Current Status of Ammonia Power Generation and Ammonia Value-chain Development for Carbon Neutrality.

1 Nov. 2023

IHI Corporation

Ammonia Value Chain Project Department,
Business Development Headquarters

Company Overview

IHI, Company Profile

Year of establishment
1853

Capital
107.1 billion yen

Revenue(Consolidated)
1,172.9 billion yen
(fiscal 2021)

Number of employees (consolidated)
28,801

Works
7

Branches in Japan
8

Overseas representative offices
14

Affiliated companies in Japan
59
[Subsidiaries: 43 Affiliates: 16]

Overseas affiliates
142
[Subsidiaries: 120 Affiliates: 22]

Revenue Compostitions by business areas (Consolidated/fiscal 2021)

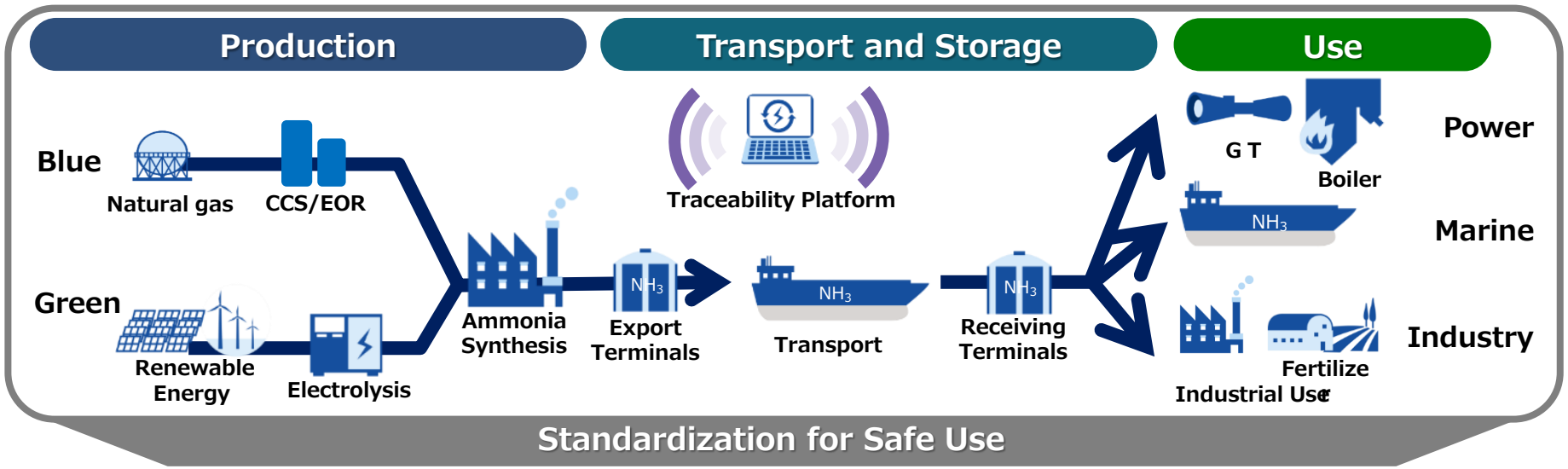




Resources, Energy & Environment	27%
Social Infrastructure	13%
Industrial Systems & General-Purpose Machinery	32%
Aero Engine, Space & Defense	27%

Note : The total may not be 100% owing to the exclusion of "Other" and "Adjustments".

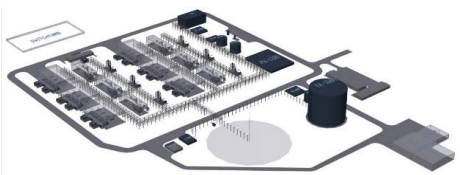
Building Fuel Ammonia Businesses Through New Value Chains



➢ IHI's ongoing activities

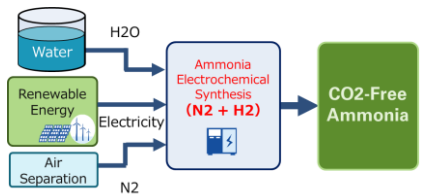
Production

Green Ammonia Production



Production

Direct Synthesis



Storage

Large-scale Receiving Terminal

Use

Power Sector

IHI's Ammonia Utilization Technologies

Ammonia

Industry

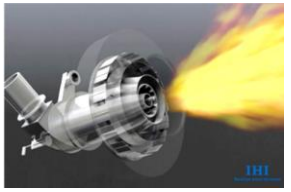
Small Gas Turbine *

Furnace

Package Boiler

Power

Heavy Duty Gas Turbine



Boiler *

Maritime /Storage

Ammonia-fueled Vessels*

Large-scale Storage

IHI issued transition bonds totaling 20 billion yen in June 2022.

