

Hydrogen Energy Supply Chain for Decarbonization

KAWASAKI HYDROGEN ROAD

Development of Innovative Hydrogen Technologies
for Future Hydrogen Society

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Kawasaki Gas Turbine Europe

11th October 2021

AGENDA



1

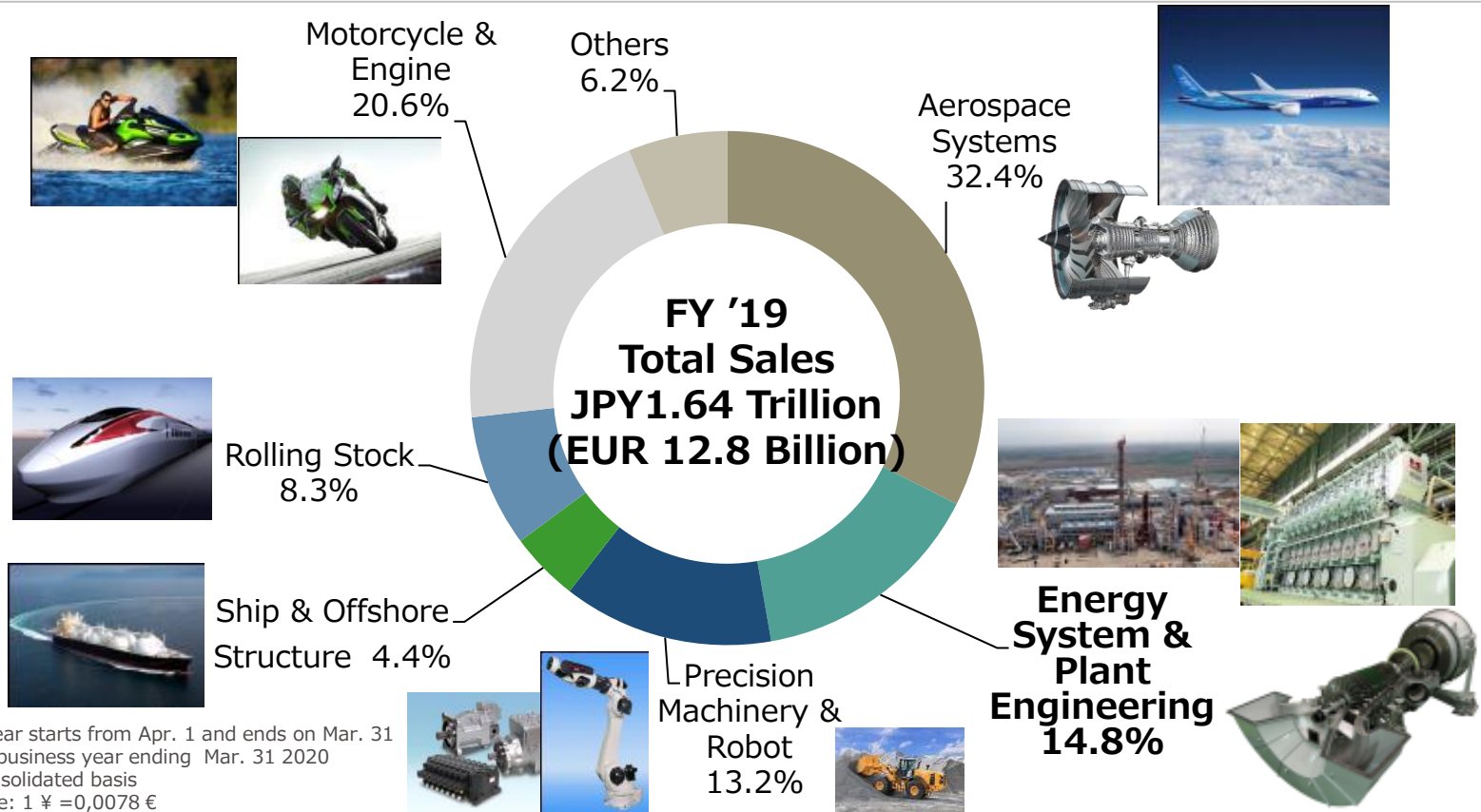
Introduction of Kawasaki and its Hydrogen Road



