

The Hydrogen Energy Supply Chain (HESC) - Project Overview -

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About J-POWER

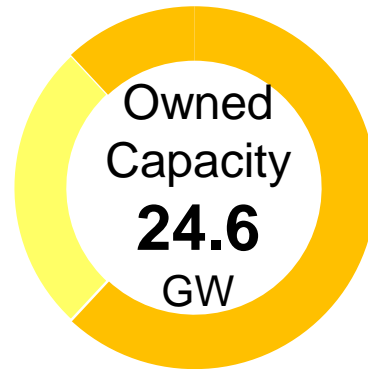
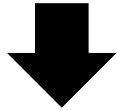


(As of November 2016)

Corporate Philosophy

- ✓ We will meet people's needs for energy without fail and play our part for the sustainable development of Japan and the rest of the world
- ▶ J-POWER is the largest wholesale power company in Japan.
- ▶ J-POWER operates power generation businesses in six countries and regions worldwide.

Overseas
6.7 GW

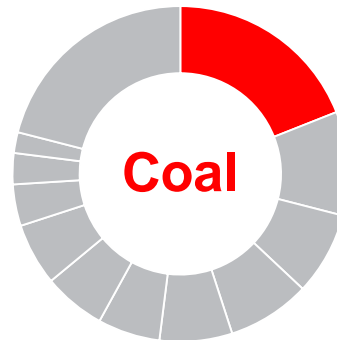
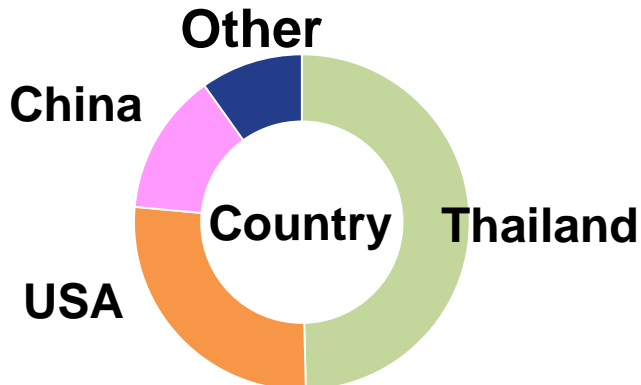


Japan
17.9 GW

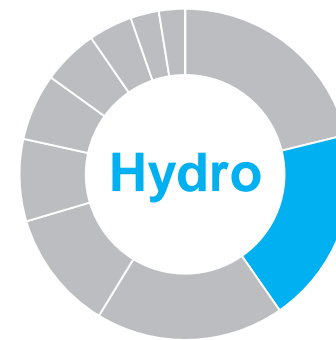


Growing significantly, especially in Thailand in recent years

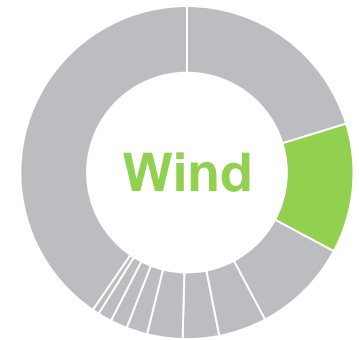
One of the leading shares in coal-fired, hydro and wind power generation



