

Role of Ammonia in the Development of Hydrogen Society

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Clean Fuel Ammonia Association

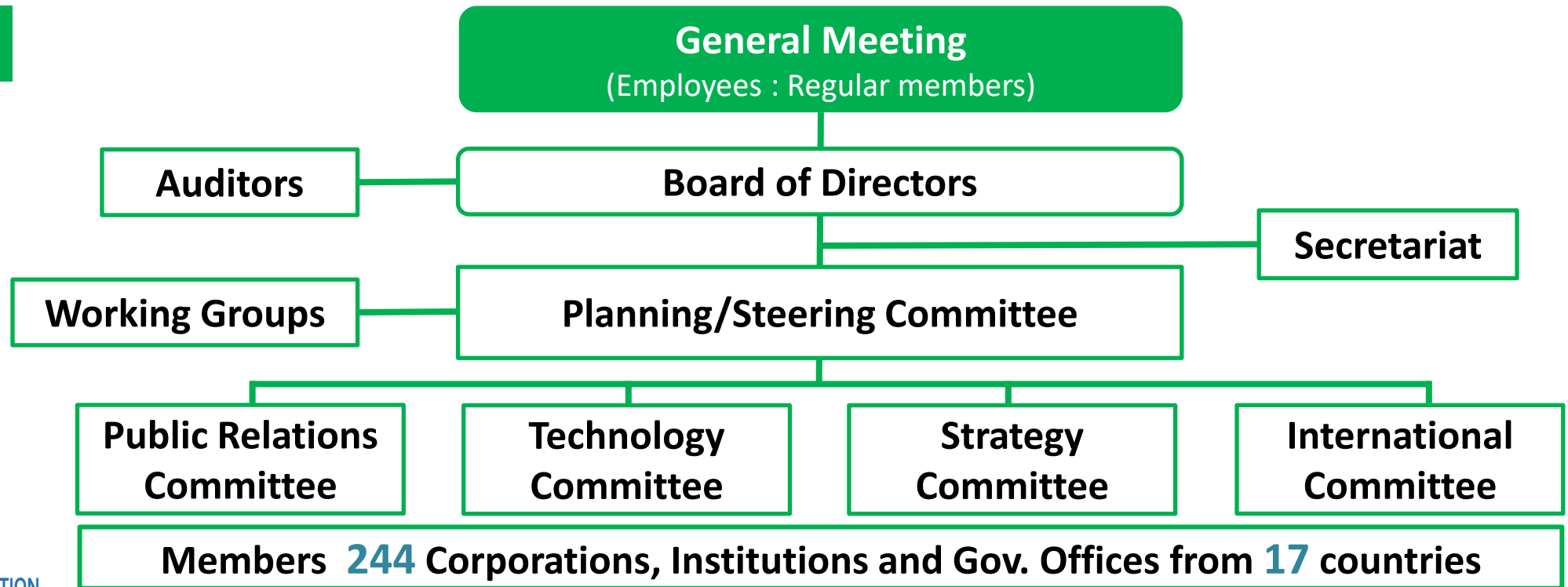
Establish

Apr. 1, 2019 Green Ammonia Consortium
Jan. 14, 2021 Clean Fuel Ammonia Association

Key Objectives

- Implementation of clean fuel ammonia value chain
- Promotion of policy and regulations
- Coordination of RD&D activities
- International relationship and collaboration

Organization



Role of Clean Fuel Ammonia

- ❑ Established technologies and systems in production, storage and transportation
- ❑ Efficient in transportation and storage of hydrogen
- ❑ Most pragmatic hydrogen derivative
- ❑ Efficient and effective zero-emission fuel through direct combustion technologies in wide range of energy markets
 - power generation, industrial furnaces, marine fuel,
 - chemical process, refinery, steel production

World Bank states 46% of all planned electrolyzer capacity is expected to produce hydrogen for ammonia production.

