

Creating **Green Ammonia** Value Chain for the Smooth Transition toward Carbon Neutrality

IHI

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I H I Corporation

IHI Corporation Company Profile



Year of establishment

1853

170 years anniversary !!



Number of employees
(consolidated)

28,801



Revenue(Consolidated)

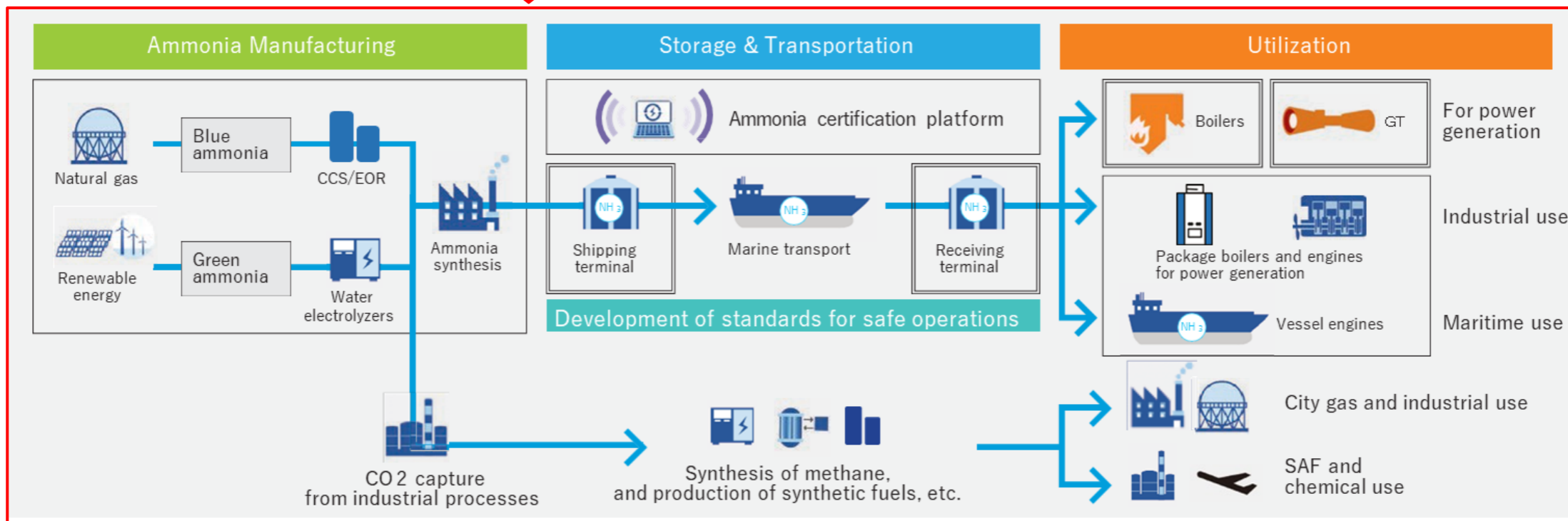
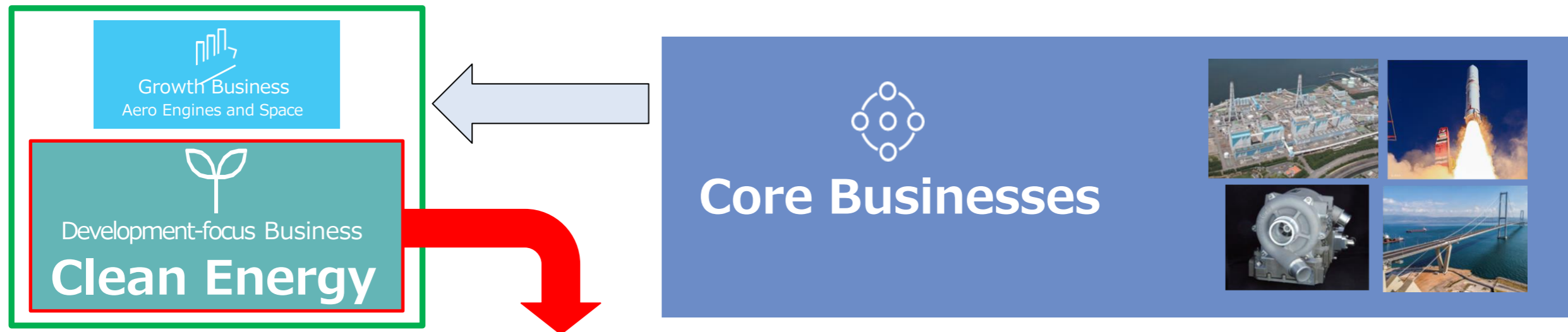
US\$ 9.663 bil. (@¥140/\$)

(fiscal year 2022)