2

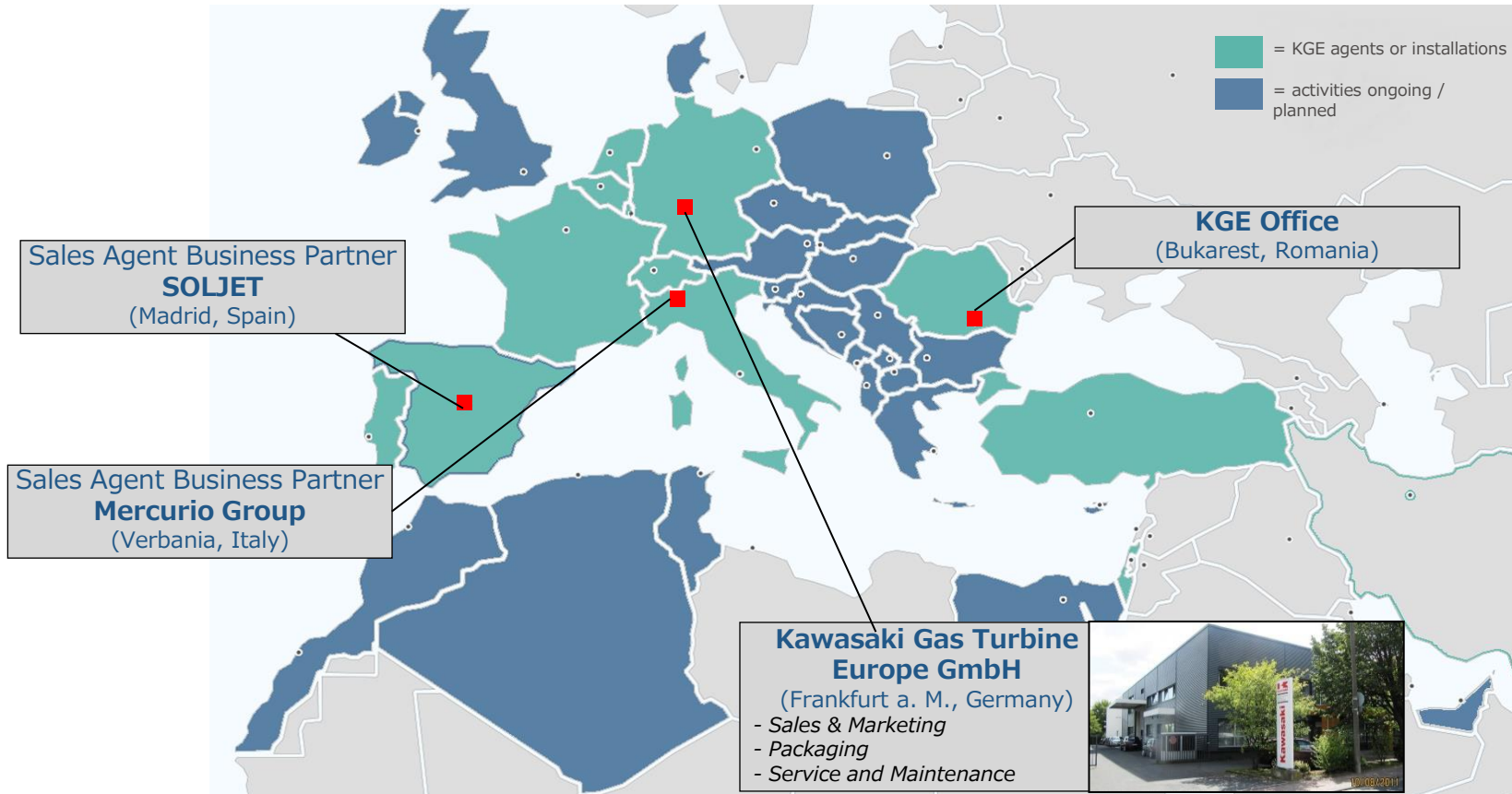
Co-Generation with Hydrogen Fueled Gas Turbines