*: This project is approved by NEDO as part of the Green Innovation Fund project.

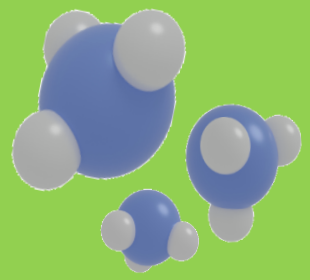
IHI's Decarbonization Roadmap in Power Sector

Newbuild & Retrofit of Ammonia firing

GT

2MW:2026 ～400MW:2030

Ammonia



Boiler

20%:2024

Fossil Fuels

>50%: 2028

Replacing with GT

Goal

Zero carbon emission thermal PP

Stepwise increase of co-firing ratio toward zero CO_2 emission

2025 → 2030 → 2040 → 2050

IHI

Gas Turbine using 100% Liquid Ammonia

株式会社IHI原動機
IHI Power Systems Co., Ltd.

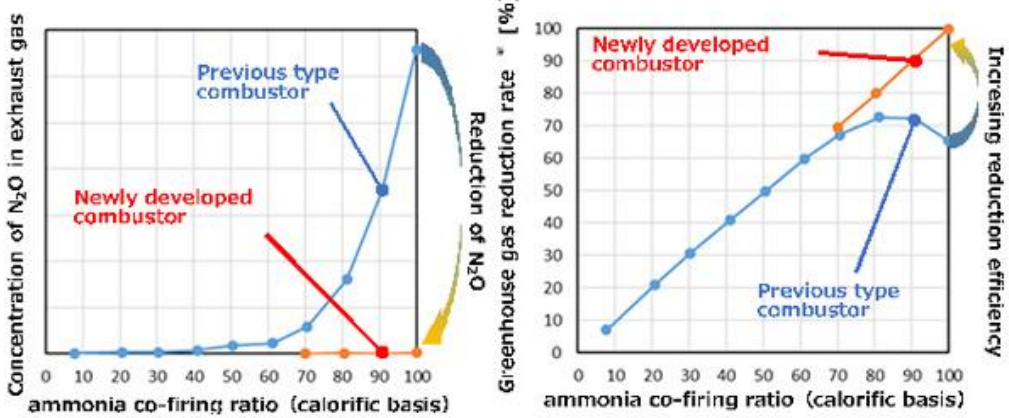
CO_2-free power generation achieved with the world's first gas turbine using 100% liquid ammonia –Reduction of over 99% greenhouse gases during combustion–

- Jun 16, 2022 - Press Release

IHI has succeeded in reducing greenhouse gases by over 99% during combustion of liquid ammonia in a 2,000-kilowatt-class gas turbine achieving truly CO_2-free power generation. Ammonia (NH_3) can be used in existing power generation facilities as a fuel which does not emit CO_2 when combusted. The combustion method which IHI is pioneering involves liquid ammonia being directly sprayed into the gas turbine combustor, which presents numerous advantages for social implementation, such as the simplification of the liquid ammonia fuel supply system from the storage tank to turbine, as well as improved controllability.

Until now, when operating gas turbines at ammonia co-firing rate of over 70%, nitrous oxide (N_2O) which has a greenhouse warming effect around 300 times that of CO_2, was susceptible to formation, nullifying the effect of reducing CO_2 emissions. As a result of mounting and testing a newly developed combustor on the 2,000-kilowatt-class gas turbine at IHI Yokohama Works, we were able to achieve a greenhouse gas reduction rate exceeding 99%, even when the ammonia fuel ratio is at 70~100%, and we verified the output of 2,000kW when mono-firing liquid ammonia. Looking forward, we will further reduce NOx levels, improve operability, evaluate long-term durability, and proceed with efforts toward the practical application of a 100% liquid ammonia combustion gas turbine in 2025.

https://www.ihi.co.jp/en/all_news/2022/resources_energy_environment/1197938_3488.html