8.5GW



8.6GW



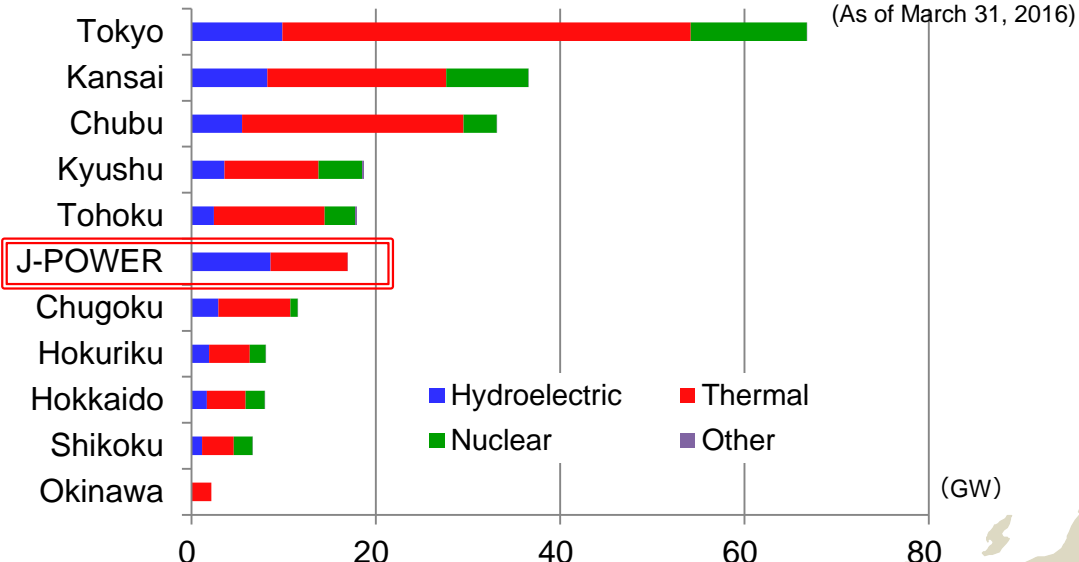
0.4GW

Domestic Power Business

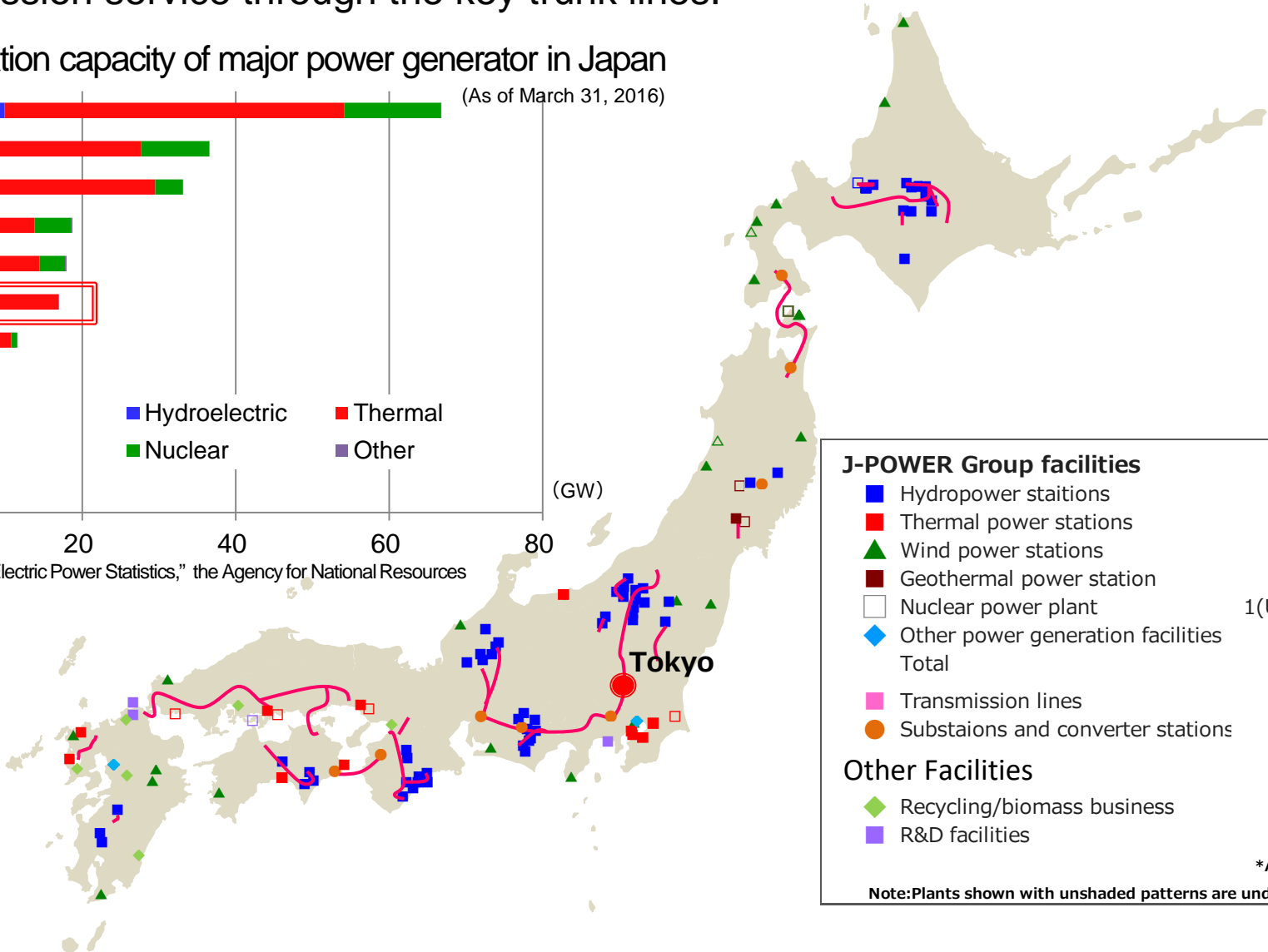


- ▶ Traditional large scale coal-fired and hydro power as well as recent expansion of wind.
- ▶ Transmission service through the key trunk lines.

Power Generation capacity of major power generator in Japan (As of March 31, 2016)



Source: Compiled from "Electric Power Statistics," the Agency for National Resources and Energy



J-POWER Group facilities	
Hydropower stations	61
Thermal power stations	12
Wind power stations	21
Geothermal power station	1
Nuclear power plant	1 (Under construction)
Other power generation facilities	2
Total	97
Transmission lines	Approx. 2,400km
Substaions and converter stations	4
Other Facilities	
Recycling/biomass business	
R&D facilities	

*As of December 31, 2016

Note: Plants shown with unshaded patterns are under construction/planned

Overseas Power Generation Business



▶ J-POWER is leveraging its more than 50 years of overseas achievements and know-how as it engages in its overseas power generation business and overseas consulting business.

- In operation: 36 projects
- Under construction/planned: 3 projects



Hezhou Coal Power Plant (China)



Elwood Energy Gas Power Plant (United States)



Nong Saeng Gas Power Plant (Thailand)

[Owned capacity of overseas project] (MW)

Countries/ Regions	In operation	Under development	Total
Thailand	3,300	-	3,300
USA	1,785	232	2,016
China	944	-	944
Other areas	656	895	1,551
Total	6,685	1,127	7,811

