2nd Hydrogen Energy Ministerial Meeting

# KHI's Activity for International Liquefied Hydrogen Supply Chain

Kawasaki Heavy Industries, Ltd.

Kawasaki

Powering your potential

# Our Products

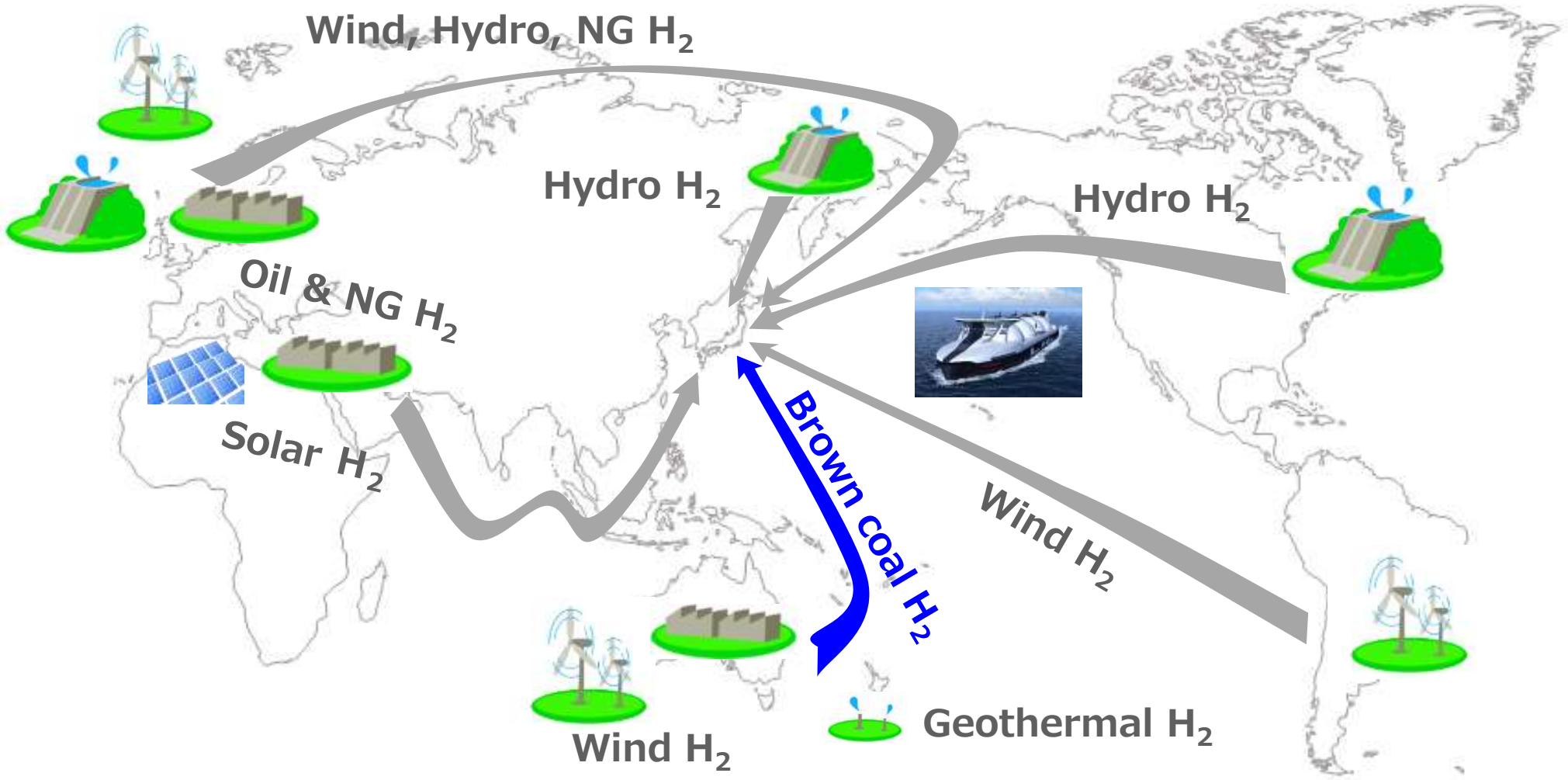



Energy System & Plant Engineering

Motorcycle & Engine

Precision Machinery & Robot

# Expected $CO_2$-free $H_2$ Supply chain



# Concept of $CO_2$-free Hydrogen Chains

## Stable energy supply while suppressing $CO_2$ emissions

### Resource country (Australia)

Production of hydrogen at low costs from **unused resources (brown coal)** and/or abundant recyclable energy

