CFAA members activities in ASEAN

13/02/2025

Clean Fuel Ammonia Association

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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



Hydrogen Energy Carrier



Why Ammonia

- Directly combusted without CO₂ emissions.
- Largest H₂ content among 3 carriers and most efficient in marine transportation.
 (NH₃ 121 kg-H₂/m³ liquid , LH₂ 71 kg-H₂/m³ , MCH 47 kg-H₂/m³)
- Large commercial supply chain is established, and cost structure is clear.
 (Global production: 200 million tons, International trade: 20 million tons)
- NOx emissions can be controlled by technologies.
 (Air-fuel ratio , Two staged combustion etc.)
- Technologies are becoming ready for commercial use.
- Safety standards are practically used in chemical and power industries.
- Primary markets are controlled facilities with trained operators such as power plant, industrial factories and data centers.

Key Technologies of Ammonia Utilization in the Energy Market

Combustion in Coal fired Boilers (IHI, MHI)

- 20 % firing is achieved.
- Over 50% up to 100 %NH₃ firing is under development.
- Large Scale Demonstration(March-June 2024) $(20 \% NH_3 in 1 GW Coal Power of JERA)$

Gas Turbines (IHI, MHI)

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



modified)

Provided by JERA





Outline Diagram of Ammonia Co-firing Burne (Existing Burners to be Partially Modified)

Provided by IHI



Provided by IHI

Provided by ©Mitsubishi Heavy Industries. Ltd.

Key Technologies of Ammonia Utilization in the Energy Market

Industrial Furnaces

(AGC, Taiyo Nippon Sanso)

- Development of NH_3 Single Fuel Glass Melting Furnace by 2025



Provided by AGC

Marine Diesel Engine

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

- Voyage test of "A-tug" equipped small 4 stroke NH₃ engine successfully completed in 2024.
- Large 2 Stroke Engine by 2026
- First NH₃ fueled NH₃ carrier is planned to be launched in Nov. 2026.





Provided by NYK

<Indonesia>

	Title	Overview	CFAA member
1	Ammonia co-firing in <mark>natural gas-fired boiler</mark>	Small amount of ammonia co-firing in NG fired boiler in 2022 was conducted. Feasibility Study for higher amount of ammonia co-firing and ammonia 100% firing is going on.	IHI
2	Green ammonia value chain and firing in <mark>coal-</mark> fired power plant	MOU has been signed to study for supplying green ammonia to demonstration combustion test at Labuan coal-fired power plant.	IHI
3	Green ammonia initiative from Aceh (GAIA)	Utilize surplus capacity of the existing ammonia plant to produce green ammonia and integrate with bunkering.	TOYO, ITOCHU
4	Production of green ammonia in existing ammonia plant	Study for green ammonia production at existing ammonia plant with new CCS equipment, with PAU, Institute Technology Bandung.	Mitsubishi Co.
5	Study on blue ammonia	Long-term ammonia offtake & joint study on blue ammonia with Pupuk Indonesia	Mitsui & Co.

< Malaysia and Singapore>

	Title	Overview	CFAA member
1	Create decarbonization roadmap of coal-fired power station with ammonia and Biomass (Malaysia)	Develop the decarbonization roadmap for coal-fired power station applying co-firing ammonia/biomass with coal and another technologies. Target: 0.35t-CO2/MWh by 2035	IHI
2	Demonstration of <mark>ammonia gas turbine</mark> (Malaysia)	IHI and Gentari signed MOU in 2023, to develop global green ammonia value chain and commercial demonstration of ammonia-powered gas turbine by 2026.	IHI
3	Study for <mark>ammonia gas</mark> <mark>turbine</mark> in Jurong Island (Singapore)	Keppel, MHI and DNV have signed an MOU towards the development of ammonia-fired GTCC power plant. From fuel receipt to the early realization of the power plant, the safety of an ammonia-fired GT was verified. Role of MH is development of GTCC fueled by 100% ammonia.	MHI