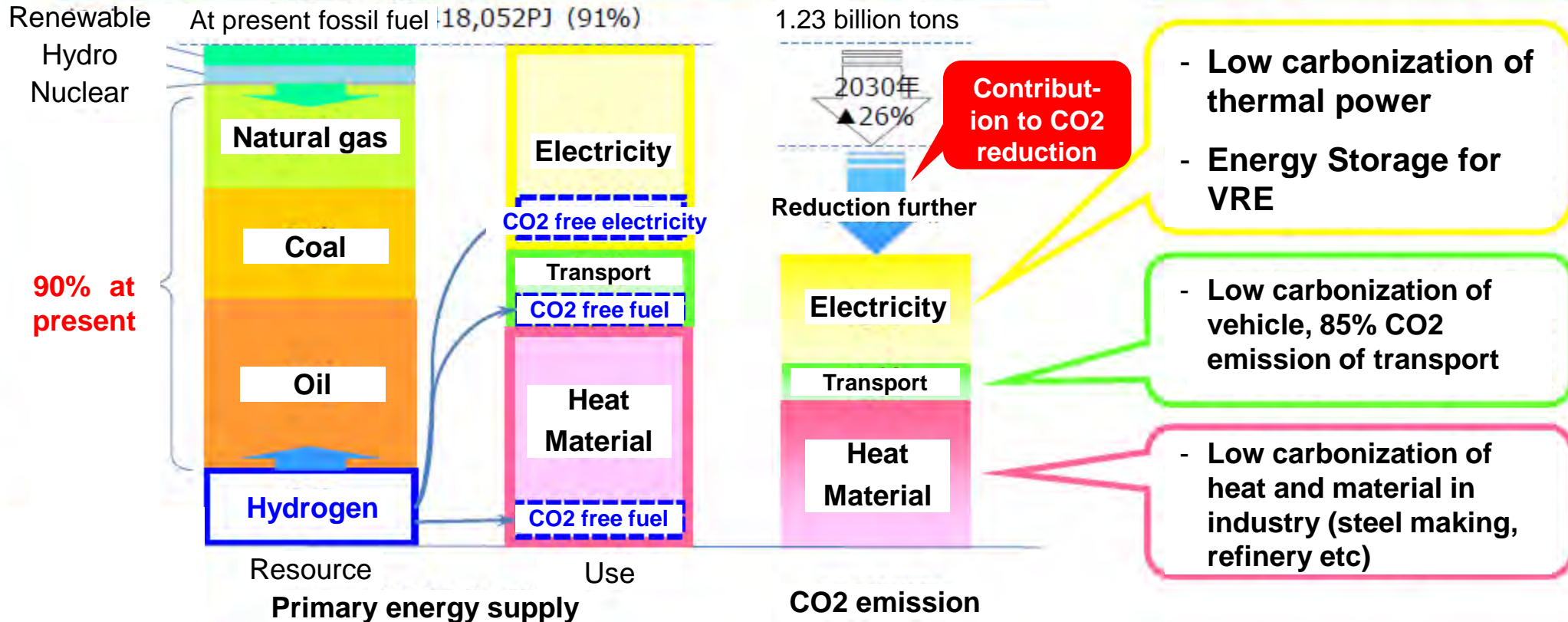
As of December 31, 2018

Significance of use of Hydrogen in Japan

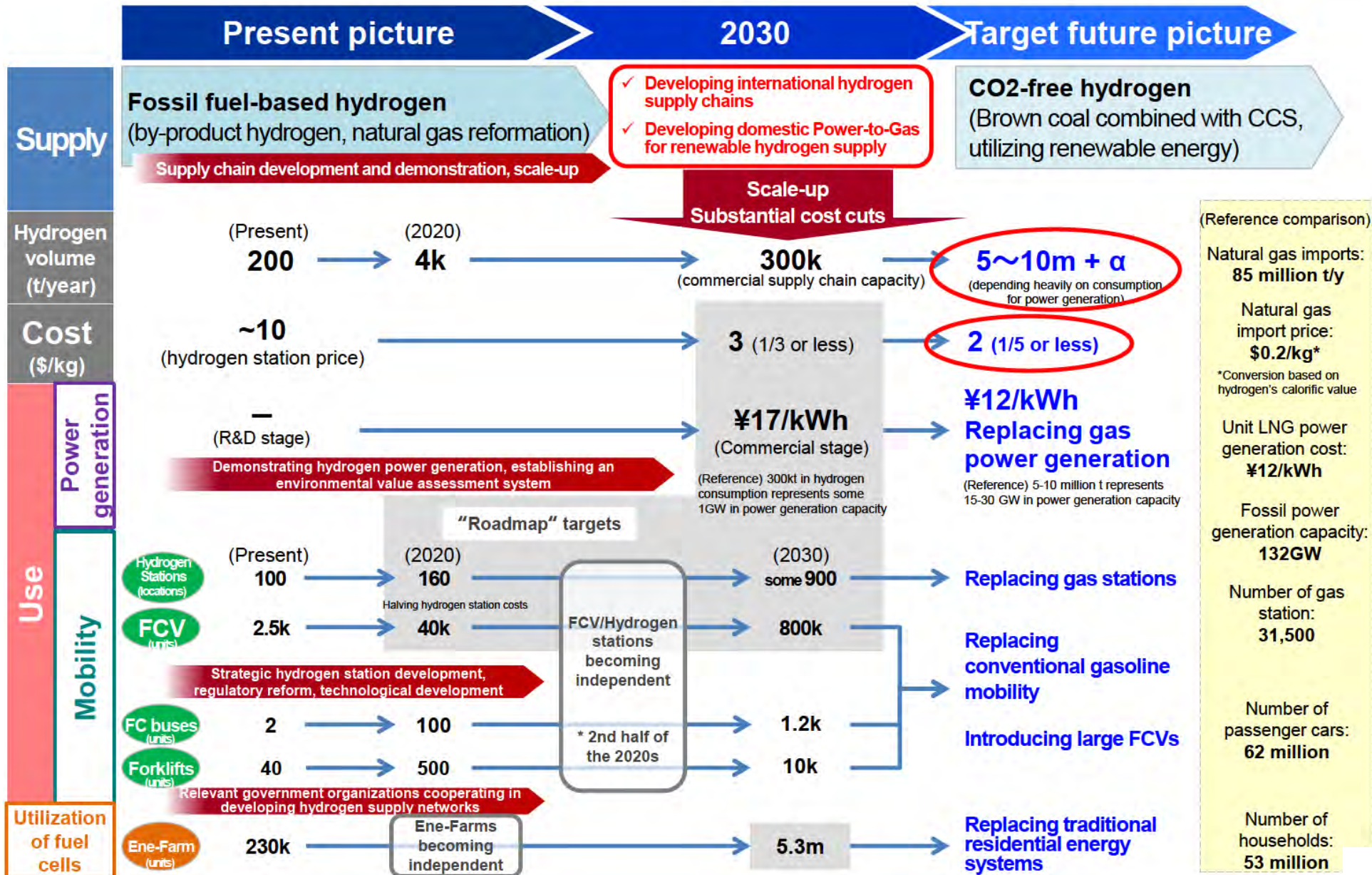
- Low carbonization in energy supply is essential towards FY2050.
- Japan imports fossil fuel as 90% of primary energy.
- Hydrogen use for generation, transport and industry (heat and material) .

Primary energy supply structure reform and CO2 reduction by Hydrogen

Direction of use of Hydrogen



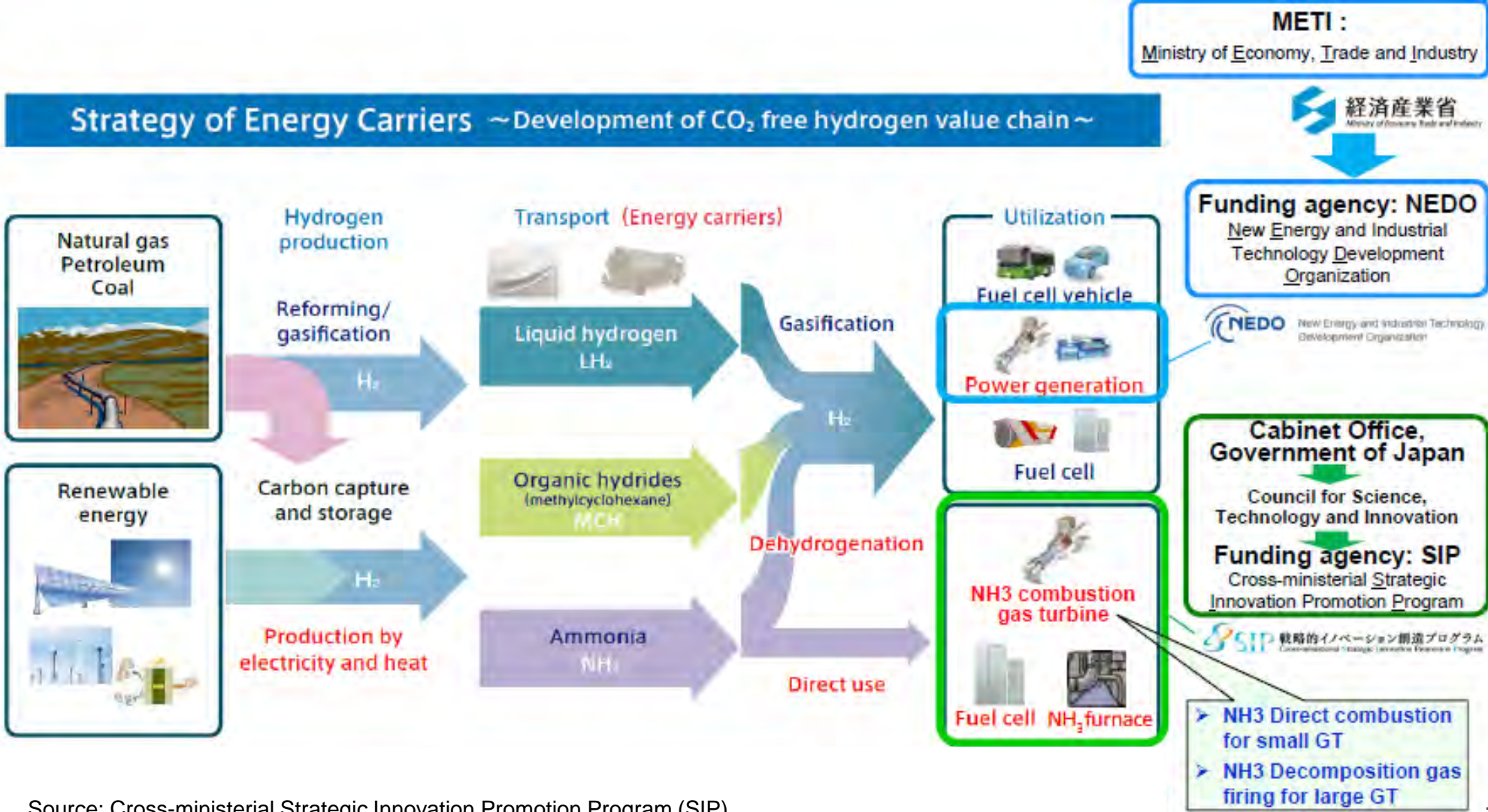
Scenario for Basic Hydrogen Strategy of Japan