Affordable renewable energy

Liquefaction/ loading

Fossil resource

CCS ($CO_2$ capture/storage)

$CO_2$-free hydrogen

**Hydrogen production**

Liquefied hydrogen cargo ships

Liquefied hydrogen containers


Liquefied hydrogen storage tanks

**Hydrogen transport/storage**

### Utilizing country (Japan)

**Process uses**
Semiconductor and photovoltaic cell manufacturing
Oil refinement, desulfurization, etc.

**Transport equipment**

Hydrogen stations
Fuel cell vehicles etc.

**Distributed power plants**

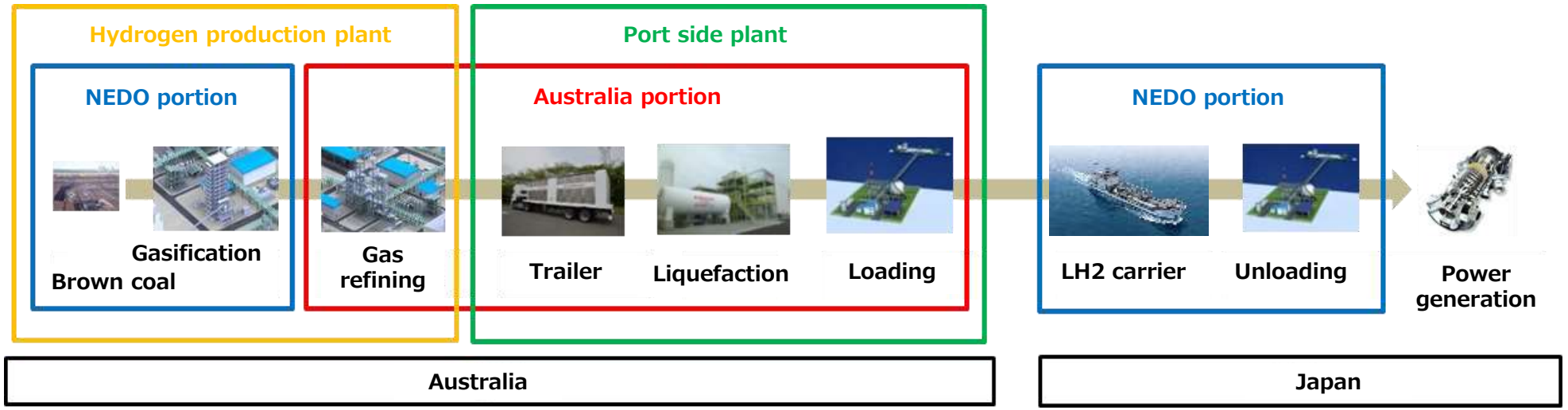
Hydrogen gas turbines
Hydrogen gas engines
Fuel cells etc.

**Electrical power plants**

Combined Cycle power generators etc.