<Thailand and Philippines>

	Title	Overview	CFAA member
1	FS for ammonia 25% substitution in <mark>coal-fired</mark> power station(Philippines)	MOU has been signed with AP and JERA in 2023 to effort in assessing the feasibility of ammonia power generation and further development of the ammonia hydrogen value chain in Philippines.	JERA
2	FS for ammonia substitution in <mark>coal-fired</mark> power station(Thailand)	Study for realizing of green ammonia value chain and co-firing at coal-fired power plant was conducted. And FS has completed without any concerns.	JERA, Mitsubishi Co., MHI
3	Study on <mark>ammonia-fired gas turbine</mark> power generation (Thailand)	FS to aim to introduce ammonia-fired gas turbine power generation has been conducted. The supply chain and safety from reviewing ammonia to storage, handling, and transportation to power plant will also be studied.	MHI
4	Demonstration study for the Utilization of Hydrogen and Ammonia for fuel (Thailand)	Study for methods of providing a stable supply of hydrogen with the ammonia cracking to extract hydrogen and optimizing design of hydrogen storage facilities, in order to achieve a hydrogen society in Thailand.	TOYO, JERA



Thank you for your kind attention



Project for Natural gas-fired boiler (Indonesia)

IHI Initiates Southeast Asia's First Ammonia Mix-Firing Pilot Facility at Operational Power Plant

Project Outline

- IHI and PT PLN Nusantara Power (PLN NP) achieved ammonia co-firing at the No.1 Boiler of the gasfired Gresik Steam Power Plant.
- This ammonia co-firing with fossil fuels at an operating unit was a first in South-East Asia. This effort proved the potential of ammonia co-firing technologies at an existing facility and the feasibility of deploying a range of facilities for ammonia co-firing.
- Apply the carbon-neutral fuels at thermal power plants to attain net-zero greenhouse gas emissions by 2060 as Indonesian government target.

◆ <u>Schedule</u>

- FY2022 Small amount co-firing achieved
- Discuss for future FS of ammonia co-firing/mono-firing

Plant where the demonstration carried out

Gresik Power Plant





Project for Green ammonia firing (Indonesia)

MOU to study for green ammonia value chain and firing at Labuan Coal-fired Power Plant

◆ <u>Project Outline</u>

- To conduct a study involving the entire ammonia value chain from the supply to combustion of green ammonia, including demonstration at the Labuan coal-fired power plant with PT PLN Indonesia Power, PT Pupuk Kujang
- To contribute to achievement of carbon neutrality in Indonesia by 2060, studying on the entire ammonia value chain and on the application of ammonia combustion which is one of the decarbonization options at coal-fired power plants.



donesia Power



Green Ammonia Initiative from Aceh (GAIA)

- Country: The Republic of Indonesia
- CFAA Member: Toyo Engineering Corporation (TOYO)
- Partner: Pupuk Indonesia Holding (PIHC), Itochu Corporation (ITOCHU)
- Start Year: 2022 (Commencement of Feasibility Study)
- Overview:
 - Collaboration Outline: Agreed to jointly develop a project to produce green ammonia by leveraging existing ammonia plant of Pupuk Iskandar Muda(PIM) which is PIHC's subsidiary
 - ✓ Strategy: Utilize surplus capacity of PIM's existing ammonia plant (designed by TOYO to produce green ammonia and integrate with ITOCHU's bunkering business. Aim to replicate this green ammonia initiative at other PIHC's existing plants in the future
- Schedule :

CLEAN FUEL AMMONIA ASSOCIATION

- ✓ Aug.2024: Selected for the Global South Future-Oriented Co-Creation Project
- ✓ Aug.2024: Signed Joint Development Agreement
- ✓ Nov.2024: Signed Shareholder's Agreement
- 1Q 2025: Establish Joint Venture Company
- 2Q 2025: Final Investment Decision
- ✓ 4Q 2027: Start Commercial Operation





[Location of PIM's Existing Ammonia Plant]



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[SHA Announcement in COP29 Japanese Pavilion]

Project for Decarbonization Roadmap of TNB (Malaysia)

Create Decarbonization Roadmap in Coal-Fired Power Stations in Malaysia with Ammonia and Biomass mix-firing technology

Project Outline

IHI and TNB Power Generation Sdn. Bhd., Malaysia's largest power producer, have finished its joint feasibility study and agreed to move to the next step in relation to TNB Genco's coal-fired power stations.