Source: METI, Japan

Hydrogen supply chain

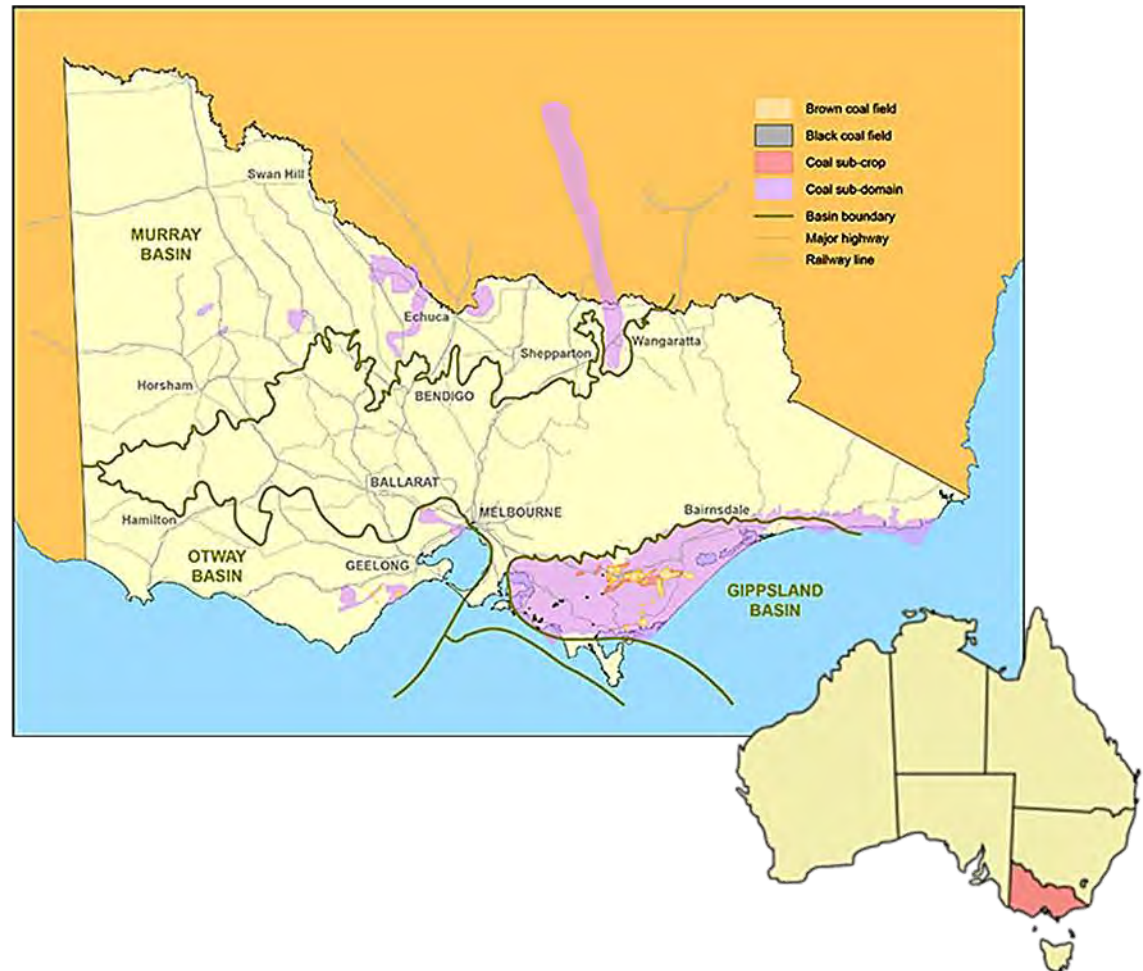
■ Hydrogen can be produced from various kinds of resources and has options for transport.



Natural Resources in Victoria, Australia

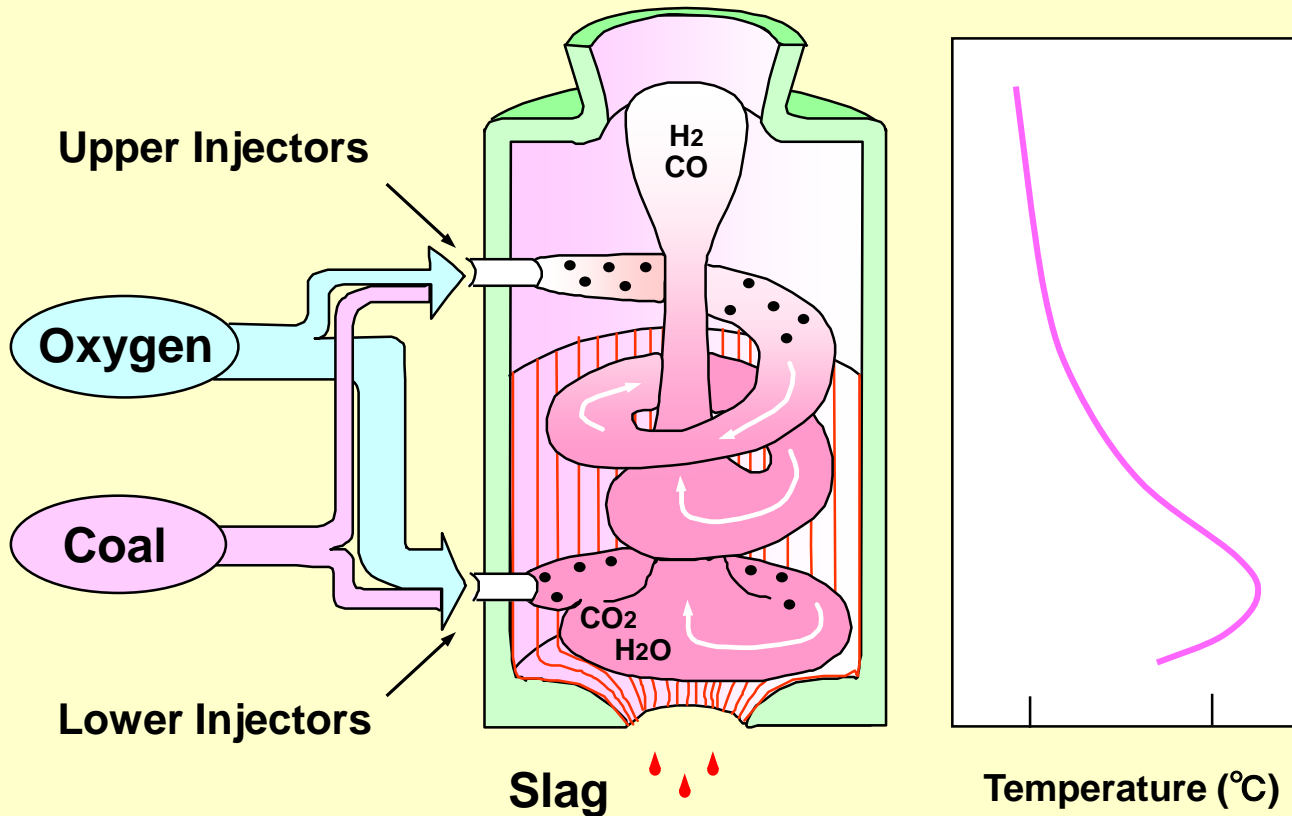
- Huge amount of coal resources with preferable potential CCS site in Gippsland Victoria.