**Hydrogen use**

# Pilot Demonstration Structure



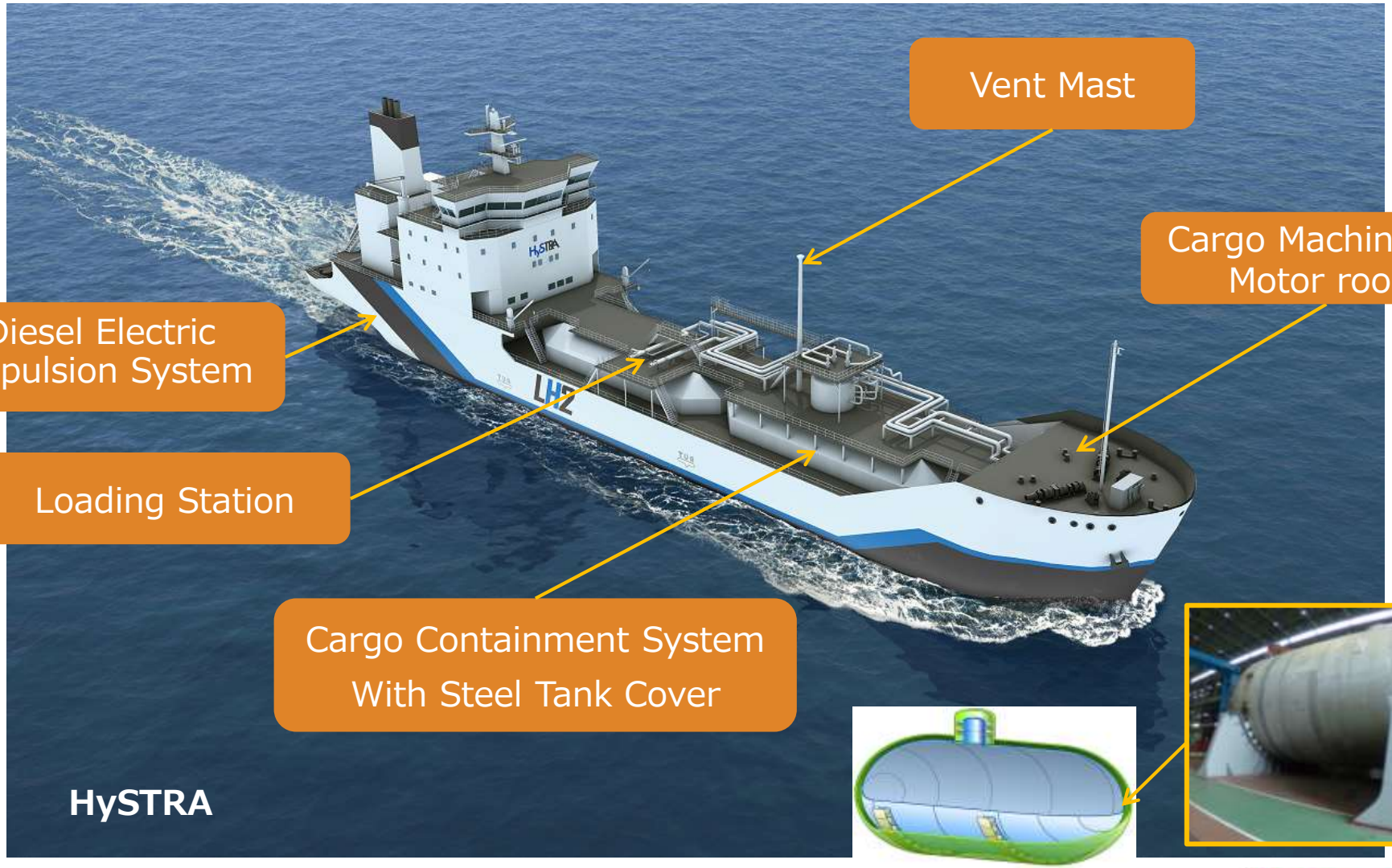

- NEDO portion: consisting of gasification in Australia, $H_2$ carrier and unloading terminal in Japan supported by NEDO, performed by HySTRA

- Australian portion: consisting of gas refining and loading terminal in Australia supported by Australian Governments, coordinated by HEA, Kawasaki's subsidiary.

