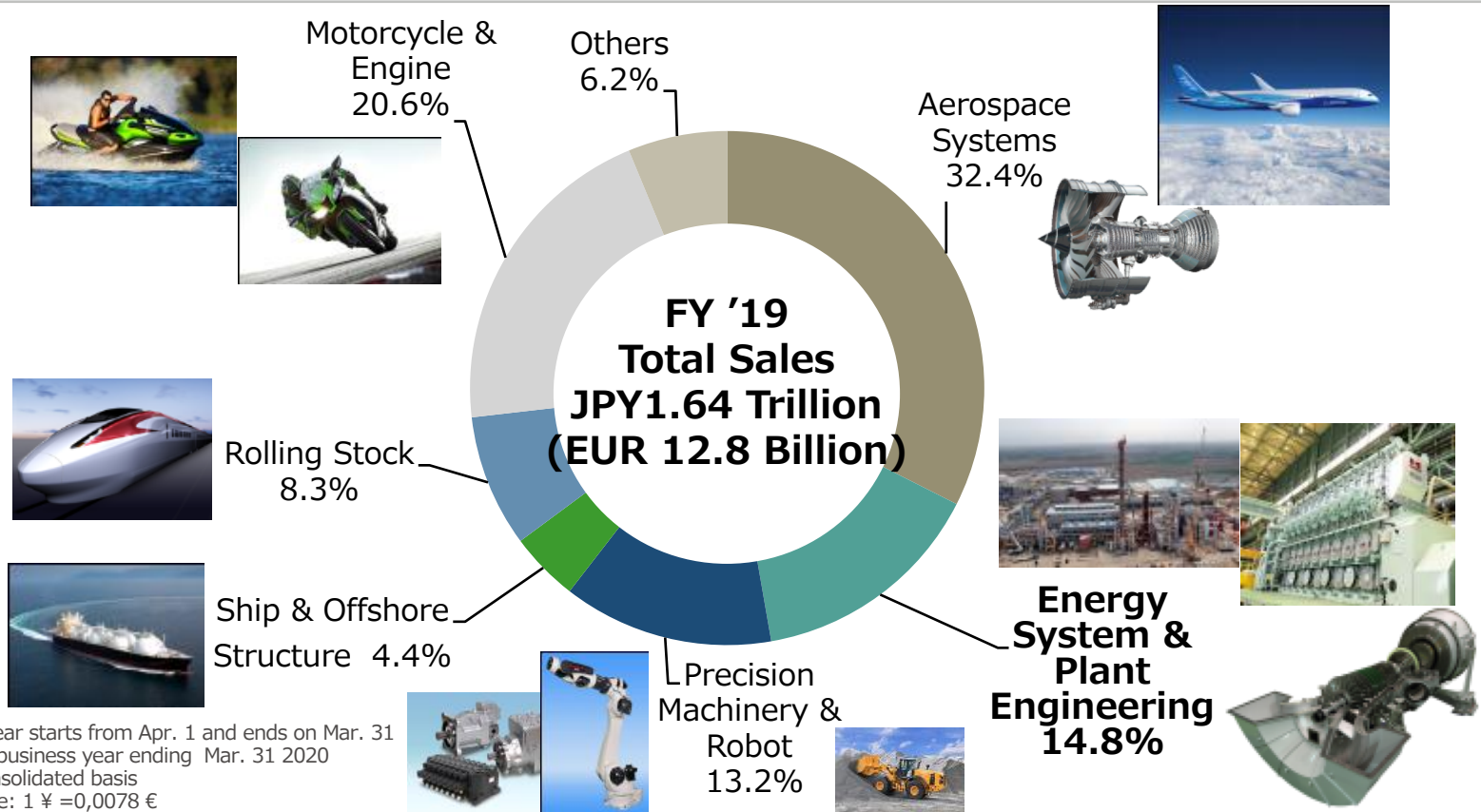
Development of Innovative Hydrogen Technologies
for Future Hydrogen Society

