

Japan – Norway Workshop

"Future Technology and Finance in the Maritime Sector"

 **Kawasaki**
Powering your potential

Hydrogen (Supply Chain)

Development of Overseas Energy Carrier with Liquid Hydrogen

Friday 12 February 2016

Why Hydrogen ?

Hydrogen :

- Does not emit CO₂ or any hazardous materials
- Used as rocket fuel (High energy density)
- Produced from various resources (Sustainable)

Clean

Powerful

Prospect of Hydrogen Energy Supply in Japan

(Conducted by The Institute of Applied Energy)

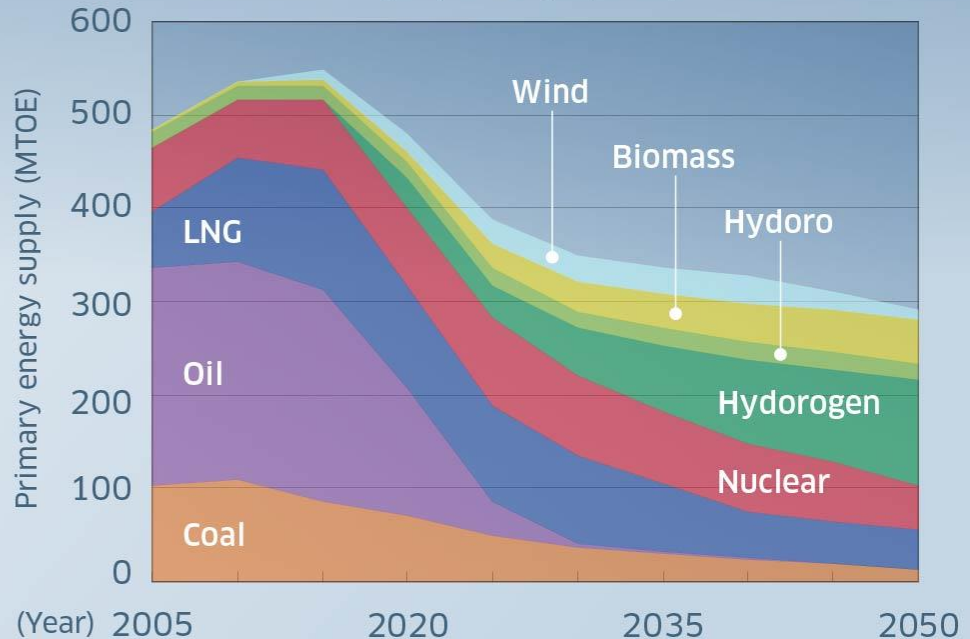
Conditions

- **CO₂ Reduction (compared to 1990)**
by 2020 : -15%
by 2050 : -80%
- **Unable to combine with domestic CCS**