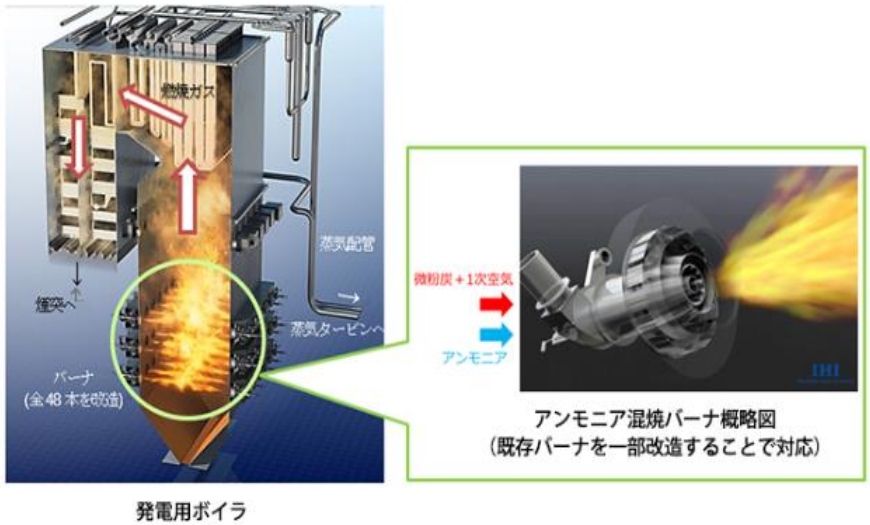


 JPNP21020

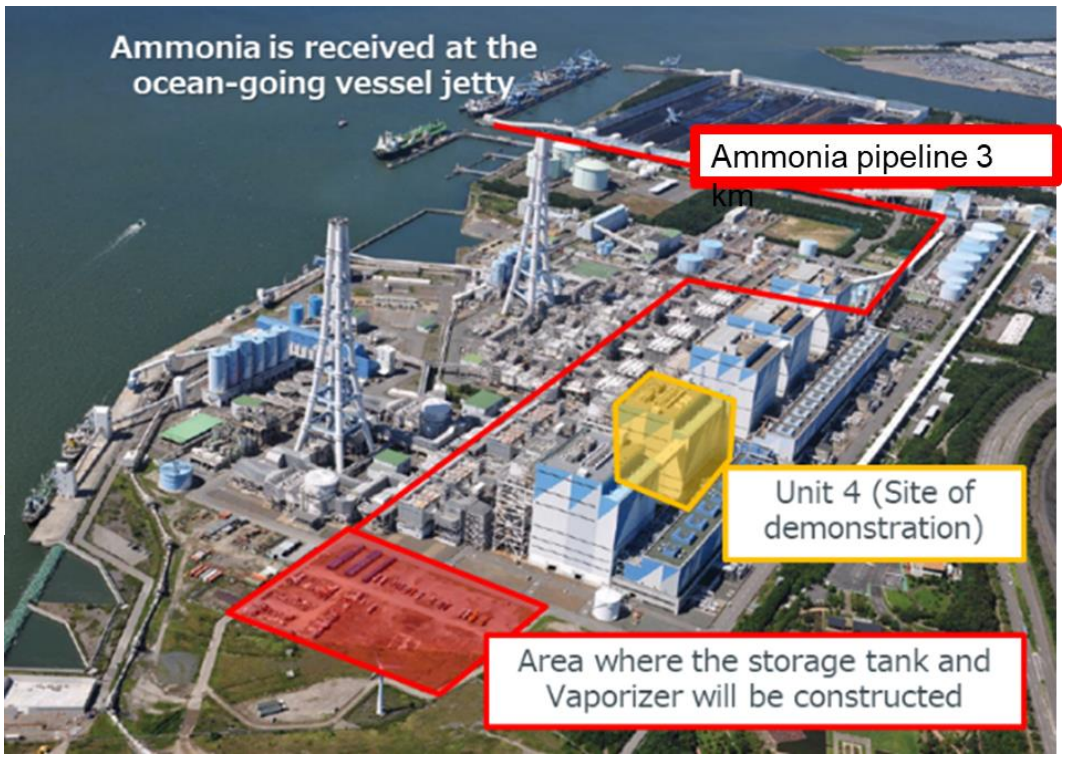
The first Large-Scale Ammonia Power Generation

IHI

- **IHI and JERA joint project, commissioning in 2024**
- **1,000MW Ammonia 20% co-firing coal-fired power plant**
- **Annual Ammonia consumption 0.5 mil. ton, CO2 reduction 1 mil. ton**



JERA Hekinan Power Station



NEDO：JPN16002

Fuel Ammonia Utilization in Coal-Fired Power

IHI Mono-Fires Ammonia with Low Nitrogen Oxide Emissions in Breakthrough toward Commercial Use at Power Plant Boilers

- May 17, 2022 - Press Release

IHI announced today that it has mono-fired ammonia while minimizing harmful emissions of nitrogen oxide. This success at the compact combustion testing facility of the Aioi Works in Hyogo Prefecture is a major step toward commercializing ammonia combustion systems for thermal power plant boilers.

IHI devised a burner structure and ammonia supply technique to successfully mono-fire ammonia. This approach reduces nitrogen oxide emissions to the level of coal mono-combustion while lowering toxic emissions from unburned ammonia. The company looks to enhance the burner structure and assess boiler performance impact. It will conduct more mono-firing burner demonstration tests in 2025.

https://www.ihi.co.jp/en/all_news/2022/resources_energy_environment/1197919_3488.html

IHI

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