<Members of HySTRA>
J-Power, Iwatani Corporation, Shell Japan, Kawasaki, Marubeni and JXTG Nippon Oil & Energy

<Members of Australian portion>
J-Power, Iwatani Corporation, Kawasaki, Marubeni and AGL(Australian company)

# Liquefied Hydrogen Cargo Ships



# Pilot Demonstration ($LH_2$ Terminal)


Computer Graphic of Liquefied Hydrogen Terminal in Kobe Airport Island

*$LH_2$ : Liquefied Hydrogen

**BOG : Boil Off Gas

# Strategic road map for $H_2$ and FC

**The Strategic Road Map for Hydrogen and Fuel Cells ～Industry-academia-government action plan to realize "Hydrogen Society"～ (overall)**

- In order to achieve goals set in the Basic Hydrogen Strategy,
- ① **Set of new targets to achieve (Specs for basic technologies and cost breakdown goals), establish approach to achieving target**
- ② **Establish expert committee to evaluate and conduct follow-up for each field.**

| | | Goals in the Basic Hydrogen Strategy | | Set of targets to achieve | Approach to achieving target |
|---|---|---|---|---|---|
| Use | Mobility | FCV 200k by 2025<br>800k by 2030 | 2025 | ● **Price difference between FCV and HV** (¥3m → ¥0.7m )<br>● **Cost of main FCV system** (FC ¥20k/kW → ¥5k/kW; Hydrogen Storage ¥0.7m → ¥0.3m) | • Regulatory reform and developing technology |
| | | HRS 320 by 2025<br>900 by 2030 | 2025 | ● **Construction and operating costs** (Construction cost ¥350m → ¥200m; Operating cost ¥34m→¥15m)<br>● **Costs of components for HRS** (Compressor ¥90m → ¥50m; Accumulator¥50m → ¥10m) | • Consideration for creating nation wide network of HRS<br>• Extending hours of operation |
| | | Bus 1,200 by 2030 | Early 2020s | ● Vehicle cost of FC bus (¥105m → ¥52.5m)<br>※In addition, promote development of guidelines and technology development for expansion of hydrogen use in the field of FC trucks, ships and trains. | • Increasing HRS for FC bus |
| | Power | Commercialize by 2030 | 2020 | ● Efficiency of hydrogen power generation (26%→27%)<br>※1MW scale | • Developing of high efficiency combustor etc. |
| | FC | Early realization of grid parity | 2025 | ● Realization of grid parity in commercial and industrial use | • Developing FC cell/stack technology |
| Supply | Fossil Fuel +CCS | Hydrogen Cost<br>¥30/Nm3 by 2030<br>¥20/Nm3 in future | Early 2020s | ● Production: Production cost from brown coal gasification (¥several hundred/Nm3→ ¥12/Nm3 )<br>● Storage/Transport : Scale-up of Liquefied hydrogen tank (thousands m³→50,000m³)<br>Higher efficiency of Liquefaction (13.6kWh/kg→6kWh/kg) | • Scaling-up and improving efficiency of brown coal gasifier<br>• Scaling-up and improving thermal insulation properties |
| | Green H2 | System cost of water electrolysis<br>¥50,000/kW in future | 2030 | ● Cost of electrolyzer (¥200,000m/kW→¥50,000/kW)<br>● Efficiency of water electrolysis (5kWh/Nm3→4.3kWh/Nm3) | • Designated regions for public deployment demonstration tests utilizing the outcomes of the demonstration test in Namie, Fukushima<br>• Development of electrolyzer with higher efficiency and durability |