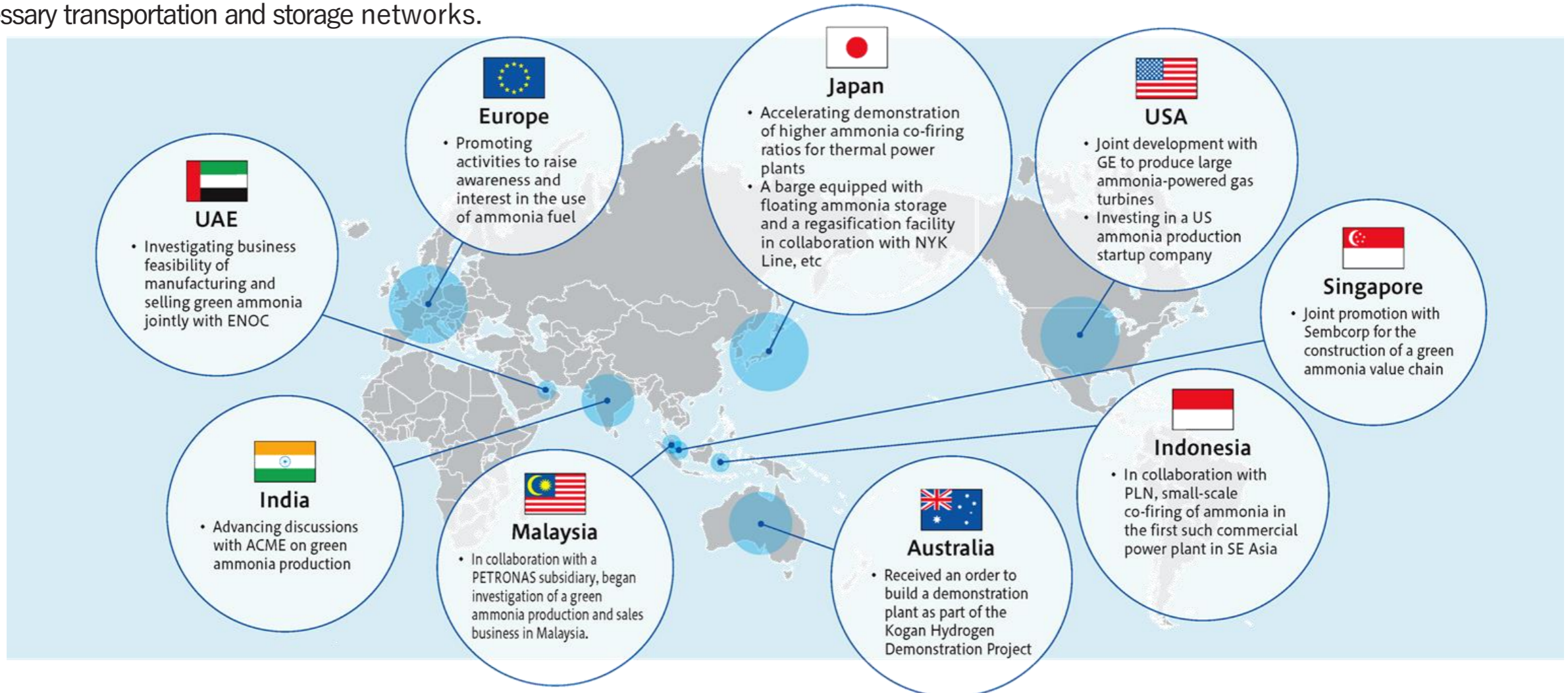
Development-focus Business : Clean Energy

Key Points for the "Group management Policies 2023"



Amid rising energy prices, interest in the use of fuel ammonia is growing faster worldwide.

- We will accelerate the creation of a network for fuel ammonia utilization with partners in Japan, the United States, Europe, and Asia.
- We will help to realize this kind of value chain by promoting discussions with European and US companies involved in ammonia handling as well as with companies in regions where renewable energy is produced. These discussions will cover production of fuel ammonia and the development of necessary transportation and storage networks.



Japanese government policy for fuel ammonia

- Clean ammonia is specified as a solution for carbon neutral for the industry, as well as hydrogen, in the joint statement of G7 in Japan this year.
- GX Promotion Law was officially voted and regally activated on 12 May 2023.
 - Fundraising by issuing GX Economic Transition Bond.
 - Contract for Deference for the gap between fossil energy and clean energy.
 - Carbon incentives and credit.
- Increasing the receiving capacity of clean ammonia from overseas.
→Y2030 : 3mil tons / y →Y2050 : 30mil tons / y
- Providing low interest loan and sovereign hook for private commercial bank loans.
- Establishing clean energy auction system.