- **430 billion tonnes** in situ brown coal
- **65 billion tonnes** of measured coal
- **33 billion tonnes** of potentially economic brown coal



Features of the EAGLE Gasifier

Oxygen blown Entrained flow Two-stage Spiral-flow Gasifier



Upper Stage: Oxygen Lean

Coal → Char

Char + CO₂ + H₂O → CO + H₂

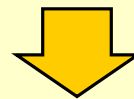
Utilizing heat from lower stage for gasification reactions

Lower Stage: Oxygen Rich

Coal + O₂ → CO₂ + H₂O

High temperature to melt coal ash

Longer residence time by spiral flow



- ✓ High Gasification Efficiency
- ✓ Stable Slag Discharge

History of the EAGLE Gasifier Development



Coal **E**nergy **A**pplication
for **G**as, **L**iquid, and **E**lectricity



**Osaki CoolGen (OCG)
IGCC Demonstration Plant
(1,180t/d / 2016~ / Osaki)**



***EAGLE* Pilot Plant
(150t/d / 2002~2013 / Wakamatsu)**



**HYCOL Pilot Plant
(50t/d / 1991~1993 / Sodegaura)**

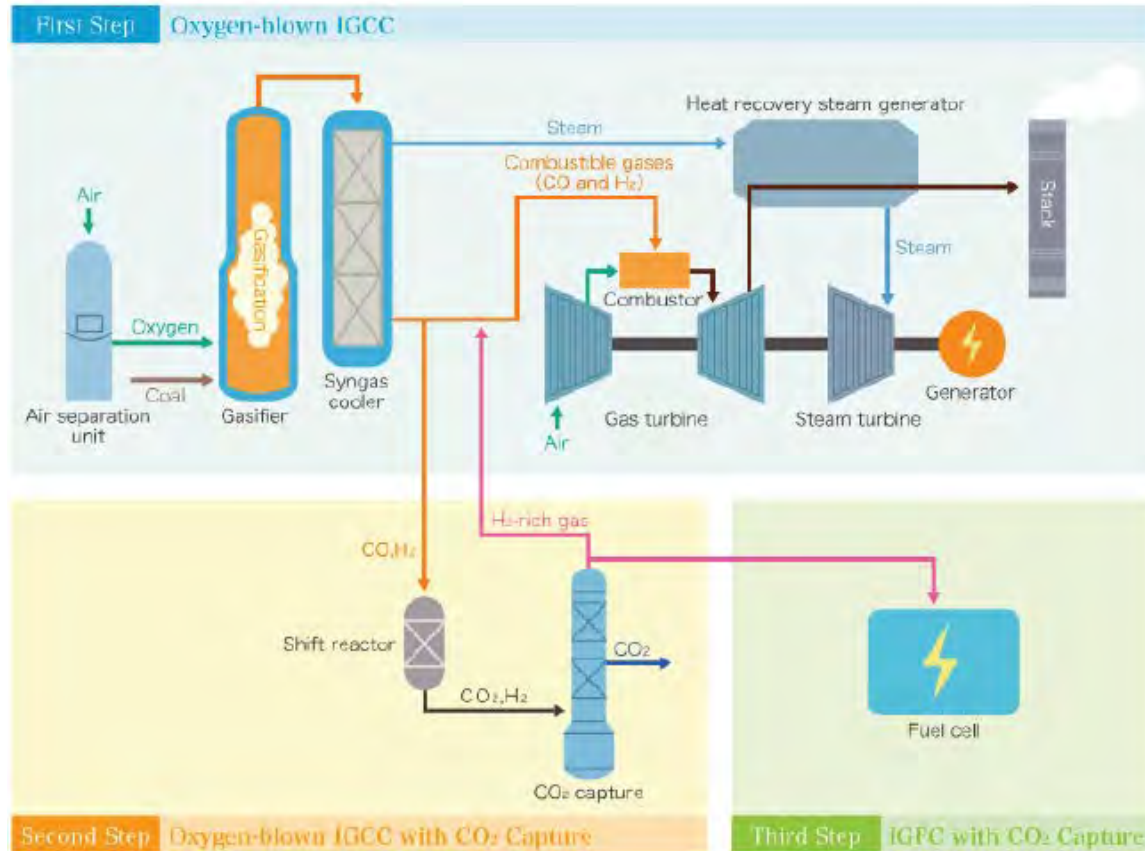
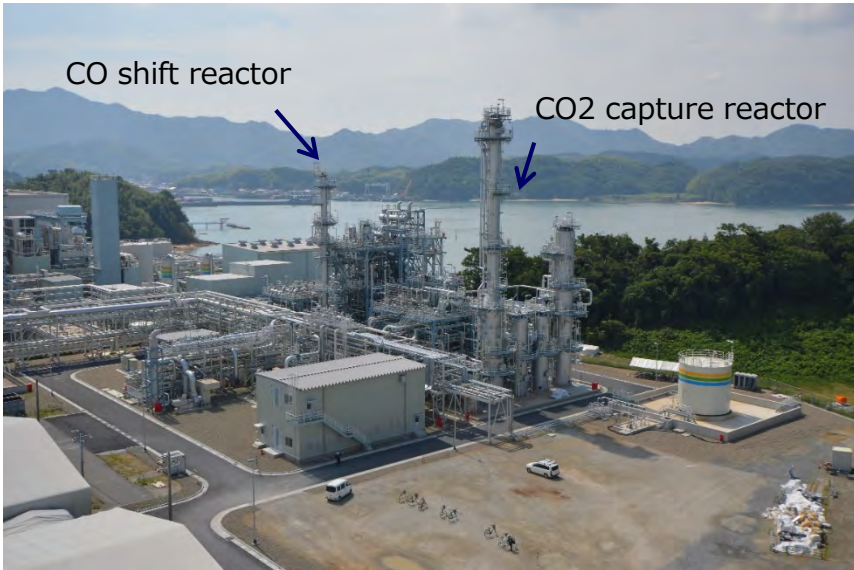


**Process Development Unit
(0.5t/d / 1981~1985 / Katsuta)**

CO2 capture demonstration with IGCC at OCG



- IGCC demonstration was successfully conducted as 1st step.
- CO2 capture system is to be demonstrated in FY2019~2020 as 2nd step.



