

The 34th Clean Coal Day International Symposium
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Ammonia power generation for carbon-neutrality

Nobuhiko MORIYA

Associate Director

General Manager, Ammonia Gas Turbine Development Dept.

Resource, Energy & Environment Business Area,

IHI Corporation

moriya4433@ihi-g.com

Company Overview



Year of establishment

1853



Revenue (Consolidated)

Approx. **10** billion USD
(@¥140, fiscal 2024)



employees (Consolidated)

28,237



IHI Global Network

30 Overseas bases and
Presence in **22** Countries

4
Areas of expertise



Resources, Energy & Environment



Aero Engine, Space & Defense

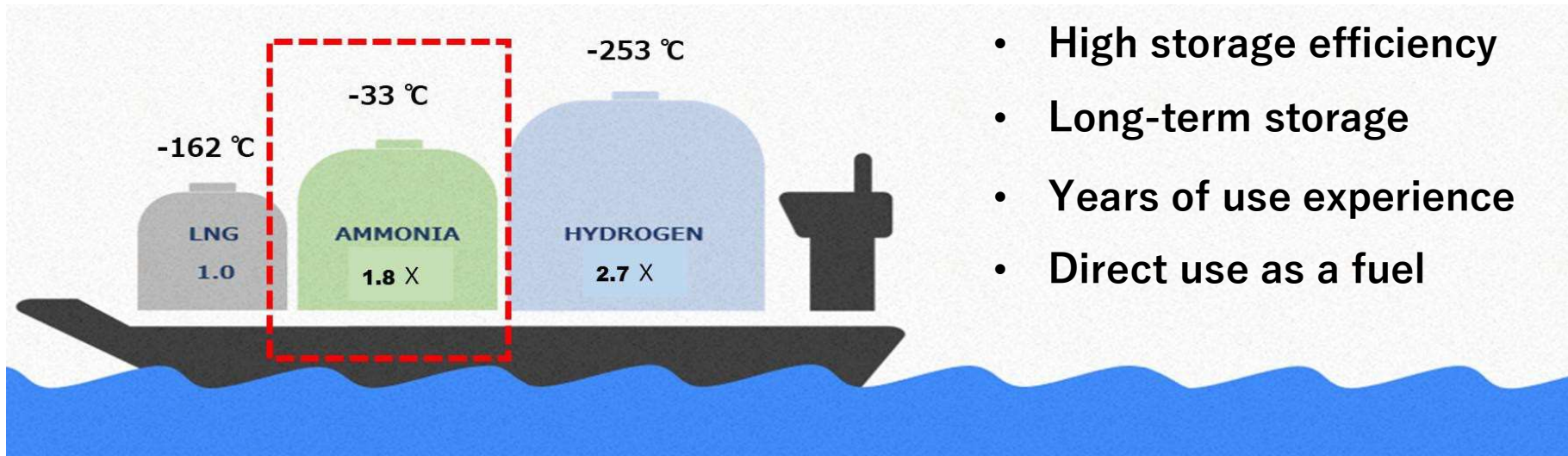


Social Infrastructure



Industrial Systems & General-Purpose Machinery

Ammonia as Energy Carrier

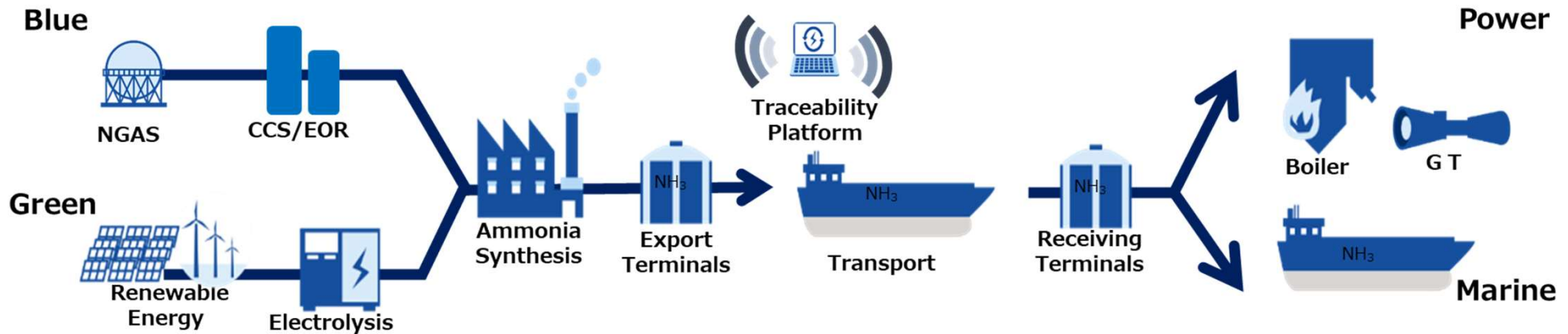


Characteristics of Liquefied Gas Fuels

	LNG	LNH_3	LH_2
Energy Density (MJ-LHV/l)	22.6	12.7	8.5
Tank Material	SUS (9%Ni)	C/S (SLA325A)	SUS
Boiling Point (°C)	-162	-33	-253
Storage Period	14 Days	Long Term	7 Days

Ammonia Value Chain and IHI key products

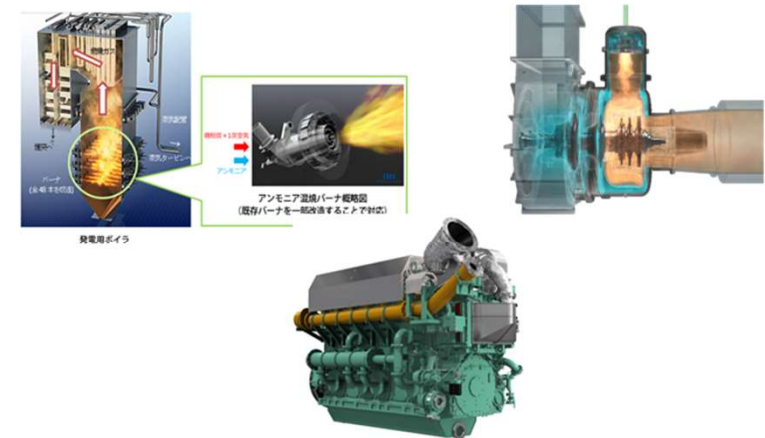
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Production:
Water Electrolyzer