EBL Energie- und Klimagipfel 2022

24th October 2022

Dr.-Ing. Nurettin Tekin
Hydrogen Product Manager
Kawasaki Gas Turbine Europe

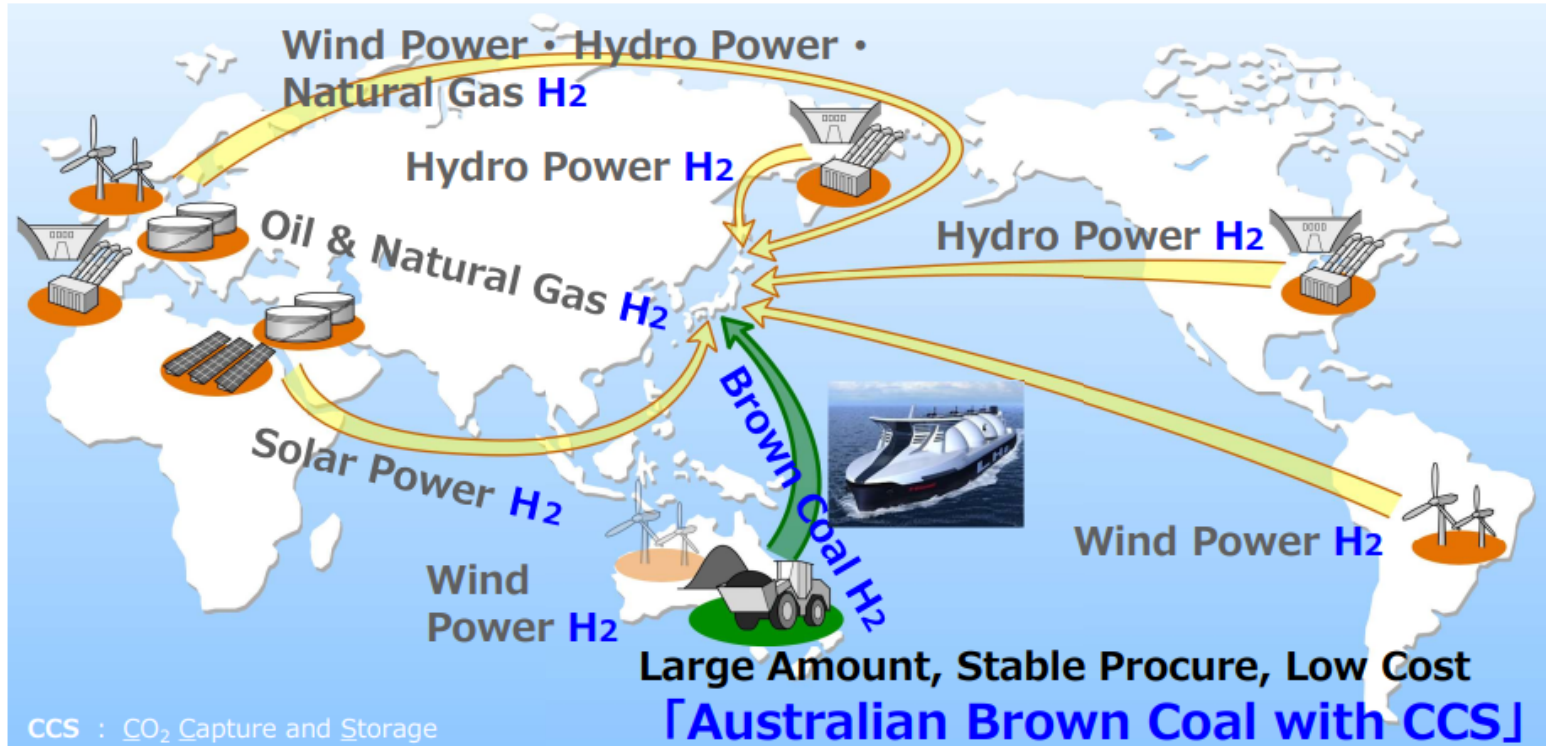
Kawasaki Heavy Industries - Sections



*Business year starts from Apr. 1 and ends on Mar. 31
 **As of the business year ending Mar. 31 2020
 ***On a consolidated basis
 ****Ex. Rate: 1 ¥ =0,0078 €

Hydrogen Road of Kawasaki Heavy Industries (KHI)

CO₂-Free Hydrogen Resources in the World



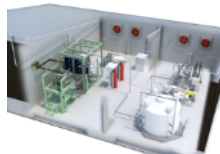
Hydrogen Road of Kawasaki Heavy Industries (KHI)



Hydrogen gas engine



Fertilizer plant



Electrolyzer



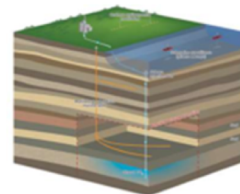
Liquefaction



Liquefied H2 Tank



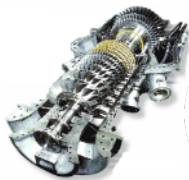
Liquefied H2 Loading Arm



KCC



H2 Compressors



Hydrogen Gas Turbine

Realization of Products with Corporate Technology Synergy

Produce

Storage

Use

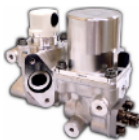
Transport



H2 Low-NOx Boiler



Fuel cell train



High-Pressure H2 valve



High Pressure Hydrogen trailer



Liquefied H2 Container



Liquefied H2 Tanker

Coal Gasification Power Plant in Australia



Liquefaction facility and loading terminal



Liquefied Hydrogen Carrier "Suiso Frontier"