Kawasaki Heavy Industries - Sections



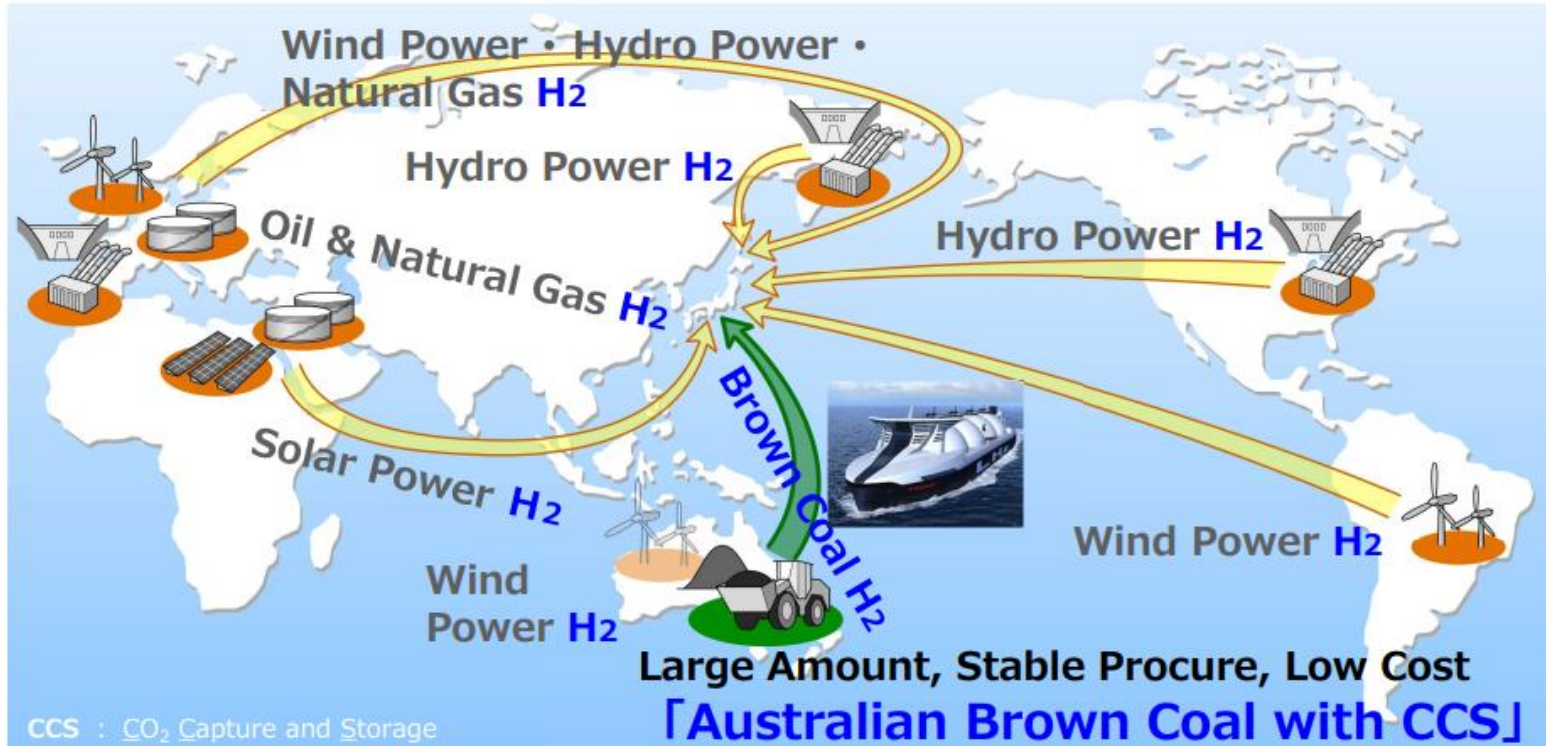
*Business year starts from Apr. 1 and ends on Mar. 31
 **As of the business year ending Mar. 31 2020
 ***On a consolidated basis
 ****Ex. Rate: 1 ¥ =0,0078 €