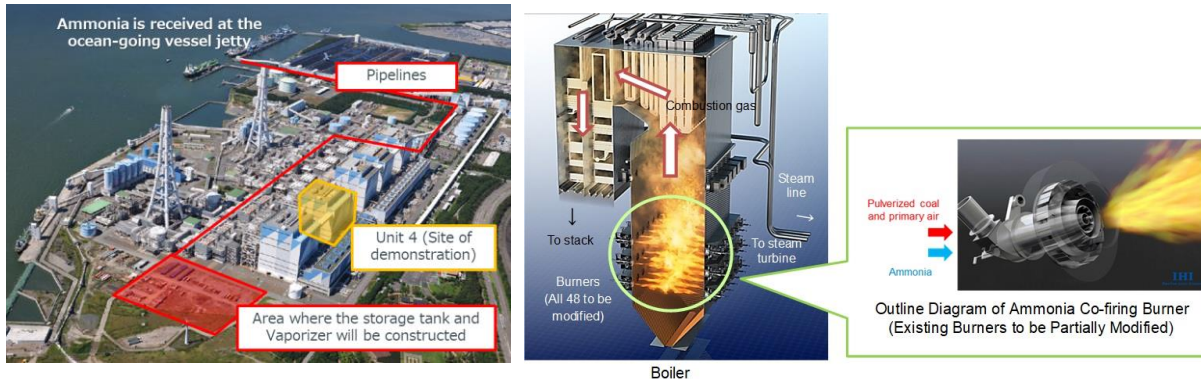
“If we need to promote hydrogen, we need to promote ammonia.”



Key Technologies of Ammonia Utilization in the Energy Market

NH₃ Substitution in Coal fired Boilers (IHI,MHI)

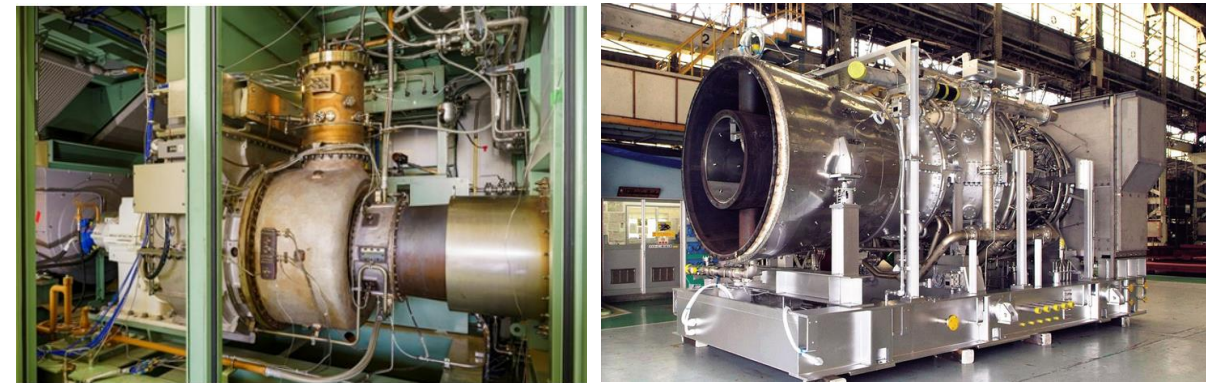
- Large Scale Demonstration (March-June 2024)
(20 %NH₃ in 1 GW Coal Power of JERA)
- Commercial use is expected to start around 2027.
- Up to 100 %NH₃ firing is under development.
- FS Studies with Malaysia, Indonesia, India, Thailand, Taiwan



Source: JERA website

Gas Turbines (IHI, MHI)

- 2 MW-60 MW
Development of NH₃ Single Fuel GTs by around 2025
- 300-400 MW Class
Developments of NH₃ Single Fuel System and H₂ Turbine with NH₃ Cracking System by 2030



Source: IHI website

Source: MHI website

Key Technologies of Ammonia Utilization in the Energy Market

Industrial Furnaces

(AGC, Taiyo Nippon Sanso)

- Development of NH₃ Single Fuel burner in Glass Melting Furnace by 2025



Source: AGC website

Marine Diesel Engine

(NYK, Japan Engine, IHI power system, Japan Shipyard)

- Small 4 Stroke Engine by 2024
- Large 2 Stroke Engine by 2026
- NH₃ Engine Tugboat since August, 2024
- First NH₃ fueled NH₃ carrier is planned to be launched in Nov. 2026.



Source: NYK website



Source: Green innovation website

Fuel Ammonia Infrastructure Development in Japan -Hub & Spoke System-

- ❑ Demand forecast in 2030 : 3MMtons.
- ❑ Collaboration with Korea for supply chain development.

Key conditions :

- Long term contracts
- Henry Hub price link (Blue Ammonia)
- Low carbon intensity
- Destination free