Launch ceremony (11 December 2019)
at KHI Kobe Shipyard



Cargo Tank Installation (7 March 2020)
at KHI Harima Works



LH2 Receiving Terminal construction completed



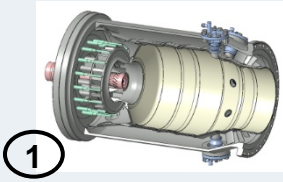
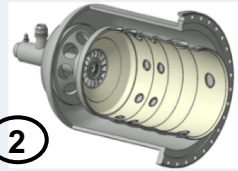
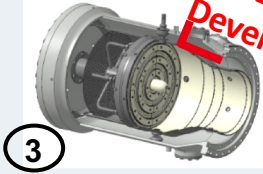
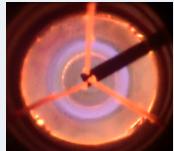


First Import

Departure (28 January 2022)
from Hastings, Australia

Arrival (25 February 2022)
at Kobe , Japan

Developments for Hydrogen Gas Turbines @ KHI

Overview of Combustor Developments

Combustor Configuration	DLE Combustor for Natural Gas	Diffusion Flame Combustor	DLE Micro-Mix Combustor
NOx Reduction	"Dry"	"Wet" Water/Steam	"Dry"
			
H2 Content	0-30vol%	0-100vol%	50-100vol%
Status	Final Combustor Test, 2021 	Final Combustor Test, 2016 Applied to KOBE Demonstration Plant, 2018 	Final Combustor Test, 2018 Applied to KOBE Demonstration Plant, 2020  Supported by NEDO