Reality of Asia

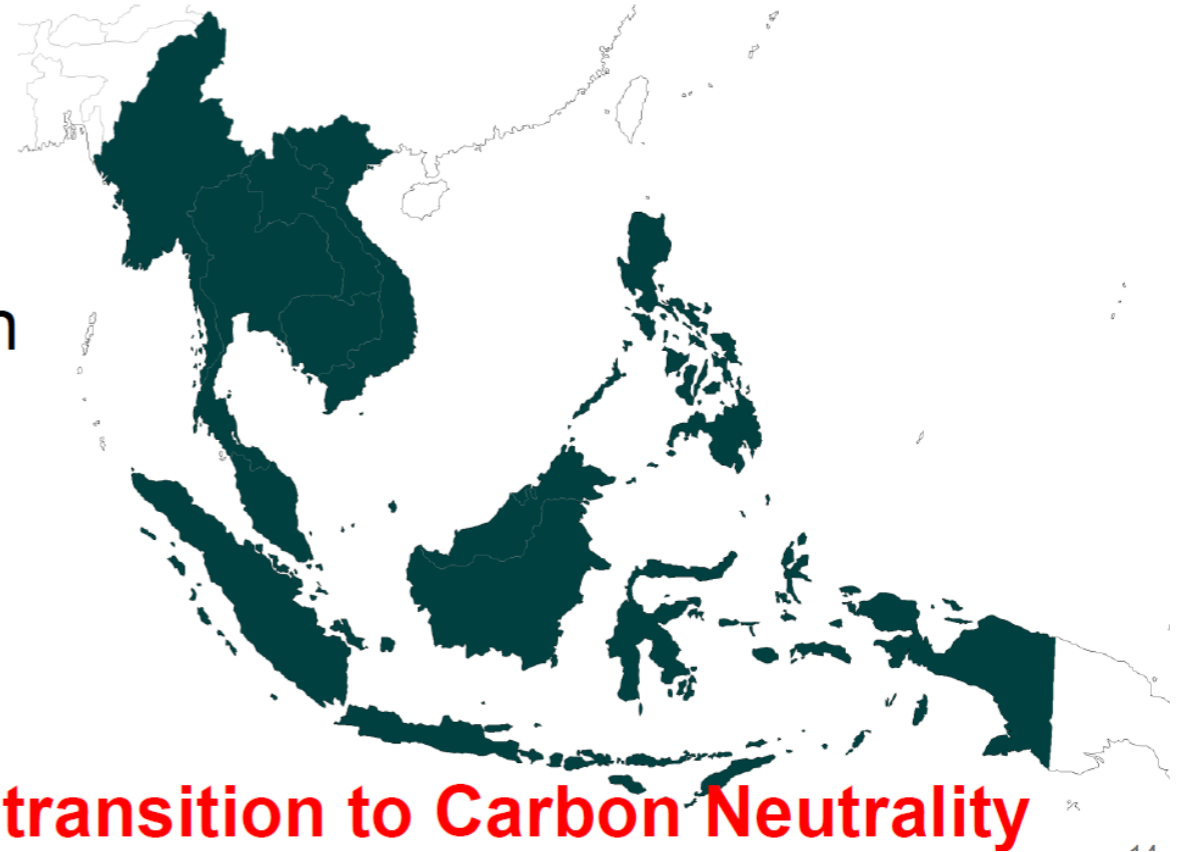
- Increasing Energy Demand
- Young Fossil Power Asset
- Uneven Renewable Distribution
- Weaker Electricity Grid

AZEC and AETI Scheme

- Provide Technologies and Installation
- Financial Scheme
- Regulations and Standards

For the smooth transition we need



- Retrofit of Existing Asset with H₂, NH₃ and CCS to reduce emission



Importance of Ammonia for smooth transition to Carbon Neutrality

Technologies to Utilize Ammonia

IHI will contribute to decarbonization in various fields by developing and providing a wide range of ammonia utilization technologies.

Field	Items		Remarks
Power	Boiler		<ul style="list-style-type: none"> ✓ Demonstration of 20% ammonia co-firing at JERA Hekinan Thermal Power Station unit 4 starts from March 2024. ✓ Commercial operation starts from 2027.
	Small Gas Turbines		<ul style="list-style-type: none"> ✓ World's 1st 100% ammonia mono-firing Gas Turbines - CO2 free power generation.
	Large Gas Turbines	 <small>Image courtesy of GE</small>	<ul style="list-style-type: none"> ✓ IHI and GE agreed MOU for joint development to apply IHI's 100% ammonia mono-firing technology to GE 6F.03,7F and 9F Gas Turbines.
	Gas Engines		<ul style="list-style-type: none"> ✓ IHI is working to develop engines for vessels with Ammonia-fueled engine. (NEDO supported project) ✓ The engine is also planned to be used as a gas engine for power generation.
Vessels			
Industry use	Packaged Boilers		<ul style="list-style-type: none"> ✓ IHI is developing Ammonia-fueled packaged boilers for factory use.
	Industrial Furnaces		<ul style="list-style-type: none"> ✓ IHI is working with Idemitsu to convert naphtha cracking furnaces and other industrial furnaces to ammonia fuel.

