

Nov.12th, 2024

AEA 21st Annual Conference @New Orleans

Gas turbine technology development for fuel ammonia

The IHI logo is displayed in a bold, blue, sans-serif font. It is positioned on the right side of a horizontal light blue bar that spans across the width of the slide.

Toshiro Fujimori

Technical Advisor, Resources, Energy & Environment Business Area

IHI Corporation








Number of employees
(consolidated)
28,486


Revenue(Consolidated)
1,352.9 Billion yen


Overseas Group companies
138

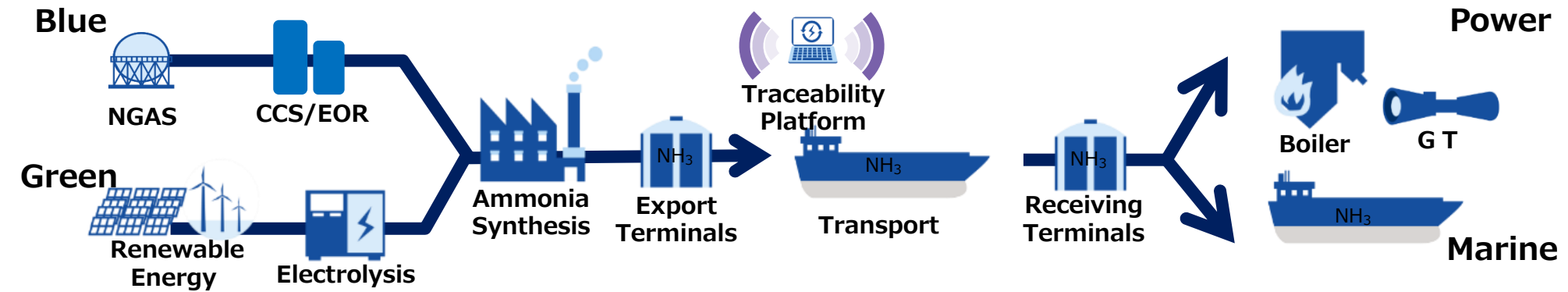
Revenue Compositions by business areas (Consolidated/fiscal 2021)

 Resources, Energy & Environment	29%
 Social Infrastructure & Offshore Facilities	14%
 Industrial Systems & General-Purpose Machinery	32%
 Aero Engine, Space & Defense	23%

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

IHI's key products in Ammonia Value Chain

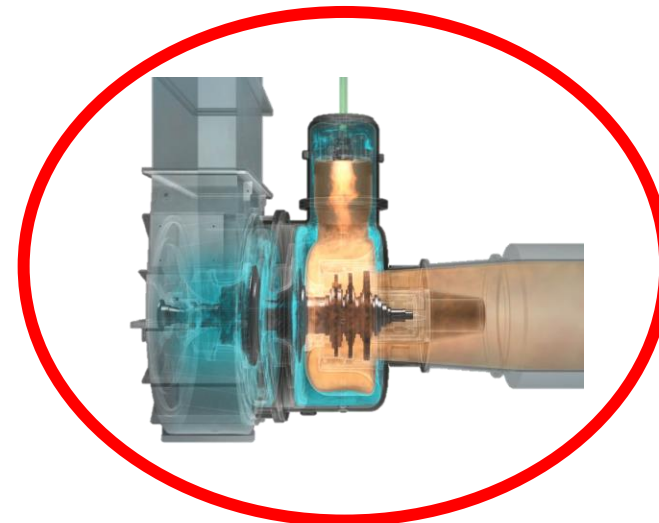
IHI aims to establish Ammonia Value Chain that covers production, transportation, storage, and utilization.