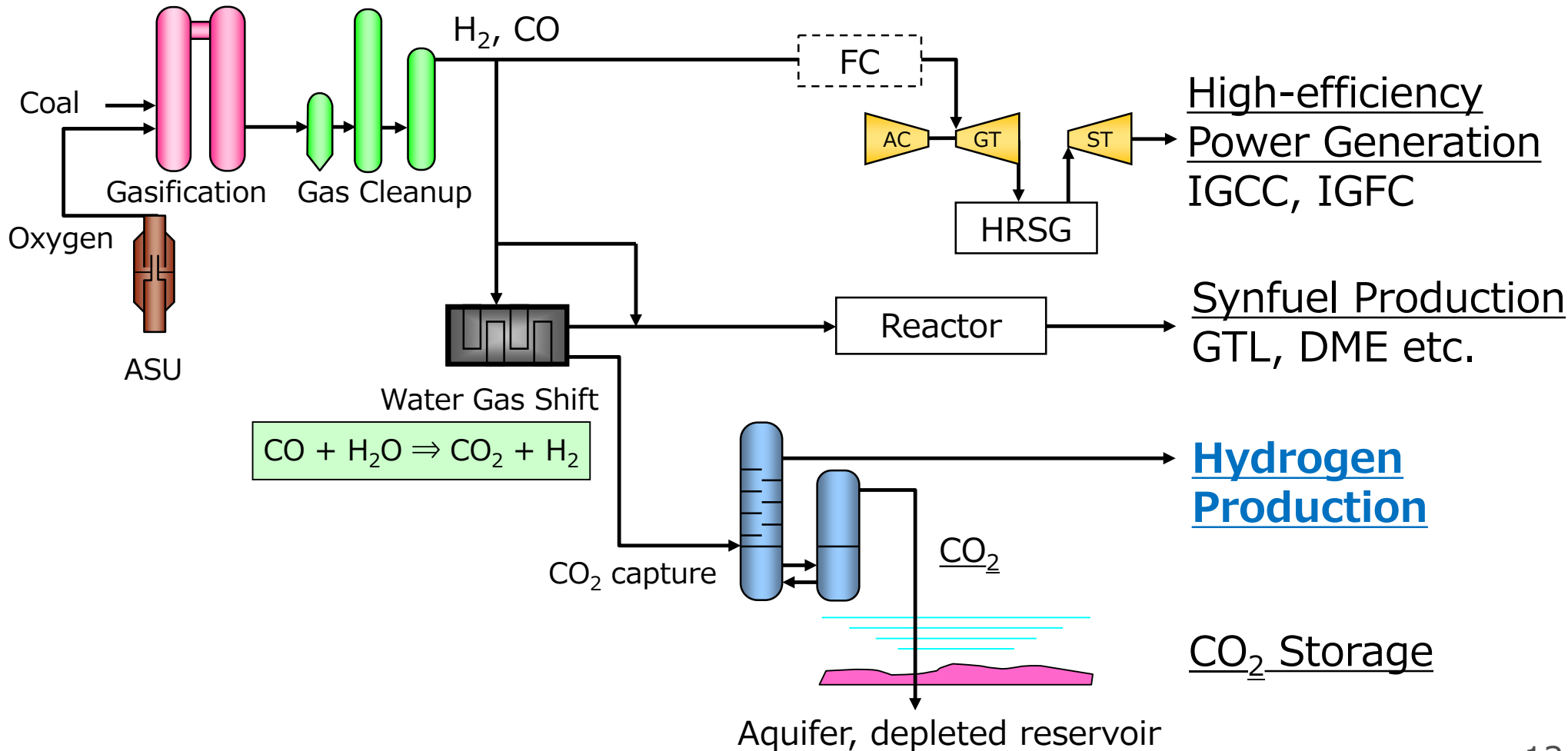
IGCC demonstration plant

- 166MW output
- Oxygen blown Entrained flow Two-stage Spiral-flow Gasifier (“EAGLE” type)
- Pre-combustion CO2 capture by 15%

FY	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
First Step Oxygen-Blown IGCC	Detailed design and construction					Demonstration		Demonstration			
Second Step Oxygen-Blown IGCC with CO₂ Capture					Detailed design and construction			Demonstration			
Third Step IGFC with CO₂ Capture							Detailed design and construction				

Diversity of Oxygen-blown gasification technology

- Oxygen-blown gasification produces the syngas mainly composed of H₂ and CO.
- is suitable for multiple applications such as synfuel, H₂ production, and power generation.



The partners & supporters of Hydrogen Energy Supply Chain Project



Industrial Partners



CSIRO / CO2CRC / BCIA
Monash / Federation Univ.
as well as GHD etc.



Governmental Supporters



Shell
Japan



Overview of Hydrogen Energy Supply Chain Project

- Liquefied Hydrogen from unused brown coal



Latrobe Valley - Australia

Port of Hastings - Australia

Brown coal gasification
(2t/d test facility)

Gas clean-up
H₂ purification



H₂ Gas Transport

H₂ liquefaction and
loading base



Liquid H₂
carrier



Liquid H₂
unloading base



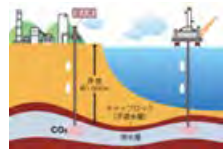
J-POWER's
Work

Brown coal exported for
testing in Japan

Brown coal gasification
(EAGLE II pilot facility; 20t/d)



Japan



In future
CO₂ Storage by
CarbonNET Project

“Blue Hydrogen”
as CO₂ free fuel
with CCS

Japanese Fiscal Year

2016	2017	2018	2019	2020
FEED (Basic Design)			Construction	Pilot Testing
Detail Design & Manufacturing				