Simulations

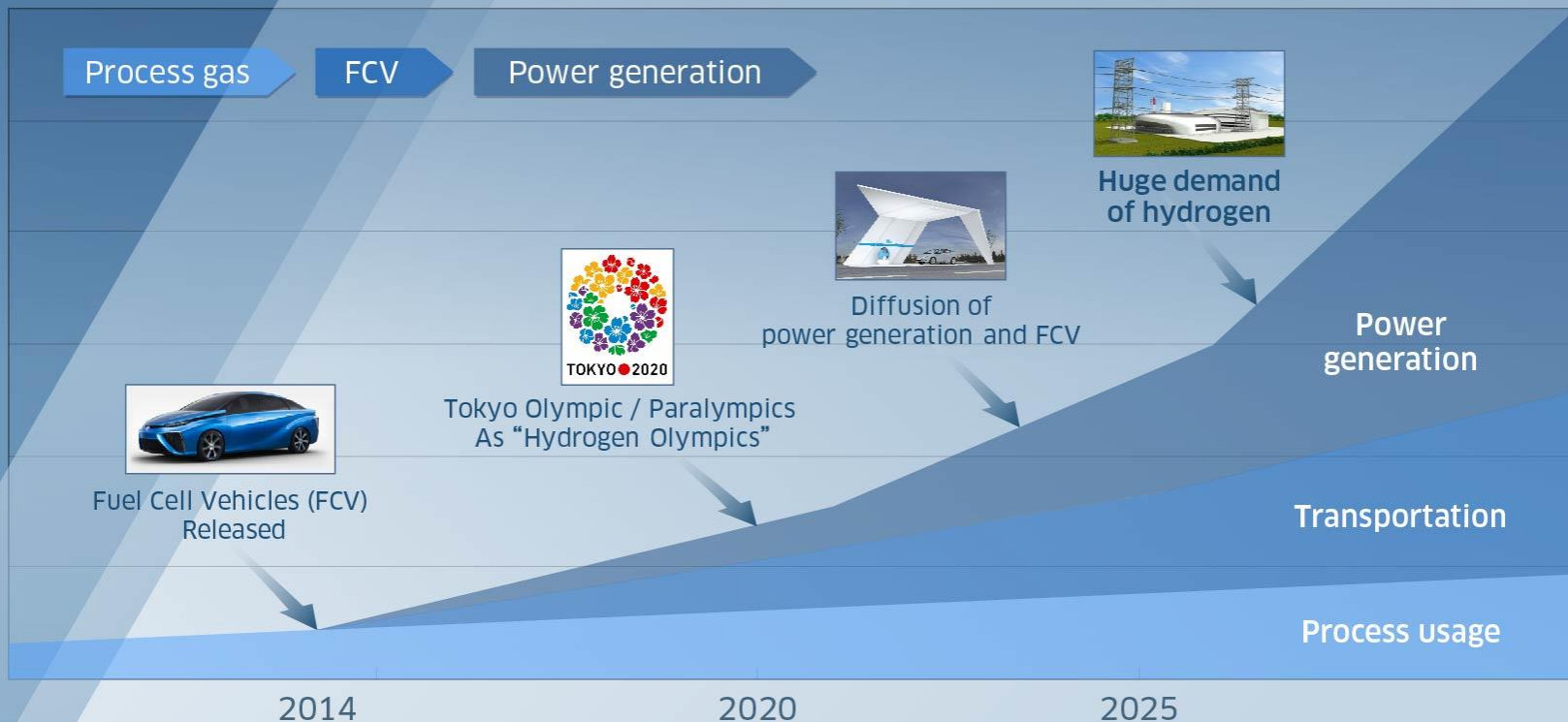
- **Search for the lowest economic burden on citizens** caused by energy supply and CO₂ emission reduction
- **Parameter: Hydrogen cost**
25-45 Japanese yen/Nm³
- In case of hydrogen cost is 45 yen/Nm³, hydrogen supply is roughly 20%.

Result in case of hydrogen cost
(CIF is 25 yen/Nm³)



Demand Expansion

“ FCV to Olympic / Paralympics ”



Kawasaki Hydrogen Road

Hydrogen Road

Technology Paving the way the Hydrogen Road.

Hydrogen Production

Producing clean, low-cost hydrogen from various resources.

Hydrogen Transportation & Storage

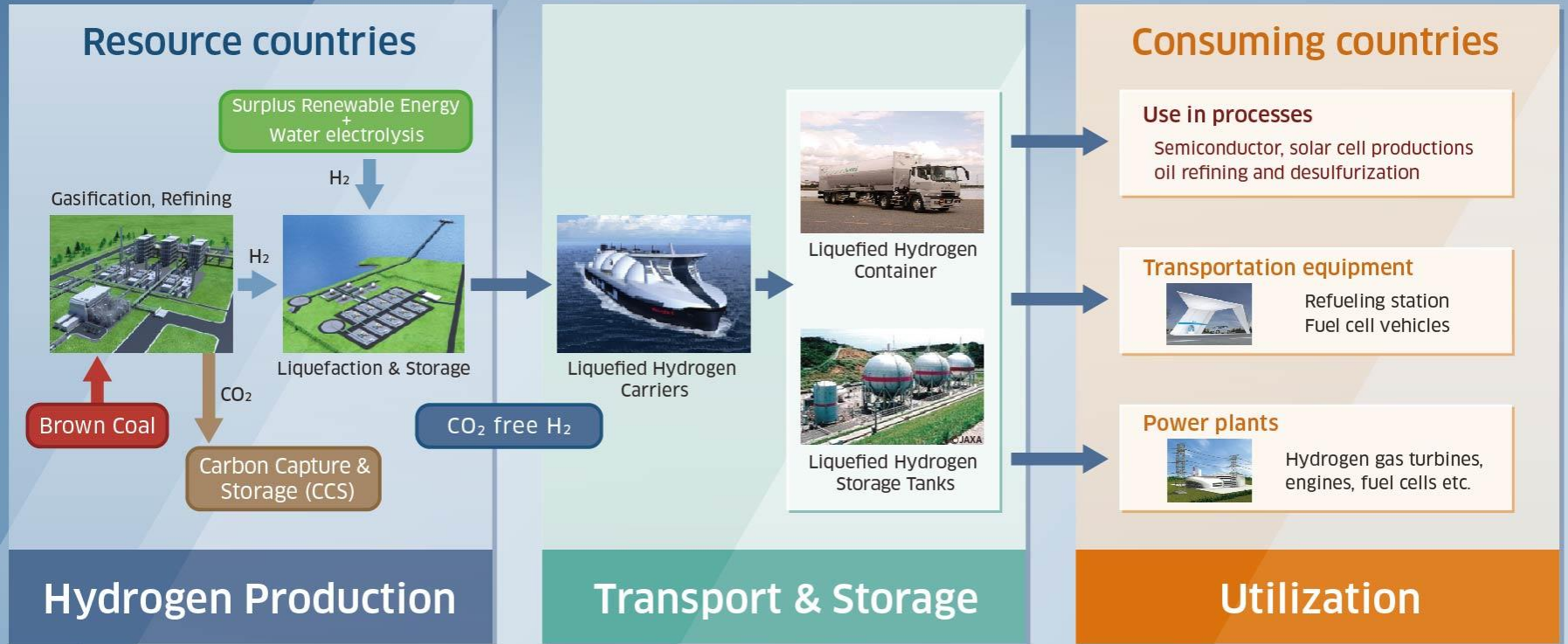
Transportation/storage technology to help disseminate hydrogen energy.