Recent achievements



Carbon solutions

IHI Achieves World's First CO₂-free Power Generation with a Gas Turbine Completely Fueled Using Liquid Ammonia

- Realized CO₂-free power generation using a 2,000 kW-class gas turbine that uses only liquid ammonia as fuel
- Succeeded in reducing greenhouse gas emissions during combustion by over 99%
- Aiming for practical use in 2025 by improving operability as well as conducting durability evaluations over a long duration



Carbon solutions

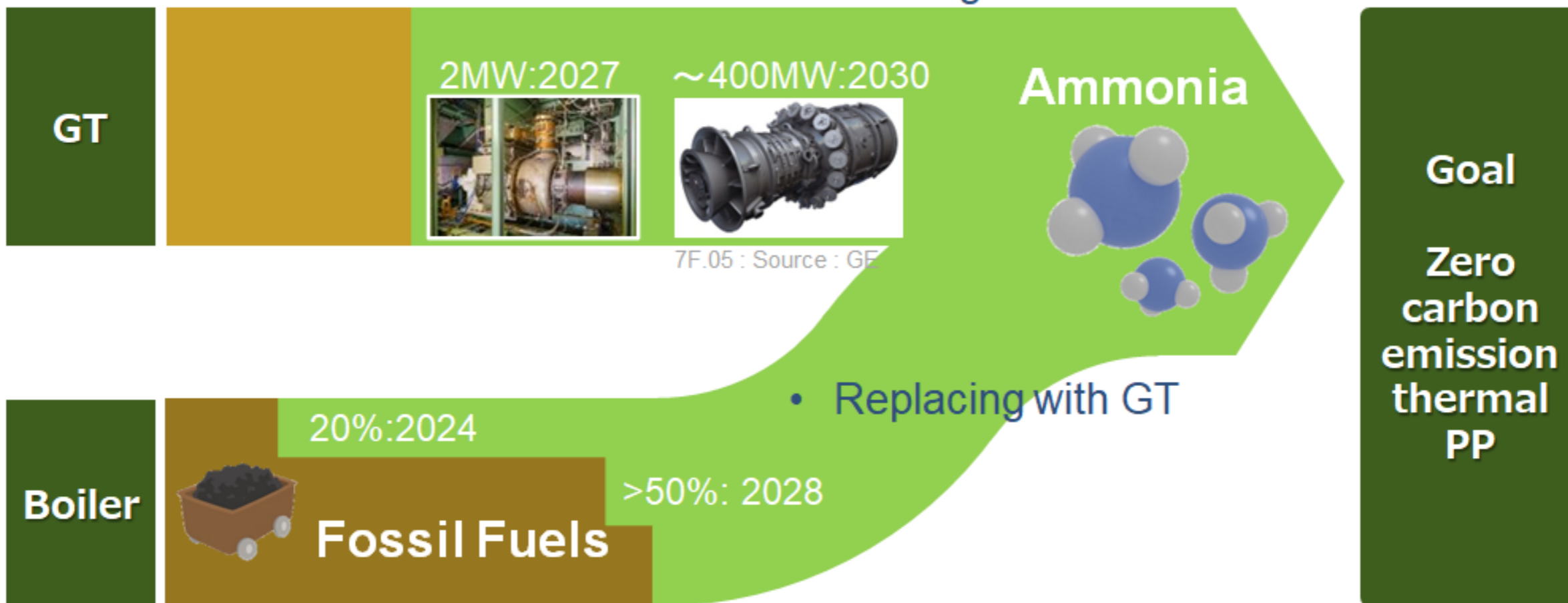
Lifecycle businesses

Ammonia Co-firing Demonstration Project at Hekinan Thermal Power Station

- Significant progress in large-scale demonstration project to establish technology in which fuel ammonia is co-fired
- Steady progress being made in adjustments to necessary facilities and the demonstration project till now
- As a result, the start of large-scale co-firing of fuel ammonia (fuel ratio of 20%) has been brought forward by about a year to FY2023

IHI Roadmap Towards Decarbonization of Power Sector

- Retrofit of Ammonia firing



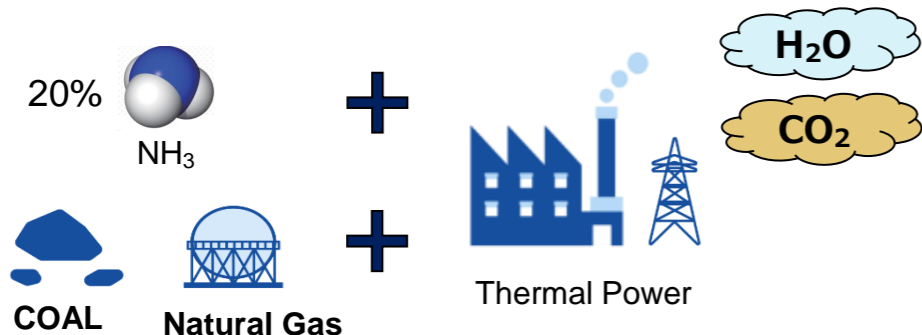
- Stepwise increase of co-firing ratio toward zero CO₂ emission



Facts of fuel ammonia combustion

Remarks

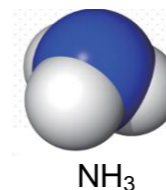
FACT



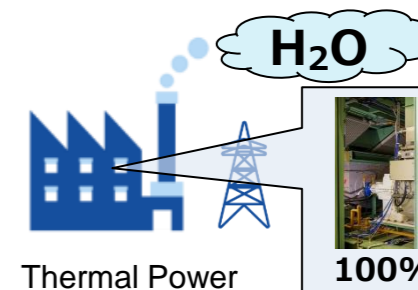
Does fuel ammonia co-firing leads to life extension of fossil fueled thermal power plants?