KGE - Regions of Activity

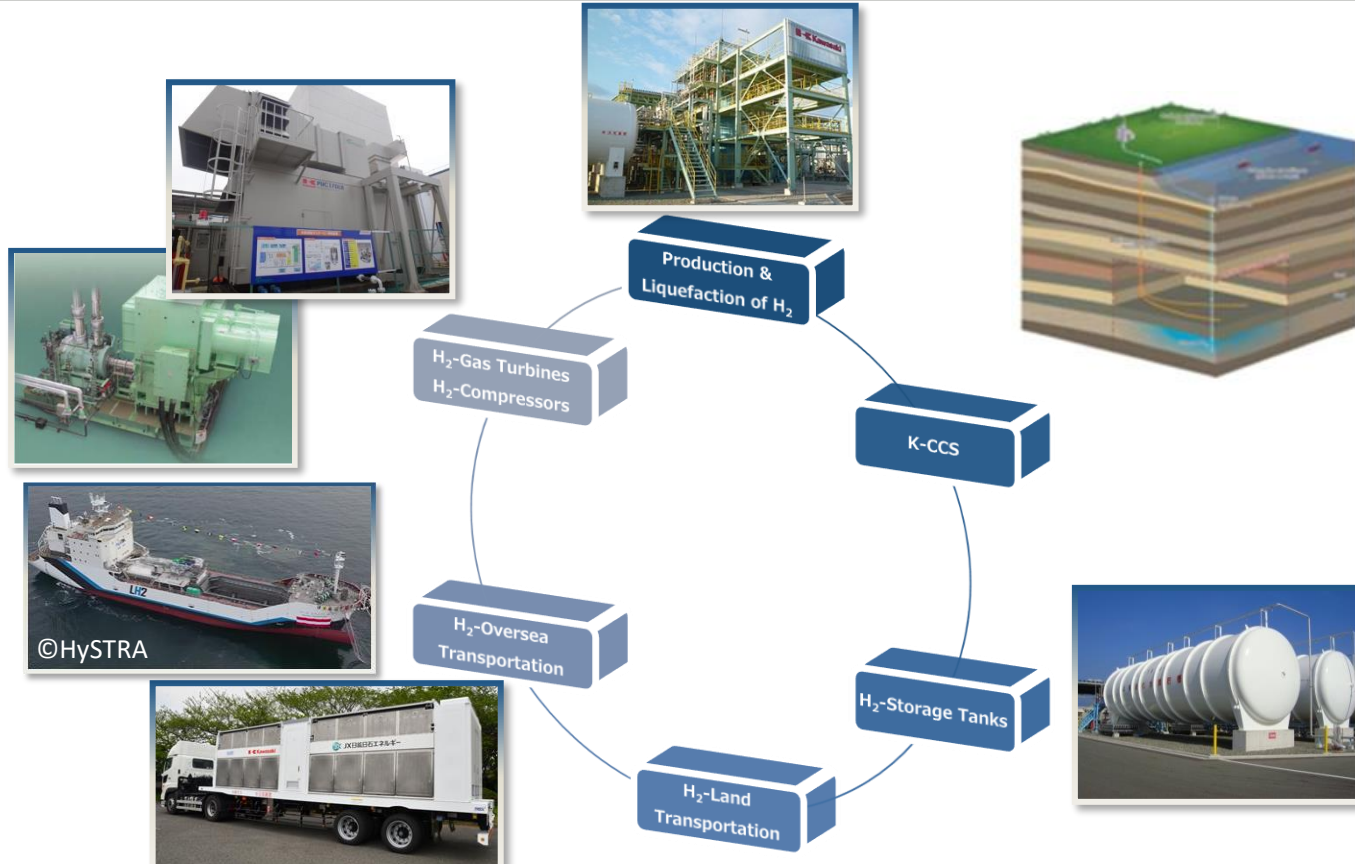


Hydrogen Road of Kawasaki Heavy Industries (KHI)

CO₂-Free Hydrogen Resources in the World



Hydrogen Road of Kawasaki Heavy Industries (KHI)



Kawasaki Hydrogen Road

Supported by NEDO and METI

<https://www.youtube.com/watch?v=vzzwqT-2Sjk>

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



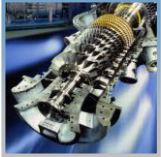
Cargo Tank Installation (7 March 2020)
at KHI Harima Works