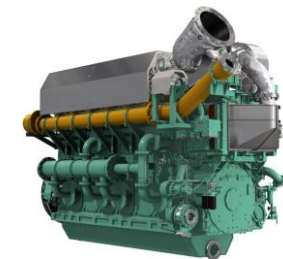
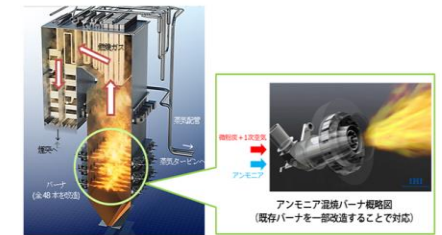
Production:
Water Electrolyzer



Storage:
Terminal System and Burge



Utilization:
Power Generation systems (BGT, GT, ICE)

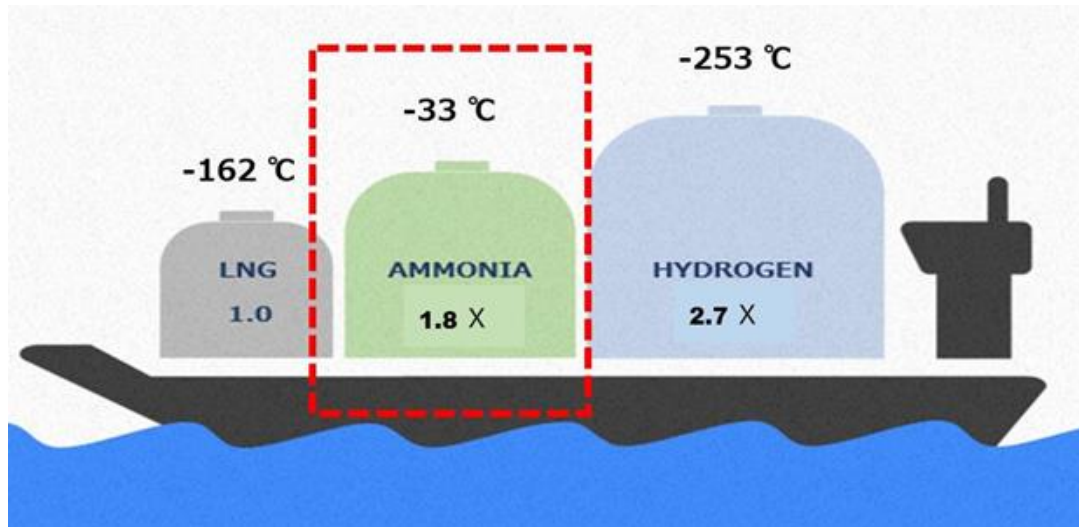


Advantage as an Energy Carrier

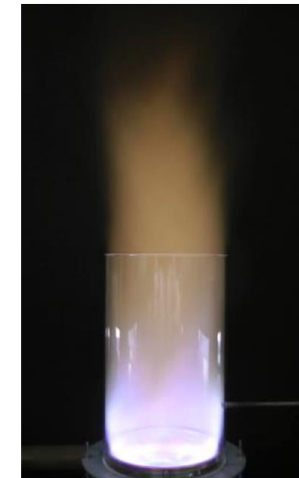
- High storage efficiency due to high energy density
- Long-term storage due to high boiling point

Challenge as a Fuel

- Stable combustion
- Emission ($\text{NO}_x, \text{N}_2\text{O}, \text{NH}_3$) control