NO!

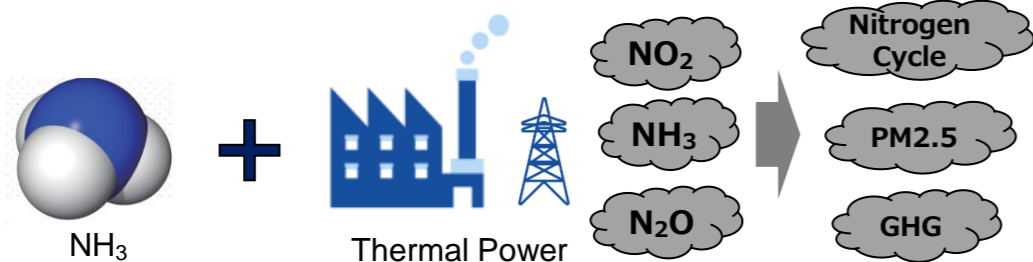
100%



+

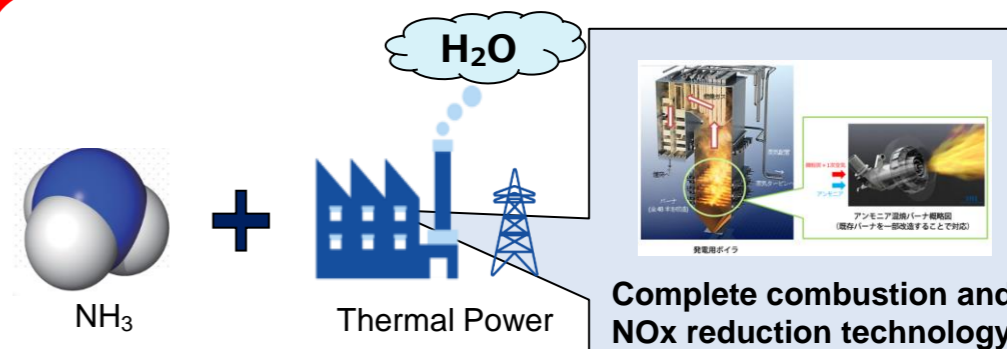


Finally fossil fuels can totally be switched to fuel ammonia which can achieve zero emission of thermal power plants.



Does ammonia firing increases negative environmental impact to the atmosphere?

NO!