LH2 Receiving Terminal construction completed



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Introduction of Kawasaki and its Hydrogen Road



2

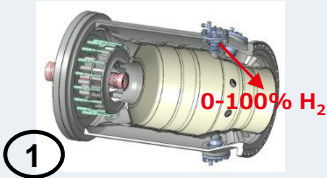
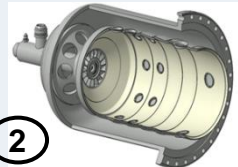
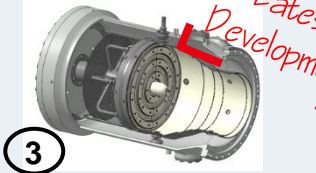



Co-Generation with Hydrogen Fueled Gas Turbines

Colors of Hydrogen

	Source	Technology	
Green	Renewable Energy	Electrolyzer	Zero CO₂
Turquoise	Natural Gas	Pyrolysis Plasmalysis	Solid Carbon
Pink	Nuclear Energy	Electrolyzer	Zero CO₂
Blue (with CCS)	Natural Gas, Coal, other Fossils	Steam Reformer Gasification	+ CO₂
Grey (without CCS)	Natural Gas, Coal, other Fossils	Steam Reformer Gasification	+++ CO₂

Developments for Hydrogen Gas Turbines @ KHI

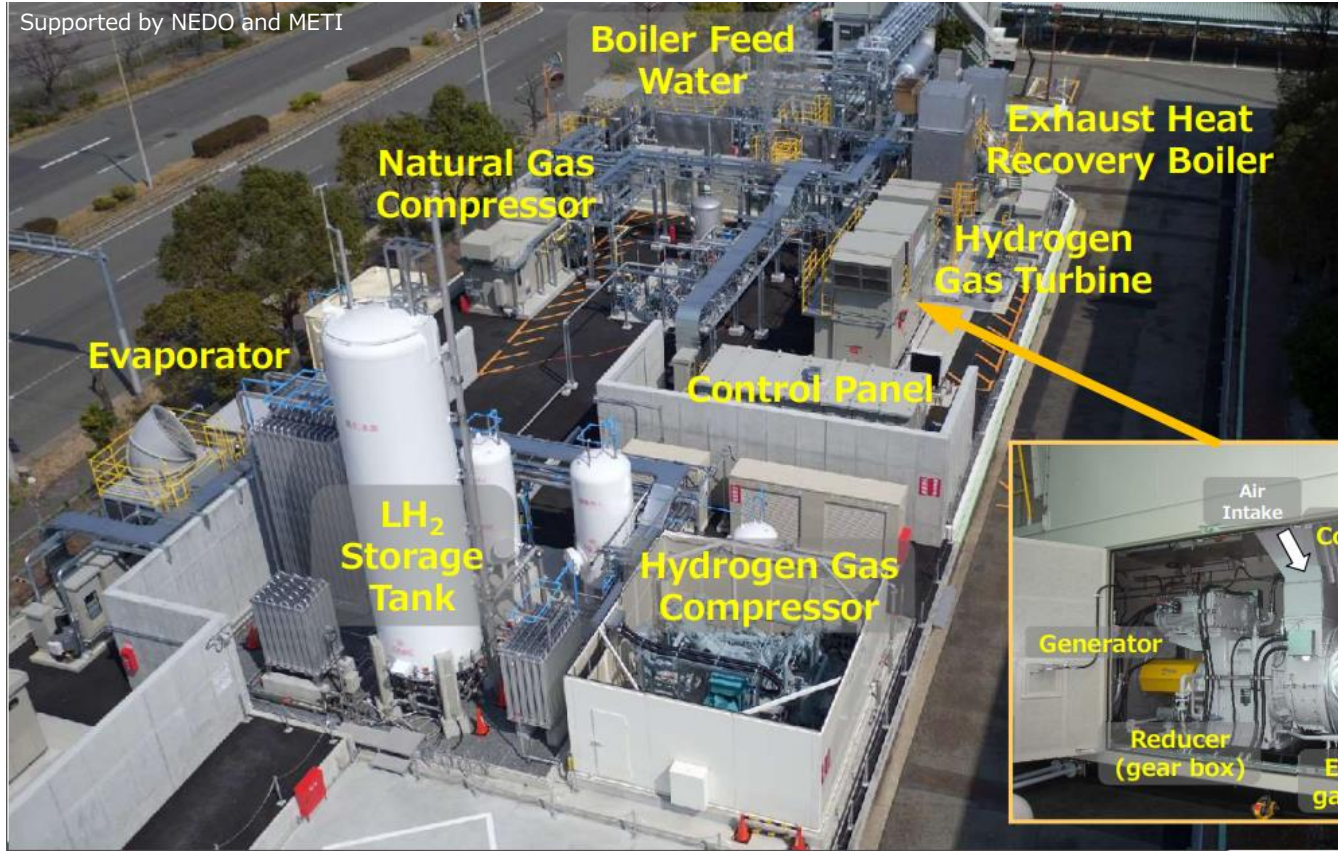
Overview of Combustor Developments

Combustor Configuration	DLE Combustor for Natural Gas	Diffusion Flame Combustor	DLE Micro-Mix Combustor
NOx Reduction	"Dry"	"Wet" Water/Steam	"Dry"
	 <p>①</p>	 <p>②</p>	 <p>③</p>
Max. H2 Content	60vol%	100vol%	100vol%
Status	<p>Engine Demonstration in Akashi Works, 2014</p> 	<p>Final Combustor Test, 2016 Applied to KOBE Demonstration Plant, 2018</p> 	<p>Final Combustor Test, 2018 Applied to KOBE Demonstration Plant, 2020</p>  <p>Supported by NEDO and METI</p>