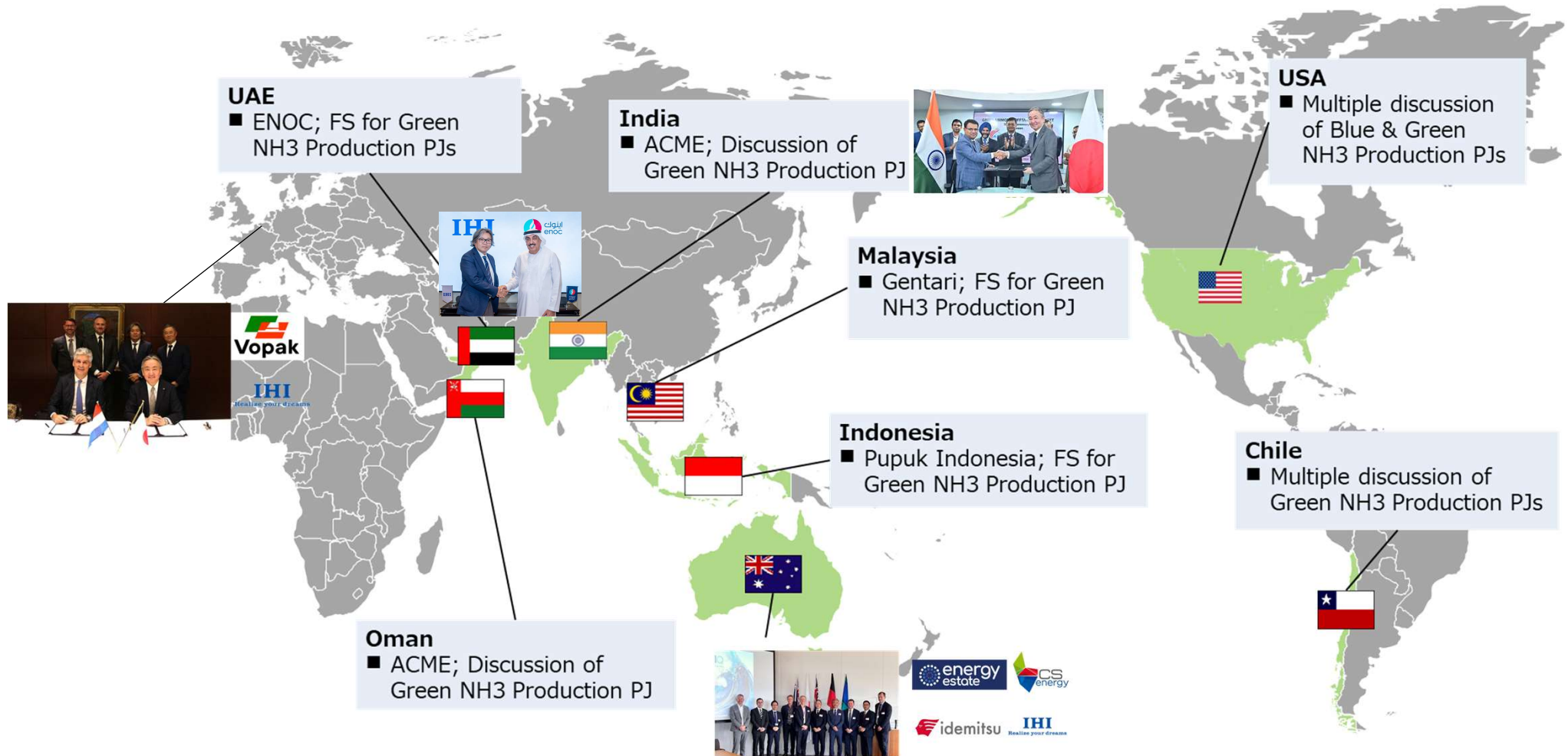
Storage & Transportation:
Tank and Burge