13A City gas



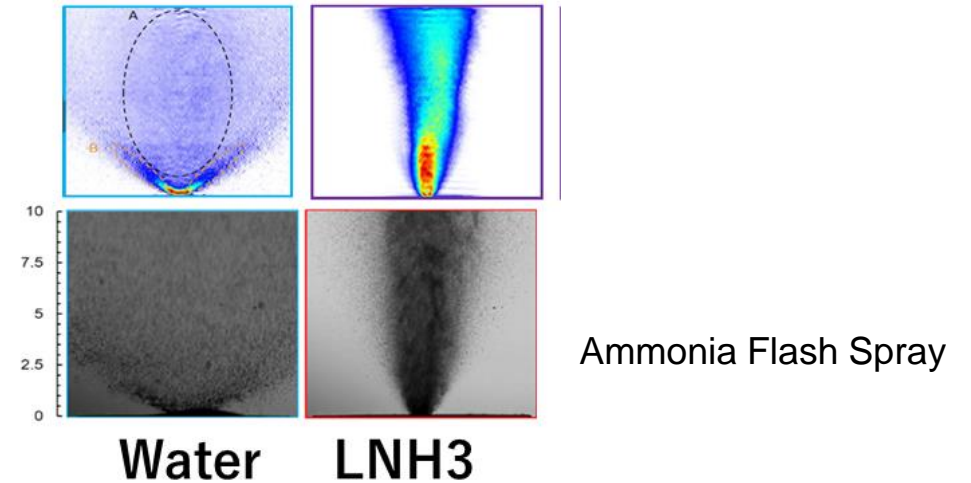
Ammonia and 10% city gas

Advantage

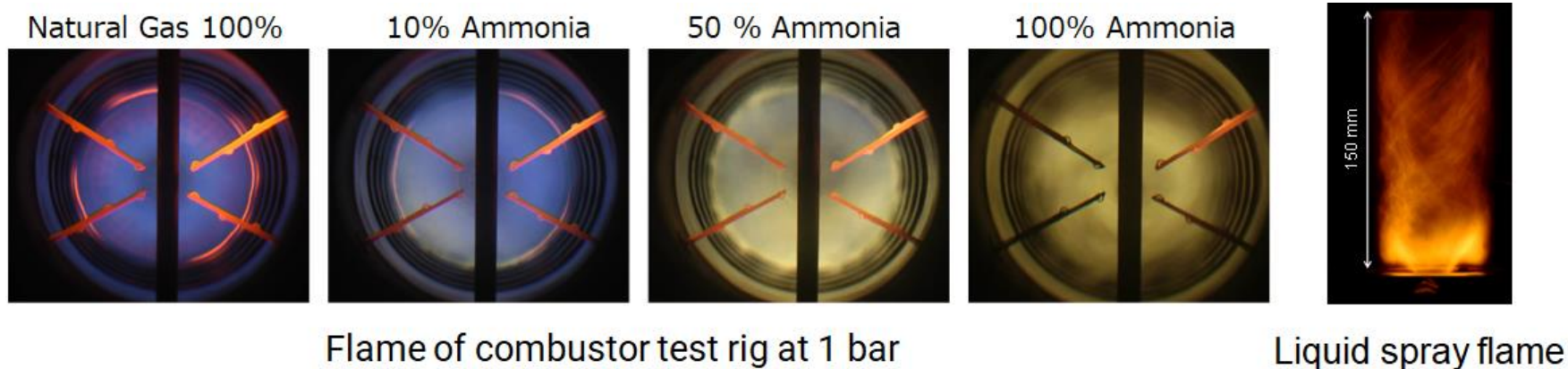
- Simple fuel supply system
- Load change response

Challenge

- Ammonia spray control



Stable combustion with 100% liquid ammonia firing by high swirl flow and mixing control