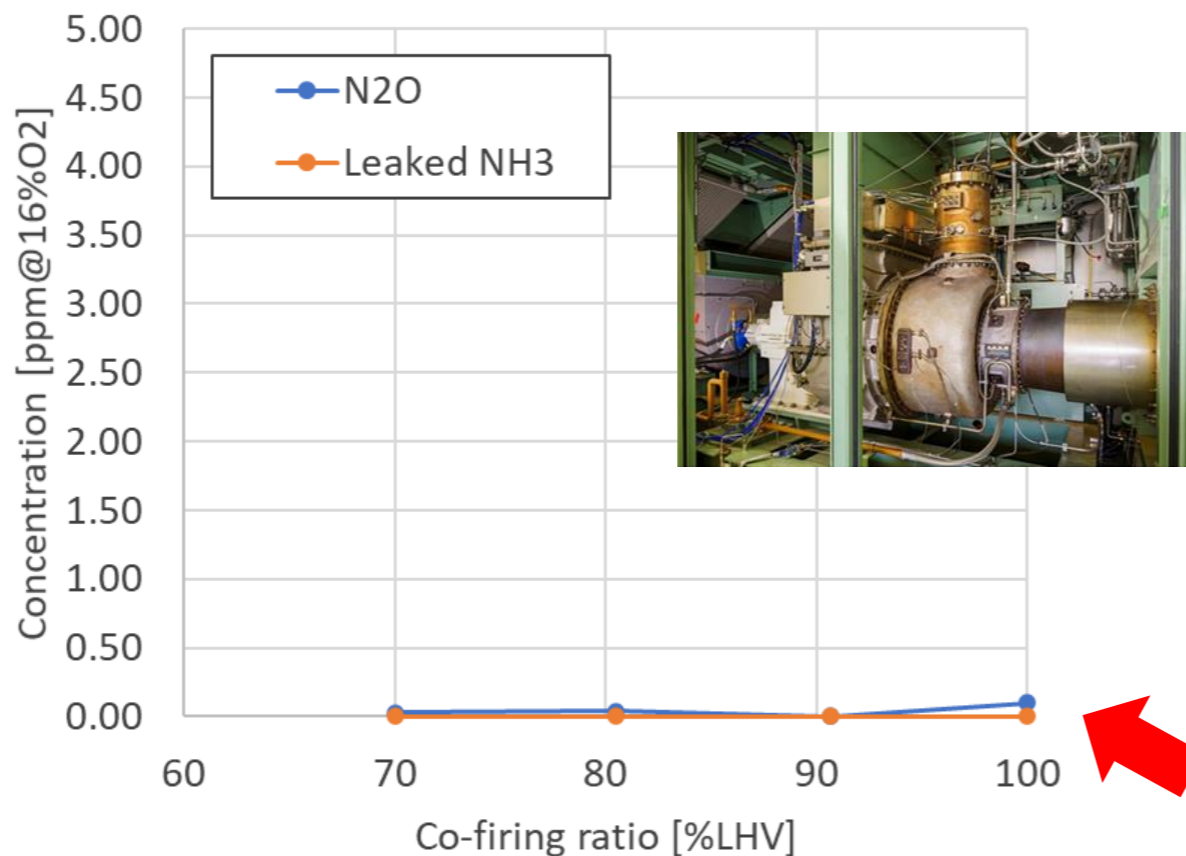


Emission of pollutants are controlled by complete combustion and NOx reduction technology.

Facts of fuel ammonia combustion

Unburned ammonia from Gas Turbine

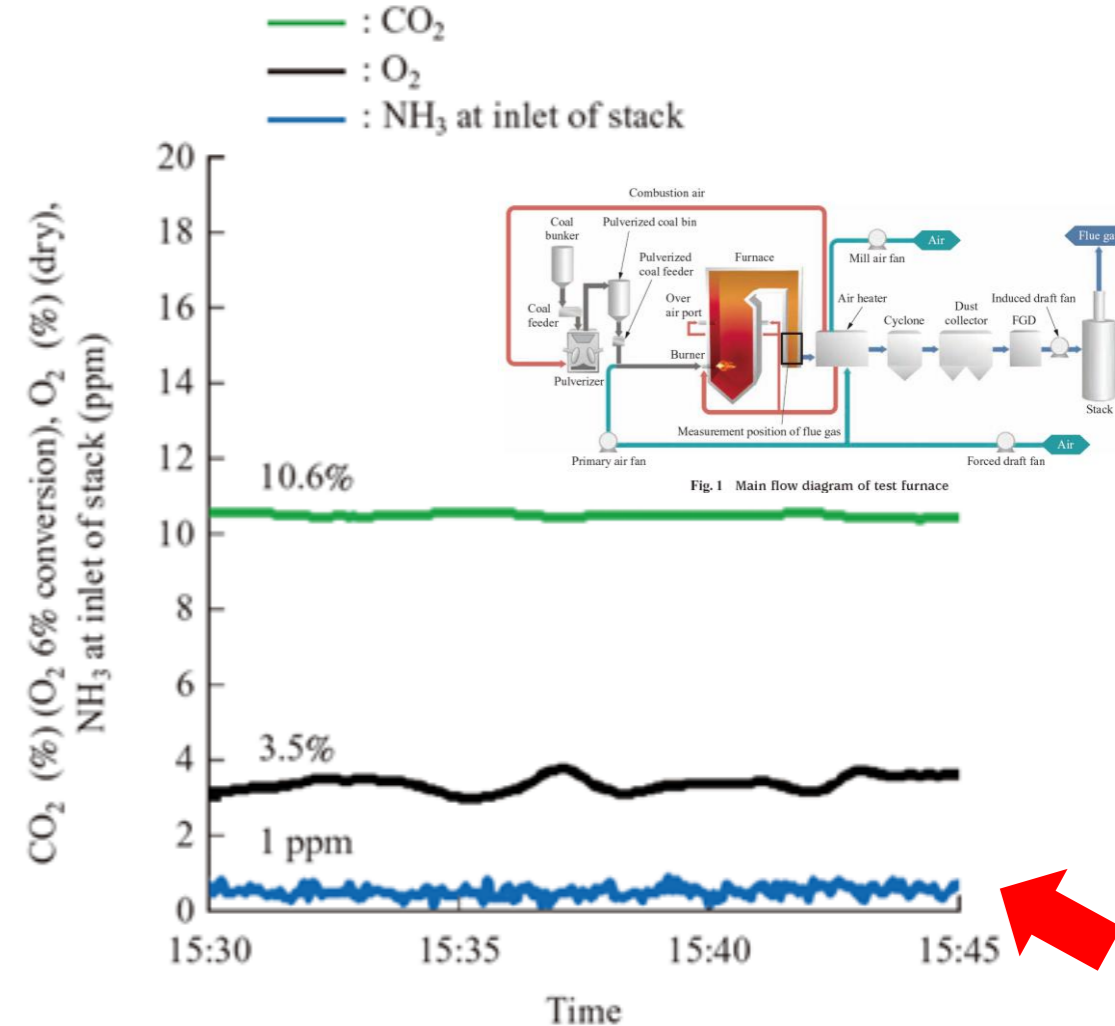
IHI has succeeded in reducing greenhouse gases by over 99% during combustion



Source: IHI Corporation

Unburned ammonia from boiler

(b) Ammonia co-firing



Source: Reprinted in translation from transaction of the JSME (in Japanese), Volume 86, issue 883