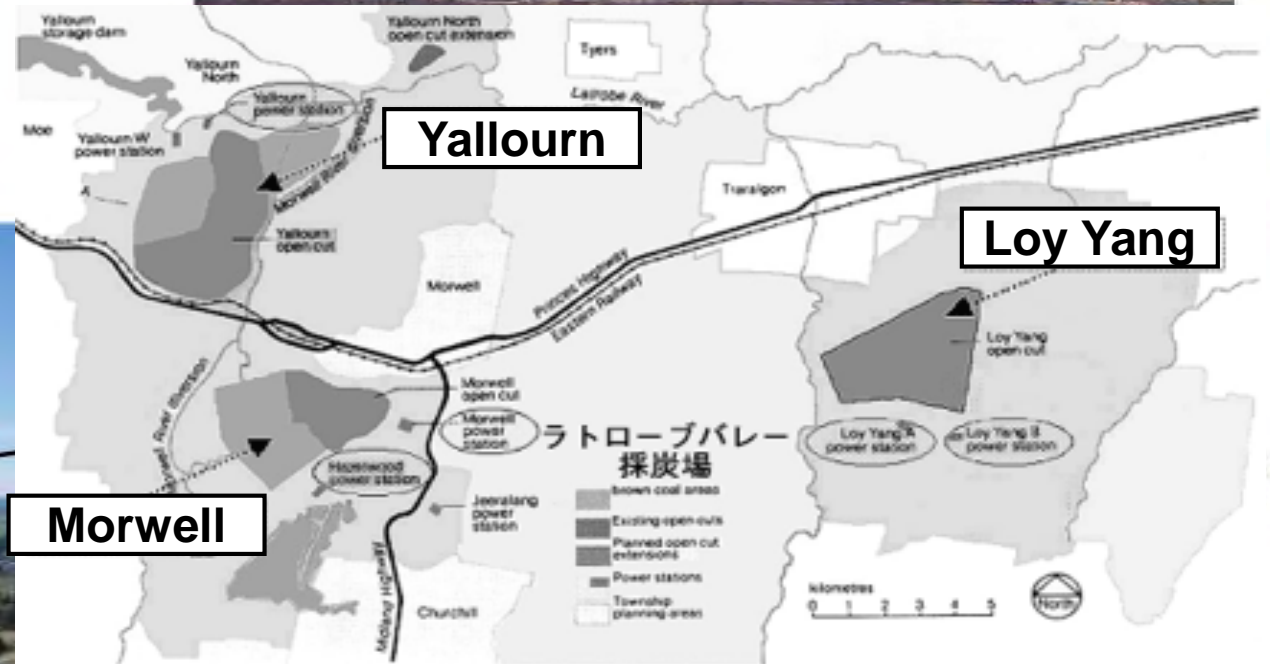
Latrobe Valley Coal Mine



Latrobe Valley



AGL Loy Yang Power Station



Yallourn

Loy Yang

Morwell

J-Power Latrobe Valley Pilot Plant



Courtesy of HySTRA



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EPA Victoria approves coal to hydrogen trial in Latrobe Valley

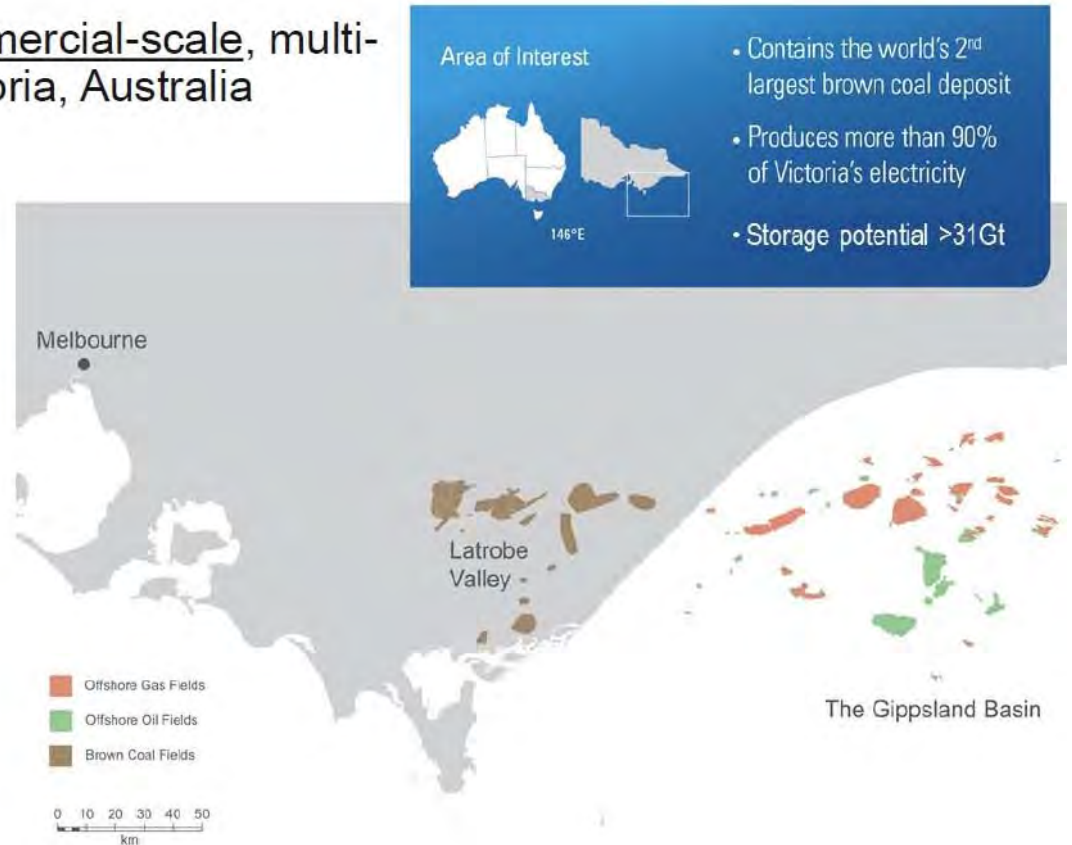
14 Feb 2019

Environment Protection Authority Victoria (EPA) has approved an application from J-Power Latrobe Valley Pty Ltd (J-Power) for a Research, Development and Demonstration (RD&D) that will investigate the potential for converting coal to hydrogen.

CO2 storage

■ CarbonNet Project is being promoted near Latrobe Valley Coal Mine.