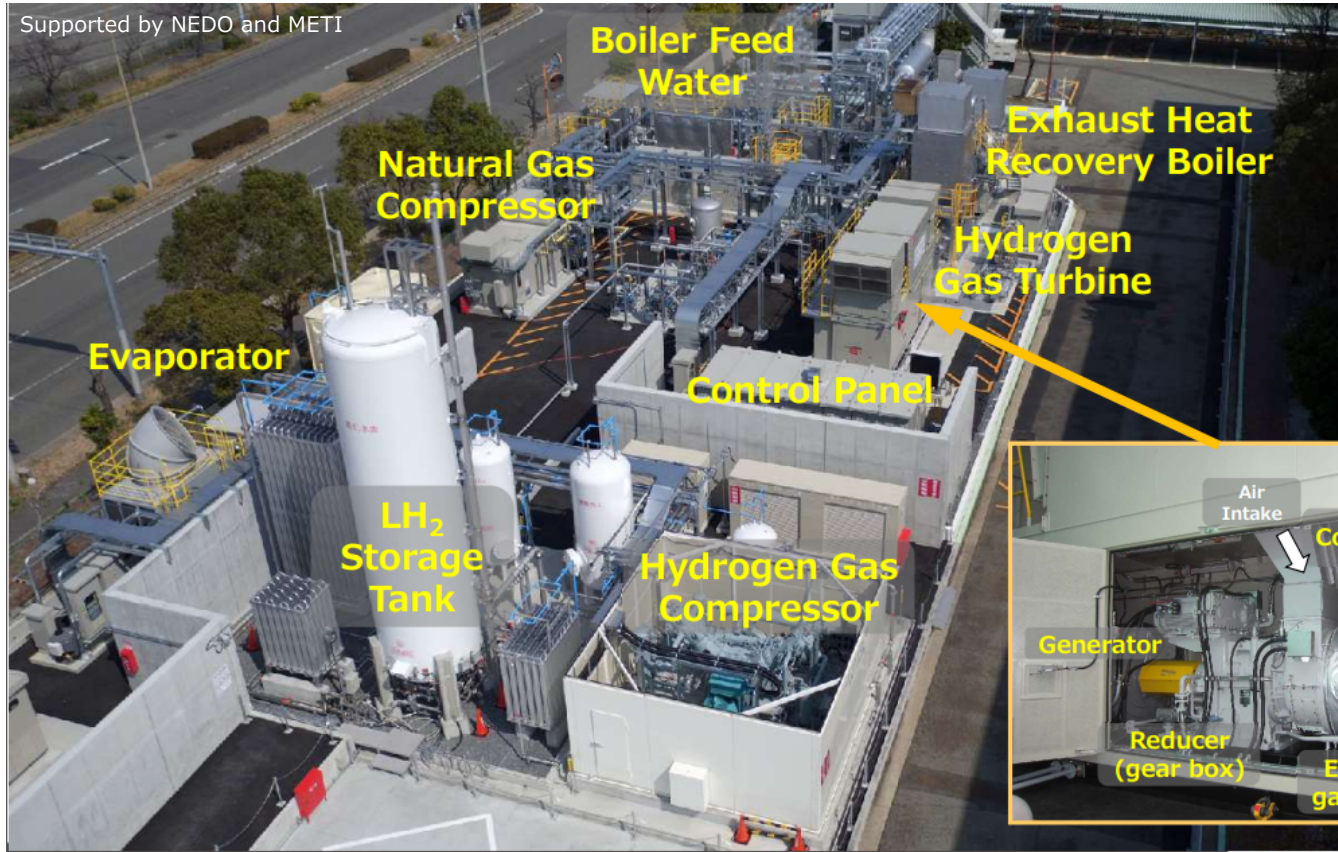
Latest Development

INNOVATIONSPREIS
DER DEUTSCHEN
GASWIRTSCHAFT

Main Difference between NG & H2 Gas Turbines is the Combustor

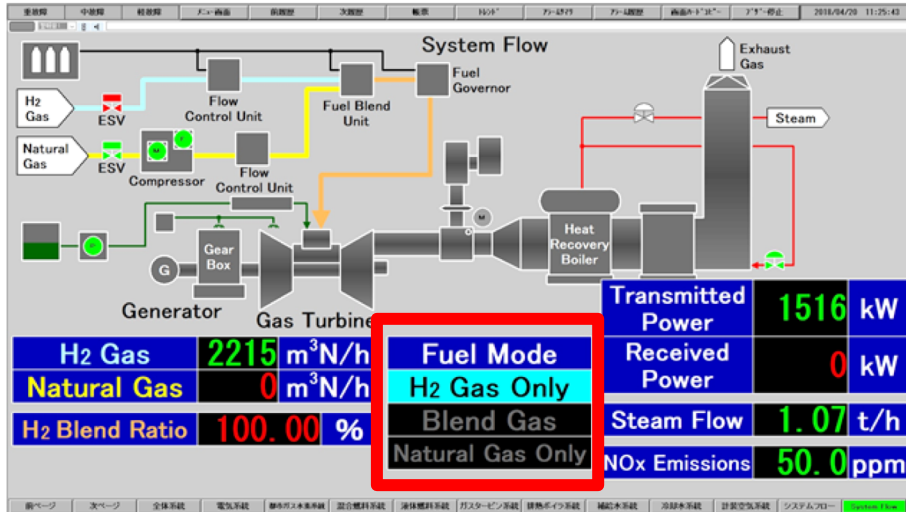
World's First 100% H2-CHP Plant at Kobe Port

Supported by NEDO and METI



World's First H2-Power Plant at Kobe Port

User Control Interface



Comparison between NG & H₂

Gas Turbine Type		M1A-17	M1A-17
		Natural Gas	Hydrogen
Fuel type		Natural Gas	Hydrogen
Electrical power	kW	1,848	1,902
Fuel input	kW	6,845	6,907
Efficiency	%	27.0	27.5
Exhaust gas mass flow	kg/s	7.98	7.89
Exhaust gas temperature	°C	529	528
Generator voltage	kV	0.4 / 6.3 / 10.5	0.4 / 6.3 / 10.5
Steam mass flow 8 bar(g) saturated	t/h	5.2	5.2
NOx Reduction method		Water injection	Water injection
Emissions (NOx)	ppm	37	73
Emissions (CO2)	%	3	0.0

Performance at 15 °C, 60% RH, at Generator Terminal,
Inlet Pressure Loss 0,98 kPa, Exhaust Pressure Loss 2,45 kPa

Supported by NEDO and METI

Liquefied Hydrogen Carrier “Suiso Frontier”

Journey for commercialization

2020
Pilot Demo



1,250m³ Ship x1

Mid 2020s
Commercial Demo



2030
Full Commercial



160,000m³ Ship x2

Commercial Supply chain

Commercial scale
Technology confirmation

Technical & social
demonstration

Length(L.O.A)	約 315m
Breadth(Moulded)	約 56m
Cargo Tank Capacity (at -253°C、100%full)	40000 m ³ / 基 x 4 基
Depth(Moulded)	28.0m
Designed Draught(Moulded)	11.0m

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