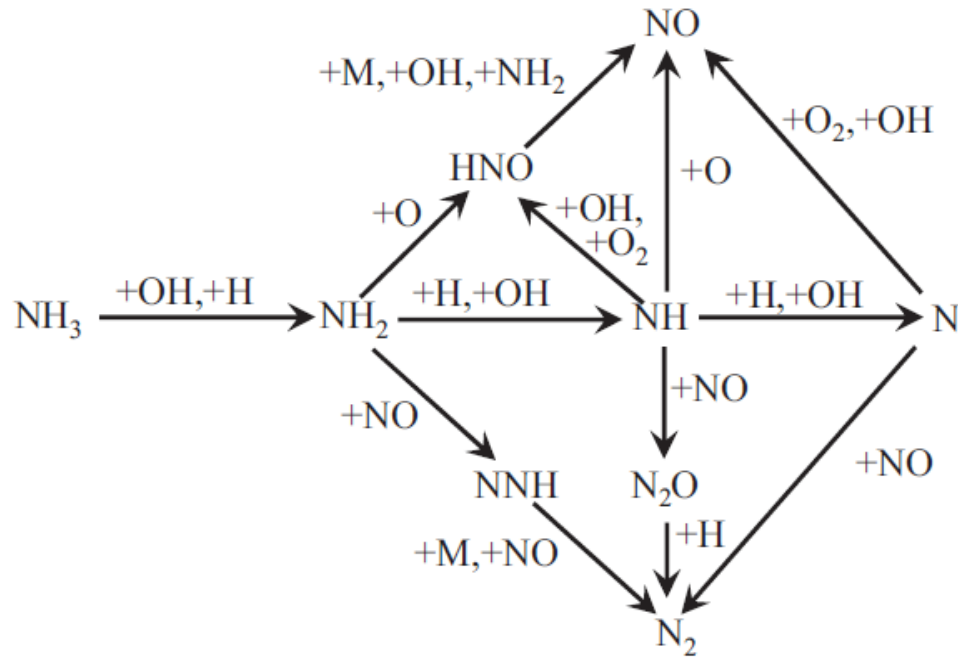


Emission control by two-stage combustion



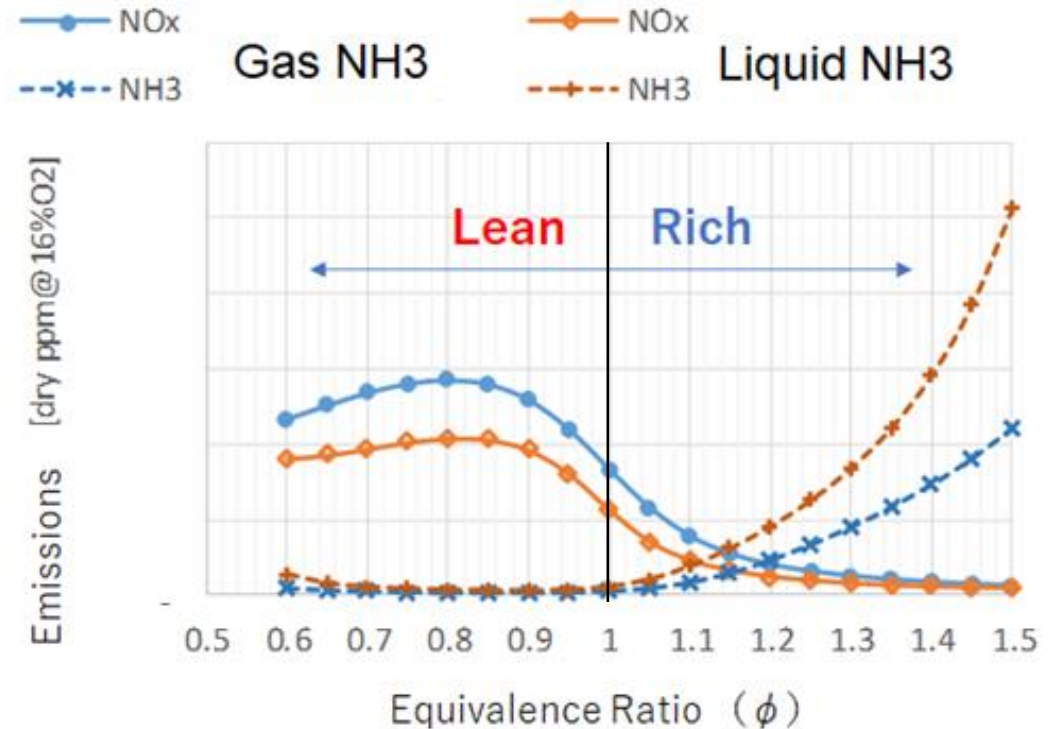
Ammonia Reaction Mechanism

Oxidizing to NOx in lean mixture



Reducing to N2 in rich mixture

Emissions vs. Equivalence Ratio(ϕ)



Network simulation model

Ammonia-fueled gas turbine

- Developing a liquid ammonia firing 2MW-class gas turbine, IM270.
- Successful operation at full load with 100% ammonia firing at IHI Yokohama test facility in 2022.