Hydrogen Utilization

Sustainable future realised by hydrogen energy.

Stable energy supply with near zero CO₂ emissions

Stable energy supply with CO₂ emission suppression



An aerial photograph showing a vast landscape. In the foreground and middle ground, there are extensive open-pit mines and processing areas for brown coal, characterized by dark, layered earth and large piles of material. A long, straight conveyor belt or road cuts through the site. The background features rolling green hills and fields under a clear blue sky. A semi-transparent blue geometric shape is overlaid on the left side of the image, containing text.

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Hydrogen Production

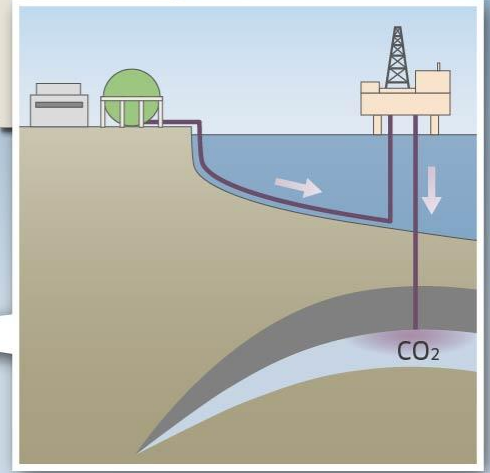
The “Hydrogen” solution takes advantage of previously unused resources.

Half of the world’s coal is comprised of brown coal. Produce low-cost hydrogen from this abundant, unused resource.

Australian brown coal project

Latrobe Valley, Victoria :
Equivalent to total amount of power
consumption of 240 years of Japan

CCS: CO₂ Storage Location



CarbonNet Project is being promoted by the Australian and Victorian Governments.

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Producing hydrogen from Renewable energy

By combining renewable energies and water electrolysis, both production and utilization of hydrogen can be free of CO2 emissions.

Hydrogen made by unstable energy resources can be stored and used when need arises.

Liquid Hydrogen: The Key to Large-Volume Transportation

Kawasaki's cryogenic technology makes large-volume transportation of hydrogen possible.

-253°C



$\frac{1}{800}$

When cryogenically cooled to -253°C, hydrogen changes from a gaseous state to a liquid state, 1/800 of its gaseous volume.

Kawasaki Hydrogen Road

Realizing -253°C , cryogenic temperature

Developed Japan's first industrial
hydrogen liquefaction system.



Based on Kawasaki's cryogenics and turbo machinery technologies, hydrogen liquefier was developed.

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Hydrogen Transportation & Storage

The world's first liquid hydrogen carrier
will be born in Japan.



December 2013:
Approval in Principle Granted by
ClassNK* for Cargo Containment
System for Liquid Hydrogen Carrier.