Large-scale Ammonia Receiving Terminal

IHI Starts Developing Large Ammonia Receiving Terminal to Help Establish Large Ammonia Supply Chain

- Oct. 5, 2021 -

Press Release

IHI Corporation announced today that it has begun developing a large ammonia receiving terminal to bolster its ammonia receiving and storage technologies and establish an infrastructure to swiftly, efficiently, and economically handle large volumes of imported ammonia.



https://www.ihico.jp/en/all_news/2021/resources_energy_environment/1197536_3360.html

Joint R&D Agreement for World's First Ammonia Floating Storage and Regasification Barge

- Aug. 22, 2022 -

Press Release

NYK Line, Nihon Shipyard Co., Ltd. (NSY), ClassNK, and IHI Corporation (IHI) signed a joint research and development agreement for the commercialization of an ammonia floating storage and regasification barge (A-FSRB). Specifically, the parties will work on the R&D of the world's first barge* equipped with a floating storage and regasification facility for ammonia.



https://www.ihico.jp/ihico/all_news/2022/resources_energy_environment/1198020_3488.html

Green Hydrogen Production Project in Australia

IHI and Subsidiary Sign EPC Contract for Demonstration Plant at Australian Carbon-Free Hydrogen Project

- Mar. 29, 2022 -

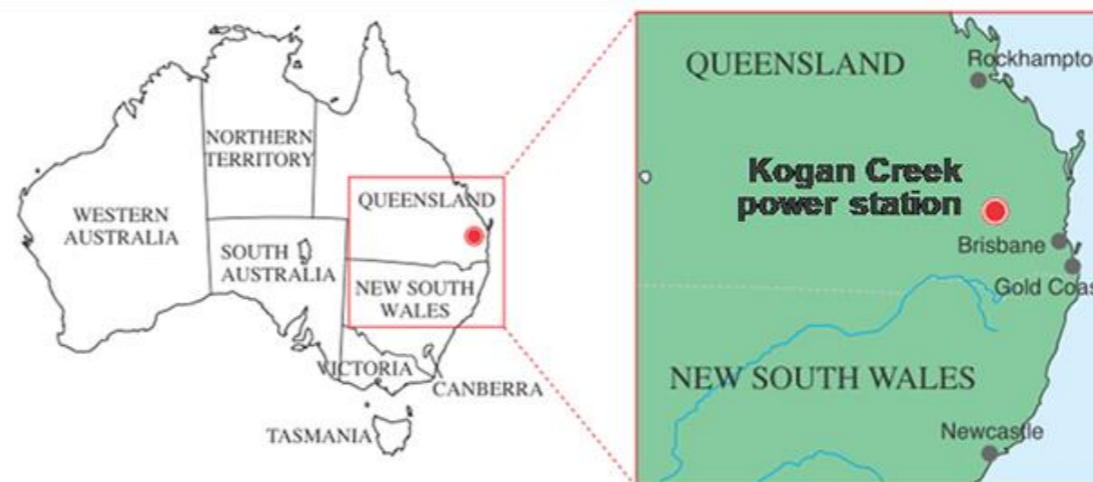
Press Release

IHI Corporation announced that Australian electricity provider CS Energy Ltd has awarded subsidiary IHI Engineering Australia Pty Ltd an engineering procurement and construction contract for the Kogan Renewable Hydrogen Demonstration Plant (HDP). This project will be adjacent to the Kogan Creek Power Station in Queensland, Australia.

The project will produce green hydrogen through electrolysis powered by a nearby solar farm and through battery energy storage. It will sell surplus electricity to the power grid.

This project originated in December 2020 with a joint feasibility study between CS Energy and IHI Corporation. That effort evaluated the technical and economic feasibility of a renewable hydrogen facility.

https://www.ihico.jp/en/all_news/2021/resources_energy_environment/1197717_3360.html



Green Ammonia Production and Sales Project in India

IHI to commence studies on Green Ammonia Production and Utilization Businesses in India

February 21, 2023-

Press Release

IHI has recently signed a memorandum of understanding with ACME, a leading renewable energy company in India, to study and investigate the feasibility of producing and utilizing green ammonia derived from renewable energy.

Most ammonia on the market currently is derived from fossil fuels with emitted CO₂ during production, but if the production of green ammonia, that is ammonia derived from renewable energy sources, is realized it will be possible drastically to lower CO₂ emissions across the ammonia supply chain, including uses such as power generation, marine fuels and fertilizer feedstock. In addition, the technologies for the production, storage and transport of ammonia have already been established and are expected to be rapidly implemented in society.

In this MoU, IHI will consider participation in green ammonia production projects, led by ACME, based in Oman, India, the USA and Egypt, as well as the use of ammonia for decarbonized power generation for in Asian islands and other regions.

http://inettms.ty.ihi.co.jp/en/all_news/2022/resources_energy_environment/1198194_3488.html



Electrochemical synthesis of ammonia

IHI to Start Developing Technology to Directly Synthesize Carbon Dioxide-Free Ammonia from Water and Nitrogen

- May 16, 2022 -

Press Release

IHI Corporation, Hokkaido University, Fukuoka University, the University of Tokyo, and metal electrode manufacturer De Nora Permelec Ltd today announced that the New Energy and Industrial Technology Development Organization has selected them to jointly undertake a project to innovate technology to directly synthesize carbon dioxide-free ammonia from water and nitrogen.