🔶 <u>Goal</u>

To develop the decarbonization roadmap for TNB Genco's coal-fired power stations by applying IHI's ammonia and biomass combustion technology

Target : 0.35 t-CO₂/MWh by 2035

Ammonia + Biomass + Coal Biomass co-firing, Natural gas conversion



From the top, TNB Janamanjung Sdn. Bhd., Kapar Energy Ventures Sdn. Bhd., Jimah East Power Sdn. Bhd.

https://www.ihi.co.jp/en/all_news/2023/resources_energy_environment/1199835_3523.html

Feasibility Study for Ammonia Substitution – Philippines

◆ <u>Project Outline</u>

- MOU has been signed between Aboitiz Power (AP) and JERA in the presence of President Ferdinand "Bongbong" R. Marcos Jr. together with key officials from the Philippine Government in Feb-2023.
- Under the MOU, AP and JERA outlined collaborative efforts in assessing the feasibility of ammonia power generation and further development of the ammonia and hydrogen value chains in the Philippines.
- The considered Power Plant: Sub Critical Coal Fired Power Plant
- Study contents
- ✓ Technological study for 25% ammonia substitution
- ✓ Ammonia Procurement cost during the project period
- ✓ Economic assessment and the CO2 emission reduction throughout the value chain

Feasibility Study Result

- Technically, there are no major isuues.
- Additional environmental impact assessment would be required, but no major issues found.
- In the point of commercial, even with the use of price-competitive blue ammonia, cost increases are inevitable compared to coal.



Signing of MOU (President Marcos is front row, fourth from left)



Feasibility Study for Ammonia Substitution – BLCP Project in Thailand

Project Outline

- JERA invested EGCO (Electricity Generating Public Company Limited, Thailand) and had a MOU about future corroboration for decarbonization technologies.
- JERA was appointed by METI (Japanese Ministry of Economy) as a consultant for feasibility study on ammonia co-firing in coal fired power plant in Thailand.
- The considered Power Plant: BLCP Power Plant, Sub Critical Coal Fired Power Plant 1,434MW(717MW×2Unit)

Feasibility Study Result

- Technically, there are no major isuues.
- Most of the environmental & social impacts expected from ammonia substitution would be technically mitigated enough to be negligible.
- In the point of commercial, the LCOE calculated in this FS is competitive with other power sources after 2030. In order to recover the necessary costs for modification, continued efforts will be necessary to obtain support from the government and other financial sources.
- As for regulations, currently, there is no concrete system in place to introduce ammonia as fuel into thermal power generation facility.



Demonstration Study for the Utilization of Hydrogen and Ammonia for fuel

- Country: Kingdom of Thailand
- CFAA Member: Toyo Engineering Corporation (TOYO)
- Partner: JERA Co., Inc., JERA Asia Pte. Ltd.
- Start Year: 2024
- Overview:
 - To quickly achieve a hydrogen society, it will be important to ensure that the ammonia cracking to extract hydrogen is able to respond to the demand for hydrogen.
 - ✓ TOYO, JERA and JERA Asia jointly investigate methods of providing a stable supply of hydrogen in Thailand and the potential for its widespread use across a range of industries.
 - ✓ The three companies verify the technology for extracting hydrogen from ammonia through cracking and developing ways to optimize the design of hydrogen storage facilities
 - ✓ The Demonstration Study is supported by New Energy and Industrial Technology Development Organization ("NEDO") International Demonstration Project on Japan's Technologies for Decarbonization and Energy Transition.
 - This basic study has run for one year beginning from the middle of FY 2024.



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