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

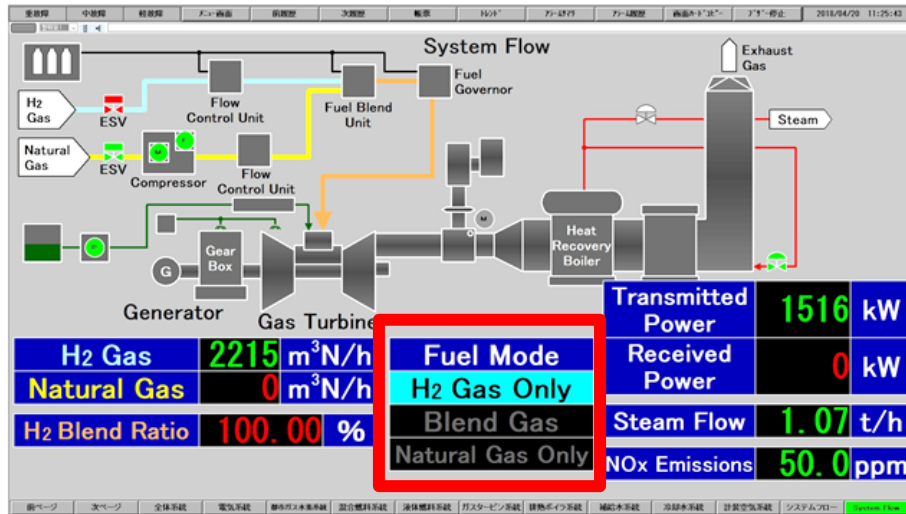
Supported by NEDO and METI

<https://www.youtube.com/watch?v=dC7AZWHC2UM>

Note: Follow or Copy the Hyperlink

World's First H2-Power Plant at Kobe Port

User Control Interface



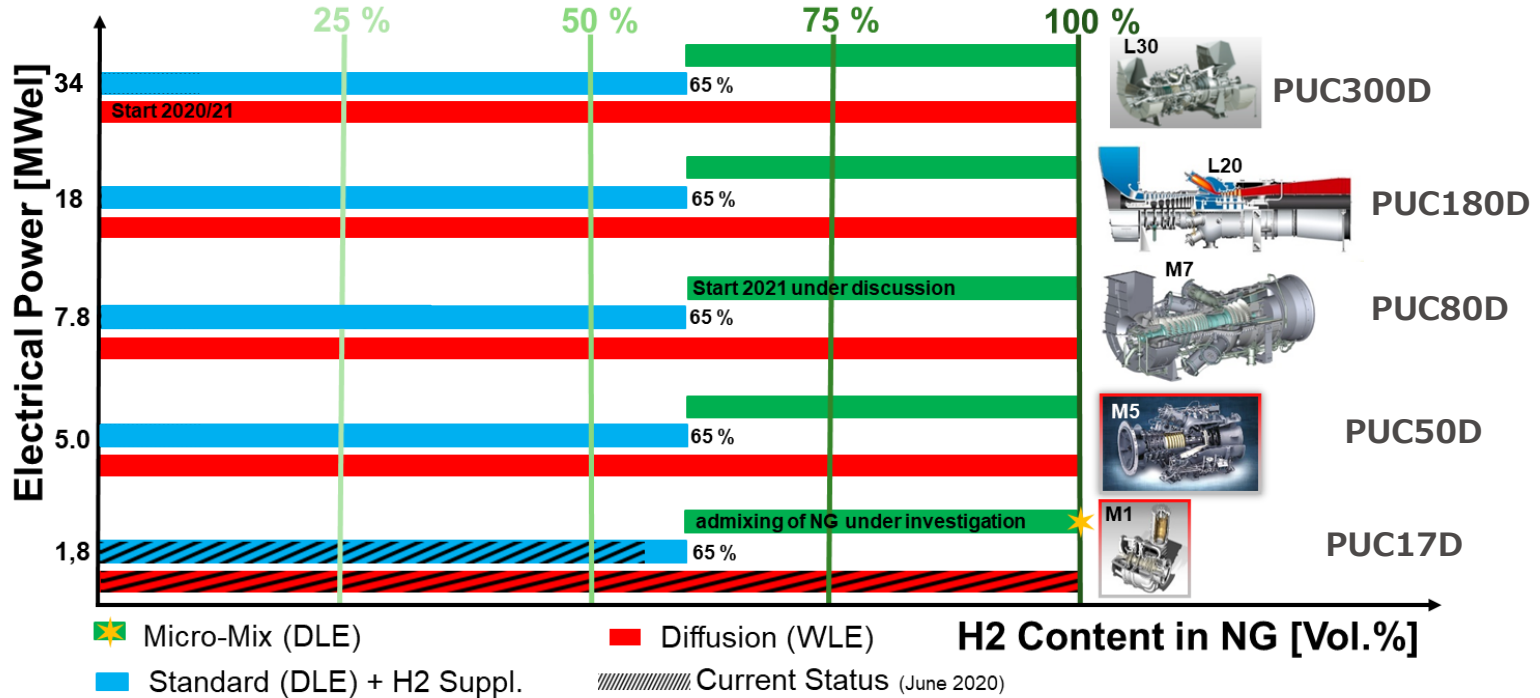
Comparison between NG & H₂