**Development of scaling up technologies are ongoing.**

# Development of Scaling Up on $H_2$

**Pilot ship tank: 1,250m³**

X 32

**Commercial ship tank: 40,000m³**

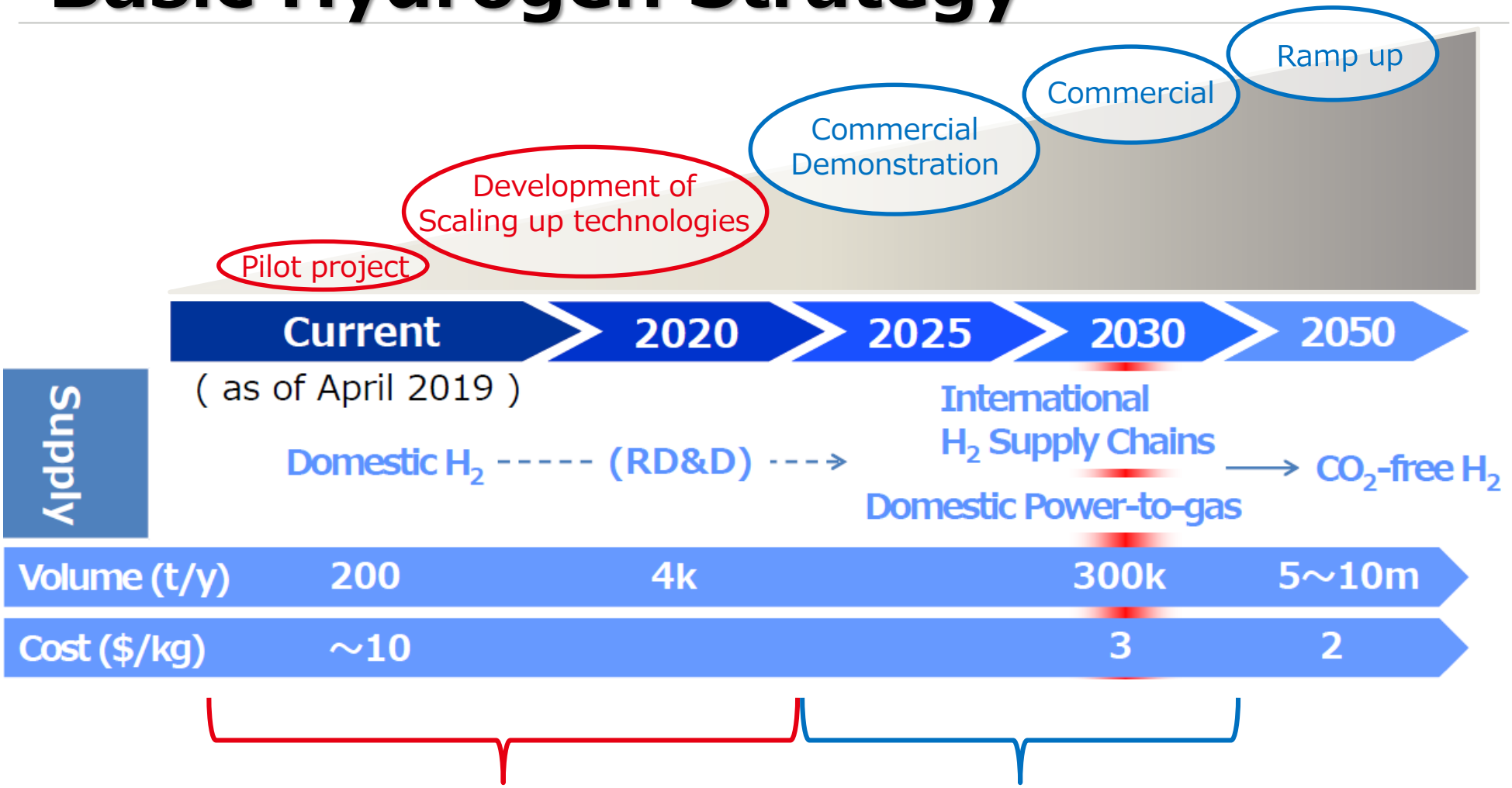

**Pilot terminal tank: 2,500m³**

X 20

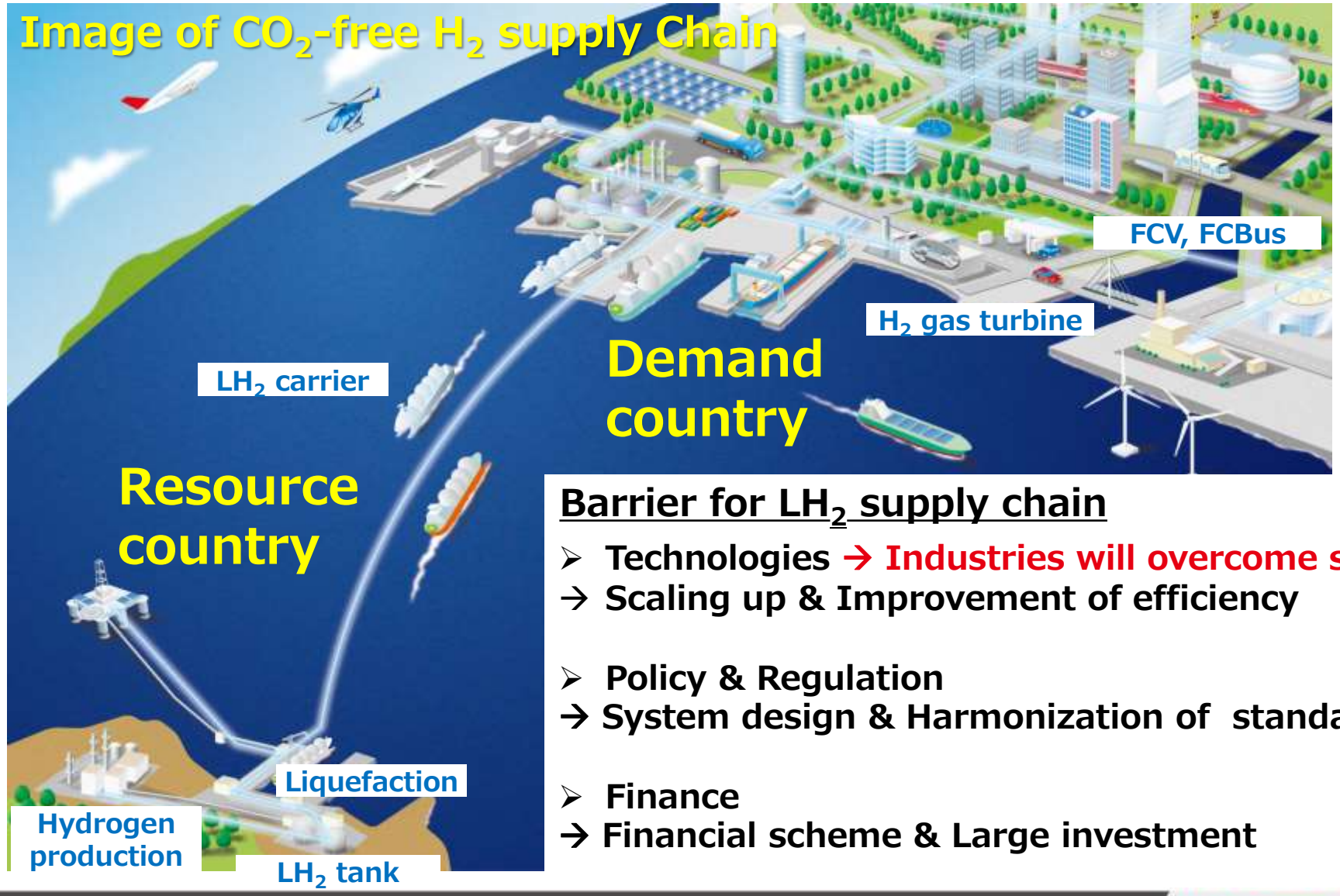
**Commercial terminal tank: 50,000m³**

**Ancillary equipment (ex: Loading arm) are also under development**

# Basic Hydrogen Strategy



# Barrier for commercialization




## Barrier for $LH_2$ supply chain

- Technologies → Industries will overcome soon
  → Scaling up & Improvement of efficiency
- Policy & Regulation
  → System design & Harmonization of standard
- Finance
  → Financial scheme & Large investment

# Thank you for listening

## Kawasaki, working as one for the good of the planet

## “Global Kawasaki”

**Kawasaki Heavy Industries, Ltd.**
**Corporate Technology Division**
**1-14-5, Kaigan, Minato-ku, Tokyo 105-8315**
Tel: 03-3435-2259 Fax: 03-3435-2081
http://www.khi.co.jp