

LH₂ Supply Chain Development

Keiichiro Segawa
Hydrogen Strategy Division

Kawasaki Heavy Industries, Ltd.

KHI's LH2-related Track Record and Milestone toward 2030s

2019.12

- The world's first liquefied hydrogen carrier, SUIISO Frontier, launched



tank capacity : 1,250m³

Capacity
×128



tank capacity : 40,000m³ × 4 tanks
Work on more detailed designs for practical use in the mid-2020s

- Japan-Australia Hydrogen Supply Chain Demonstration Test Completed
- Obtained approval in principle (AiP) for a large, 160,000 m³ liquefied hydrogen carrier

- Completed basic design of marine hydrogen boiler to be installed on large liquefied hydrogen carrier

2022.4

Current Position

NEW!

- Selected Sites for shipping and receiving liquefied clean hydrogen

Receiving at Kawasaki City, Kanagawa, Japan

Shipping at Port of Hastings, Victoria, Australia

Accelerate cooperation with potential customers, who are conducting hydrogen power generation demonstrations, and local governments



URL to our press release
https://global.kawasaki.com/news_230308-2e.pdf



2025

2026



2030



Demonstration for commercialization



×1ship



×2ships~

Start commercializing

¥400bn~

Image of expanding our hydrogen business

¥130bn~

(including supplying and licensing key parts to other companies)

¥52bn~

Large-scaled LH₂ Carrier



June 2023

Completed technological development for a cargo containment system (CCS) to be used in large LH₂ carriers.



April 2022

Obtained AiP (approval in principle) for Large 160,000m³ LH₂ Carrier from Nippon Kaiji Kyokai (ClassNK).

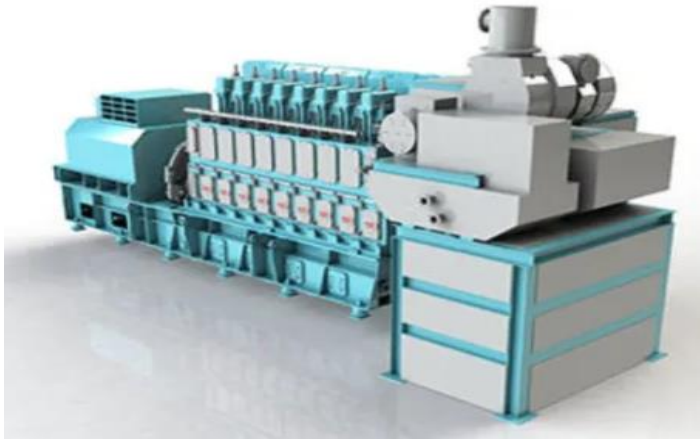
Measures in Marine Transportation

In addition to scaling up of facility side, operational measures to enhance **efficiency** are also ongoing.

⇒ Effective use of BOG enables to maximize the delivery volume by minimizing CO2 emission.

H₂-Fueled Vessel Propulsion System

KHI established JV with Yanmar and J-Eng in 2021 to develop and aim to complete lineup for various applications.



AiP for Dual Fuel Generator Engine Using Hydrogen Gas as Fuel

KHI got ClassNK's Aip for the above engine and related machinery systems & arrangements for 160,000m³ LH₂ Carrier (November 2022)

The dual fuel generator engine can switch between hydrogen and low-sulfur fuel oil flexibly, and when hydrogen fuel is selected, boil-off gas naturally evaporated from the ship's liquefied hydrogen cargo tanks is used as the main fuel at a calorie - based mixed ratio of 95% or higher to generate and supply electricity in board,

which is expected to reduce greenhouse gas emissions from the ship significantly.



Japan's Hydrogen Unit Cost Reduction Target

Kawasaki
Main Contribution

H2 Production& CCS



H2 Liquefaction



Loading base



LH2 Carrier



*CIF Cost

2030

(1st commercial scale)

14.7 JPY/Nm³

770 t/day

9.4 JPY/Nm³

1,000 t/day

3.2 JPY/Nm³

200k m³

2.5 JPY/Nm³

225k t/year

30 JPY/Nm³

2050

Market development will make further cost down.

20 JPY/Nm³

Source: the Ministry of Economy, Trade and Industry "Future hydrogen policy issues and directions of response: Interim arrangement (draft),"

The Issue of Prevailing “Cost Comparison” Argument

- ◆ Is the typical argument such as “The issue with LH2 is the energy loss and costs that buyers will incur when transporting it over even moderate distances.” fair enough?
- ◆ LH2’s advantages such as “non-toxicity”, “high-purity” and “no-greenhouse gas” elements are often ignored as “taken for granted” in the prevailing argument, but those can save huge cost behind the scene. The benefit of the cryogenic heat utilization (-253°C) @demand side is also seldomly referred.
- ◆ While NH3 option is said to be described as “valid utilization and co-existence with the existing coal facilities”, risk-management cost for “transporting huge volume of NH3 to power plant sites, etc. throughout the demand countries and then storing it for later use over long storage periods” is often neglected.
- ◆ Also, in case of ammonia as a hydrogen energy carrier, additional facility and energy-related costs to extract H2 and that for safety/security management during the storage and transportation until the final consumption points should properly be incorporated into the argument for “apple to apple” cost comparison.
- ◆ By achieving the ongoing facility-enlargement and operational measures such as the effective use of BOG during the voyage, we believe that the LH2 option becomes to have the advantageous position since having less costs factors until its ultimate use at the consumption end thanks to the above-mentioned elements.



 **Kawasaki**
Powering your potential