- Investigating the feasibility for a commercial-scale, multi-user CCS network in Gippsland, Victoria, Australia
- Jointly funded by the Australian and Victorian Governments to 2020, also supported by GCCSI
- Governments have made significant research investment to support CarbonNet
- CO2CRC is CarbonNet's lead research organisation
- Working collaboratively with industry to secure customers and investors in a **CCS service**



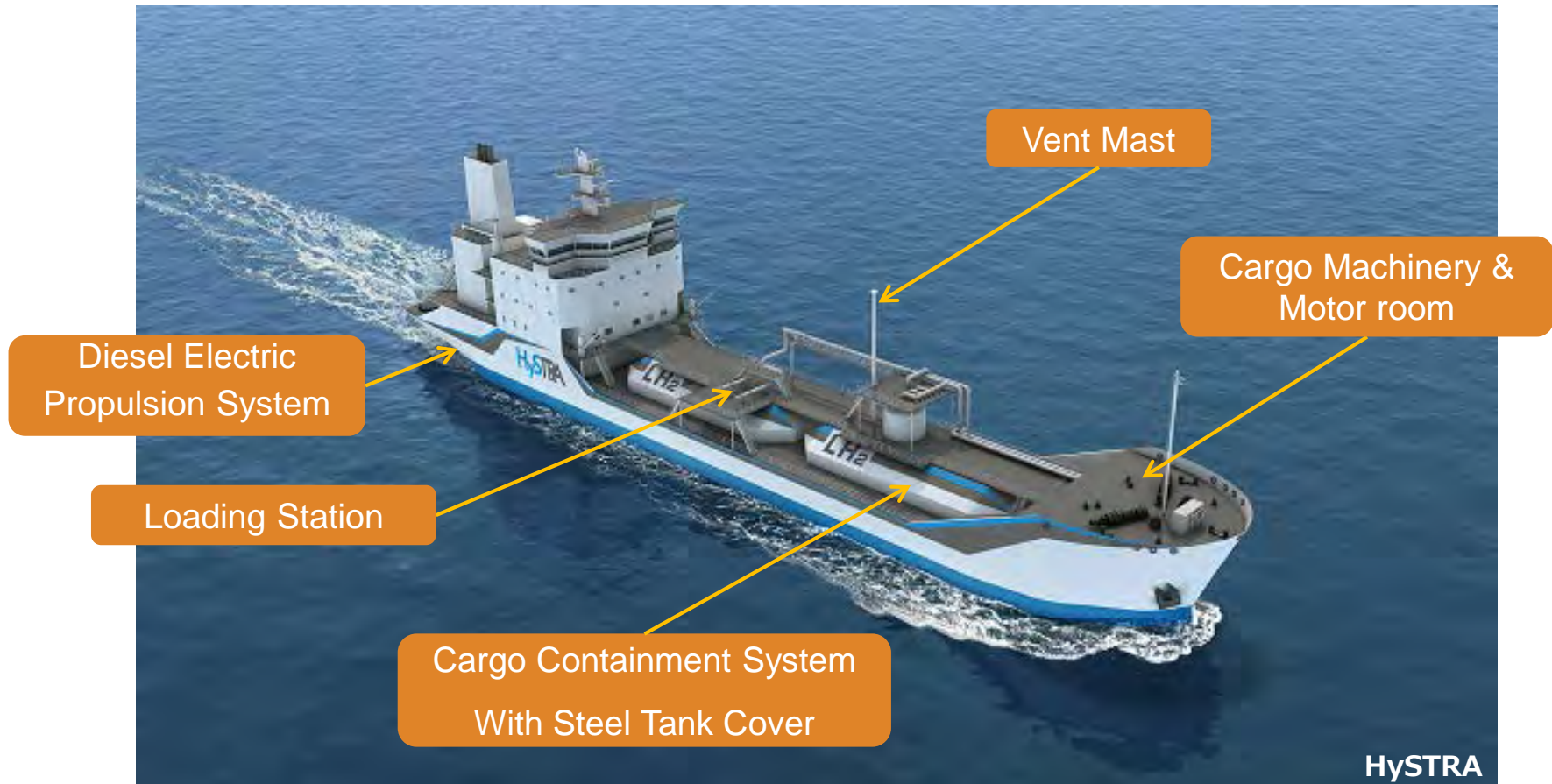
Source: Victorian Government

Hydrogen Liquefaction and Loading Terminal



Liquefied Hydrogen Cargo Ships

- Official launch of the specialized marine carrier scheduled in December 2019.

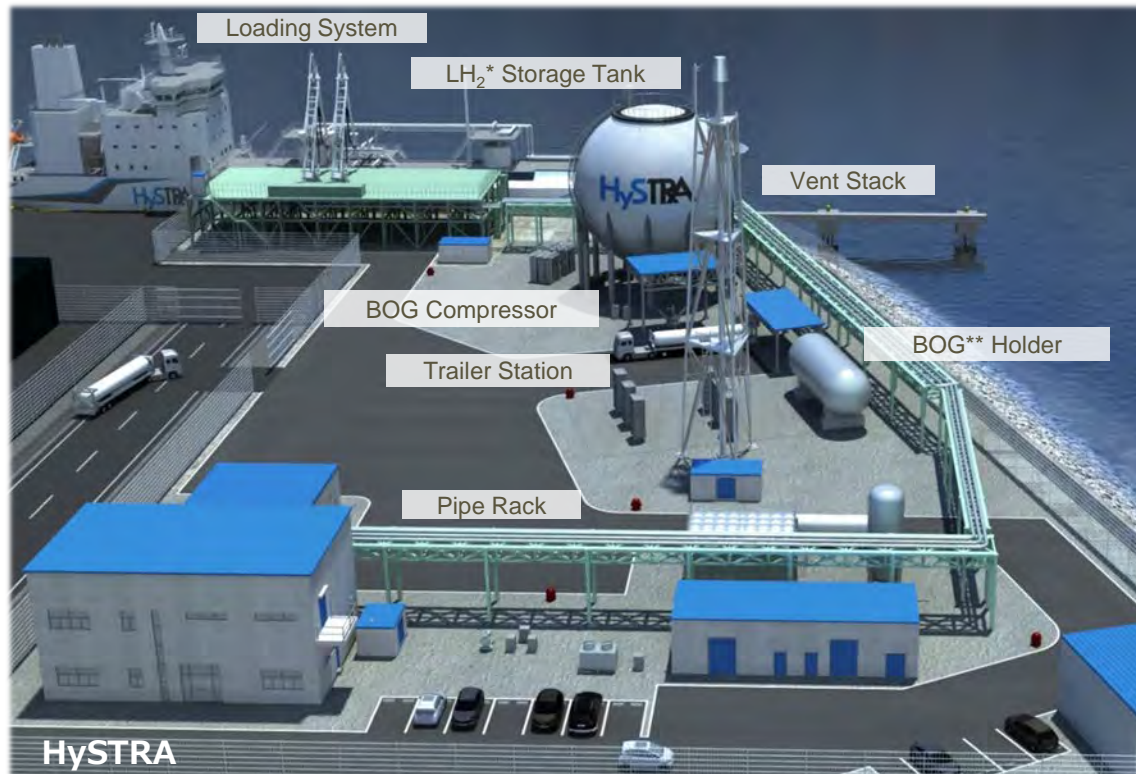


Overall length : 116.0m
Overall width : 19.0m
Depth : 10.6m
Maximum crew : 25 persons

Gross tonnage : 8,000 tonnes
Vessel speed : 13 knots
Draft : 4.5m
Tank capacity : 1,250 m³

Kobe Hydrogen Unloading Terminal

Liquefied Hydrogen Terminal in Kobe Airport Island



*LH₂ : Liquefied Hydrogen

**BOG : Boil Off Gas