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

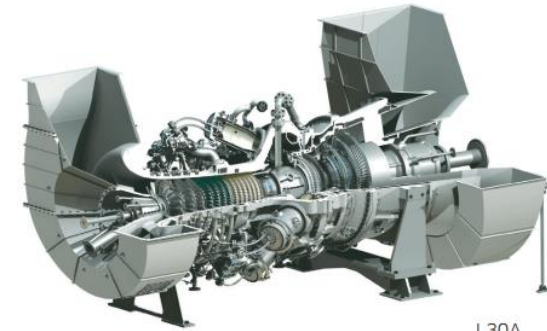
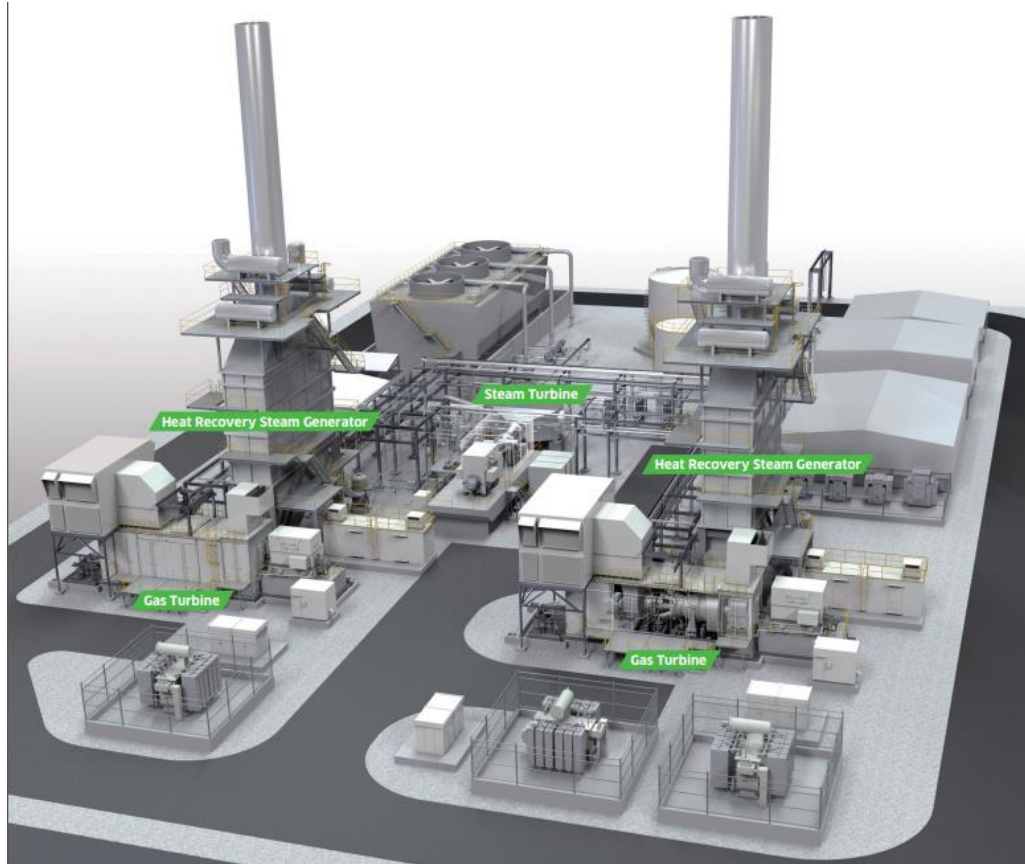
Performance at 15 °C, 60% RH, at Generator Terminal,
Inlet Pressure Loss 0,98 kPa, Exhaust Pressure Loss 2,45 kPa

Supported by NEDO and METI

Hydrogen Capability of Gas Turbines @ KHI

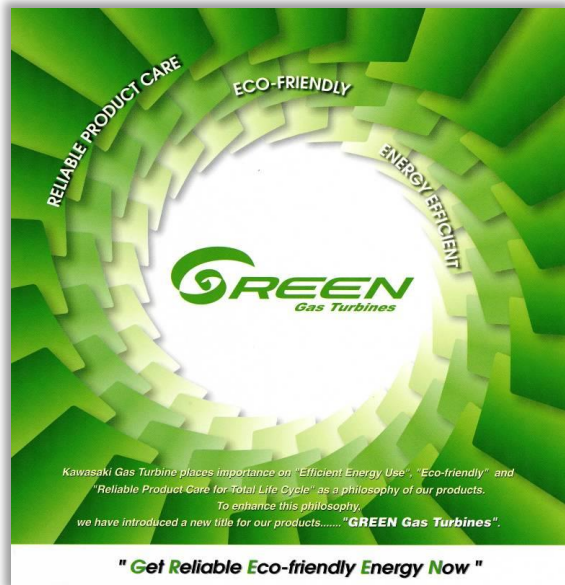


High-Efficiency 100 MW Combined Cycle Power Plant



	1 on 1	2 on 1	2 on 1 (Reheat)
CC Electric Output [MWe]	44.7	89.9	101.5
CC Heat Rate [kJ/kW-hr]	6,650	6,620	6,520
CC Electrical Efficiency [%]	54.1	54.4	55.2
Number of Gas Turbine	1	2	2
Bottoming Cycle Type	2PNRH	2PNRH	3PRH

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