Small-scale liquid hydrogen carrier
(Coastal vessel scale)

Kawasaki Hydrogen Road

Hydrogen Transportation & Storage



The future proposed by Kawasaki:
Large-scale liquid hydrogen carrier.

Large-scale liquid hydrogen carrier

Cargo size: 40,000m³ x 4

Evaporated hydrogen gas-fuelled engine

Hydrogen Potential from Overseas



Kawasaki Hydrogen Road

Built on more than 25 years of working with rocket fuel



Largest Japanese domestic liquid hydrogen storage tank, equipped with advanced insulation technology for minimising boil-off gas



Type	Spherical double-shell tank
Storage Volume	540m ³

Liquid hydrogen containers to enable on-land transport of liquid hydrogen



Type	ISO 40ft-type container
Volume	45.6m ³

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Hydrogen Utilization

Future Society with Widespread Hydrogen Energy
Use in Sight



Hydrogen Refueling Station



Hydrogen gas turbine

Progress of Hydrogen Project

2014

Technologies of
Kawasaki



LNG



Liquefied Hydrogen

"Energy Basic Plan"
"Strategic Roadmap for
Hydrogen and Fuel Cell"



2020

Tokyo Olympic /
Paralympic Games



Technology
Demonstration



2025~

Commercial Chain



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Technology Demonstration

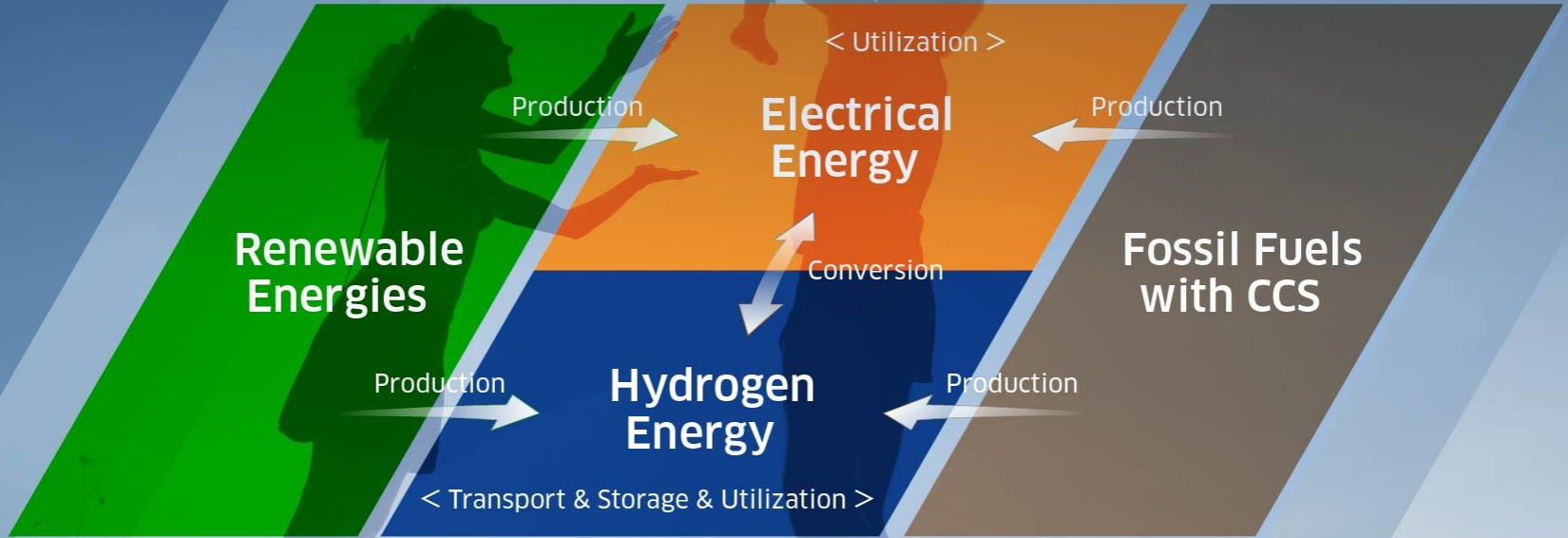
- Brown coal gasification
- Loading and unloading of liquid hydrogen
- Transportation of massive amount of liquid hydrogen



Demonstrate in 2020,
Tokyo Olympic Game year

Hydrogen Society

This dream energy will help create a sustainable future.





Kawasaki

Powering your potential