LCOA

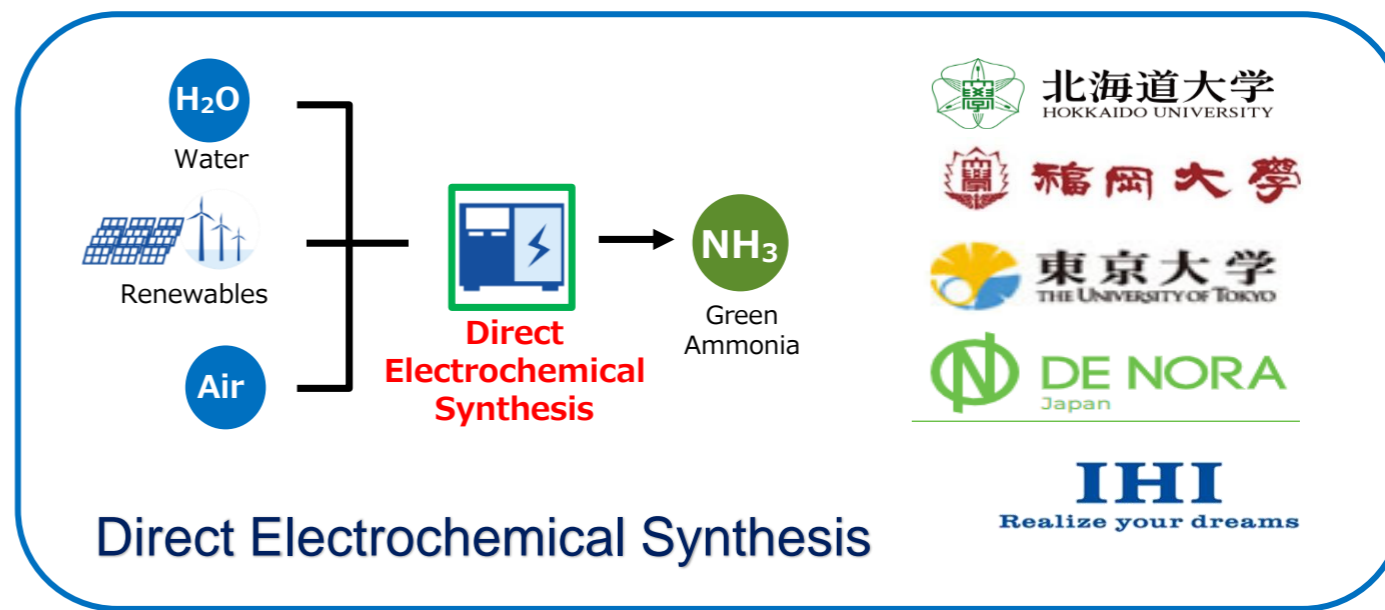
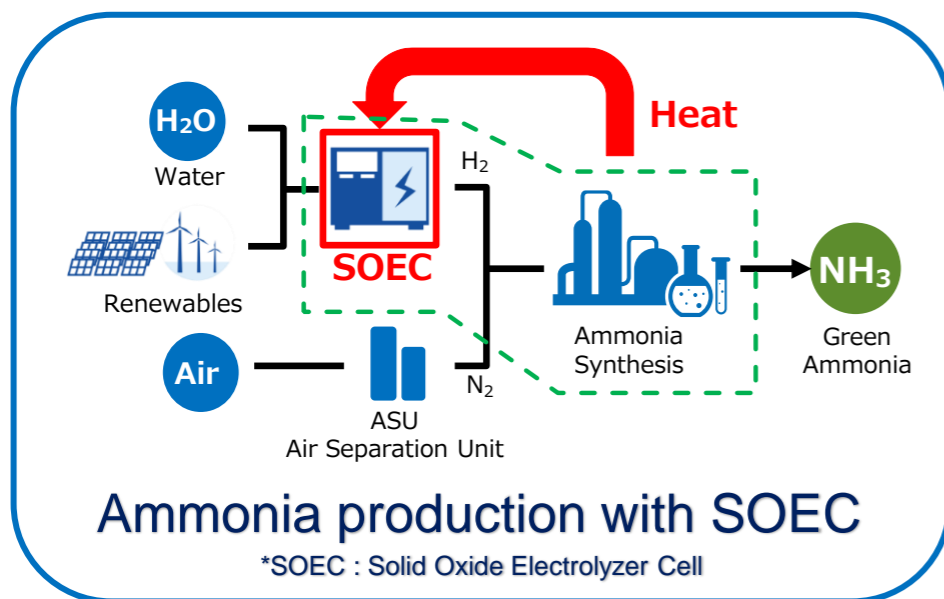
Levelized cost of ammonia

Base : Production by Alkaline or PEM electrolyzer

-31%



-47%



IHI
Realize your dreams