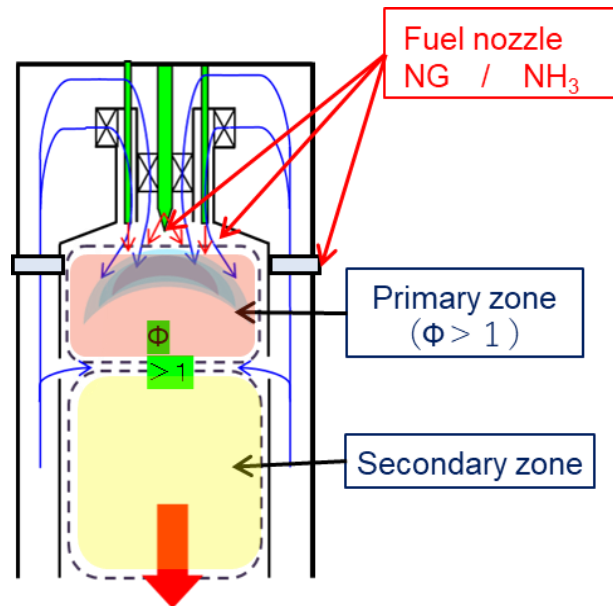
IHI IM270 gas turbine



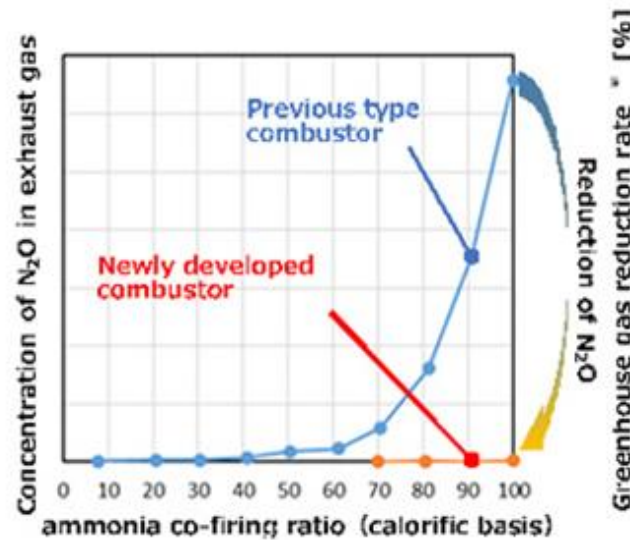
Ammonia GT test facility & Fuel Supply System
@ IHI Yokohama

Ammonia-fueled gas turbine operation results

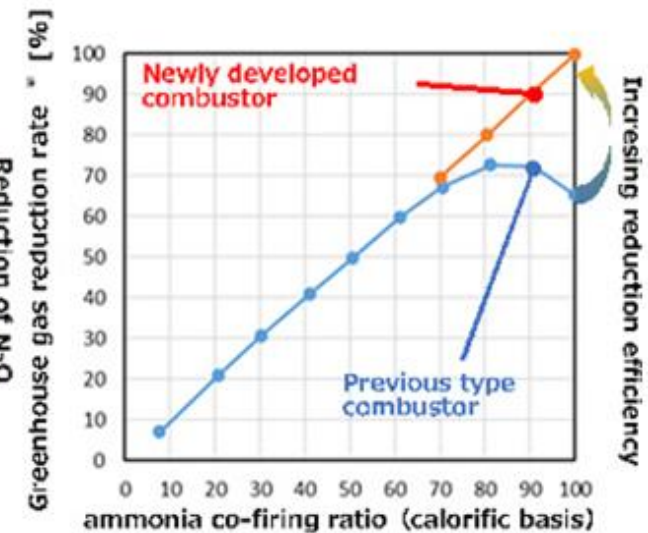
- Two-stage combustor configuration.
- 99+% Reduction of Green House Gas (CO₂ & N₂O) from natural gas operation.
- Regulatory compliant NO_x emission level with conventional NO_x after treatment systems.



2MW single can NH₃ spray combustor gas turbine (IHI, IM270)



N₂O emission vs. NH₃ co-firing ratio



Reduction of greenhouse gas emission vs. NH₃ co-firing ratio

Demonstration test for market launch

In long-term durability test operation at IHI Aoi since July 2024

- Objective:
- Confirmation of long-term durability performance
 - Improving Safety Technology for Ammonia Handling in Gas Turbines



Current Achievement,

- 100% Liquid Ammonia Operation in 2MW Gas Turbine
- Over 99% GHG reduction, and environmental compliance for urban areas in Japan with SCR.
- A long-term durability test of more than one year is ongoing. Knowledge and experience in operation, safety management are accumulated.

From now on,

- Developing large ammonia-fueled gas turbine technology, working with GE Vernova
- Aim to deploy ammonia-fueled gas turbines mainly in Asia, where imported energy is needed.

Together with our partners, we will promote energy transition through the realization of the ammonia value chain.