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

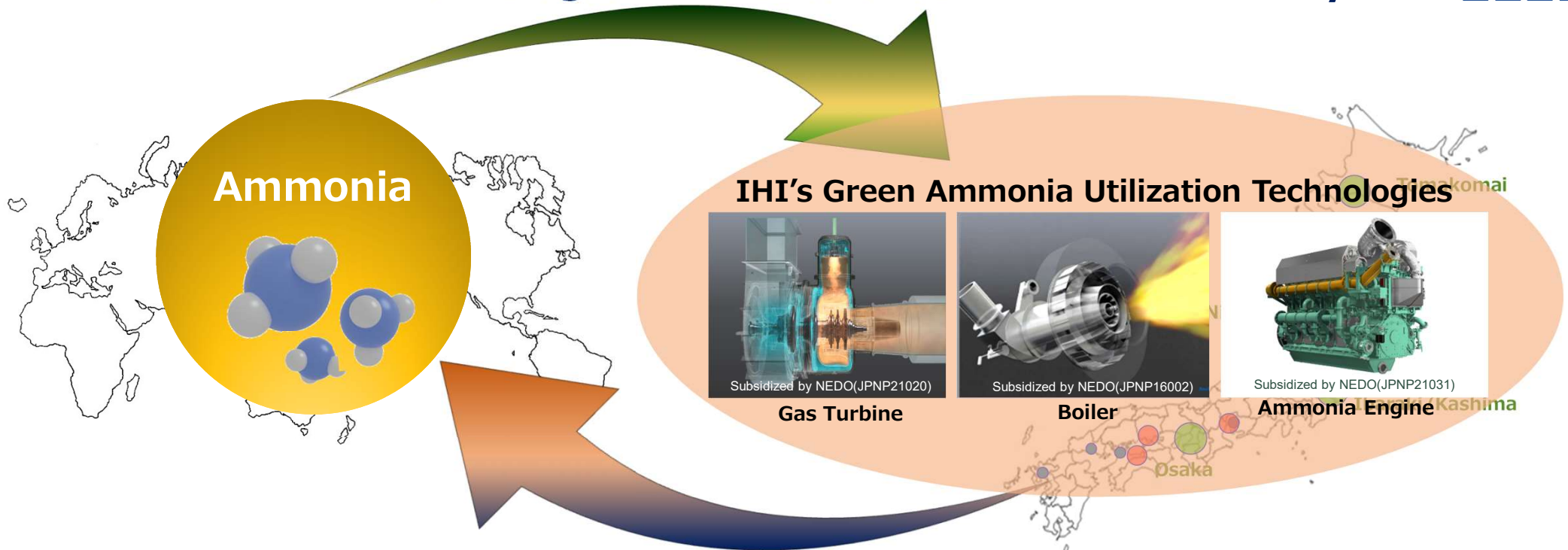
Green Ammonia Production Projects

IHI



IHI's Utilization Technologies to create Green Ammonia society

IHI



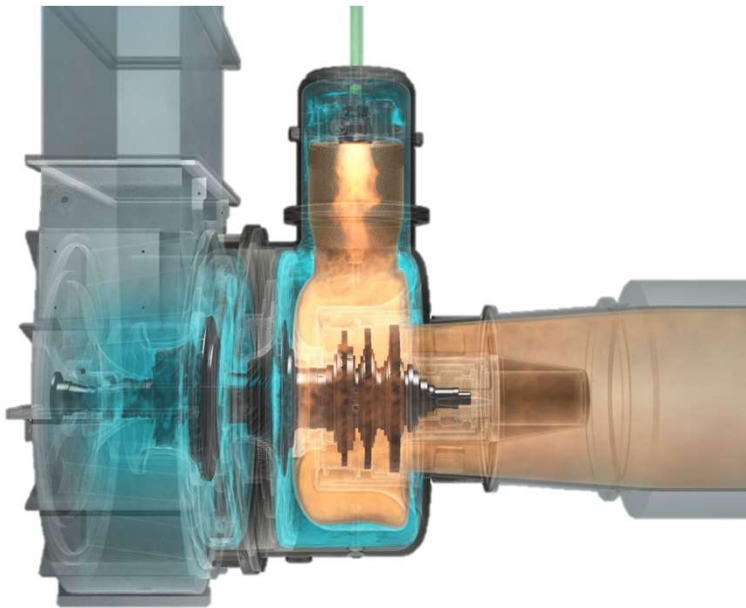
IHI developing utilization technologies **since early 2010s** and **achieved excellent results** whilst conducting multiple **breakthrough demonstrations**

Key year 2024 – series of world's first implementation demos under three important initiatives were conducted in Japan to verify the **reduced environmental impact, safety** and **operational reliability** of **fuel ammonia**

IHI Ammonia 100% IM270 gas turbine current achievements



- Ammonia fueled single can combustor 2MW gas turbine
- Gas turbine test facility in IHI Yokohama Works
- Achieved full load operation with 100% liquid ammonia combustion in 2022.



IHI IM270 gas turbine

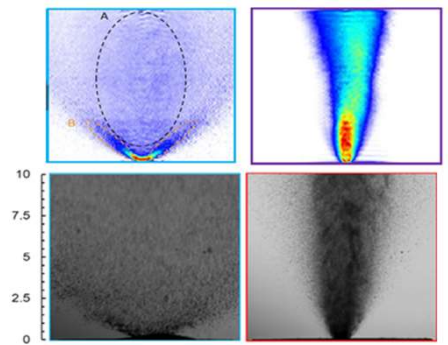


Ammonia GT test facility & Fuel Supply System at IHI Yokohama

Liquid ammonia firing gas turbine combustor

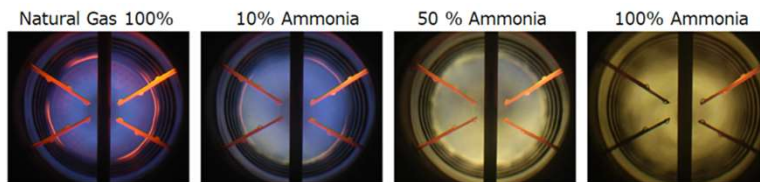
Atomization and mixing control

- Simplification of equipment
- Capability of high load change



Water LNH3

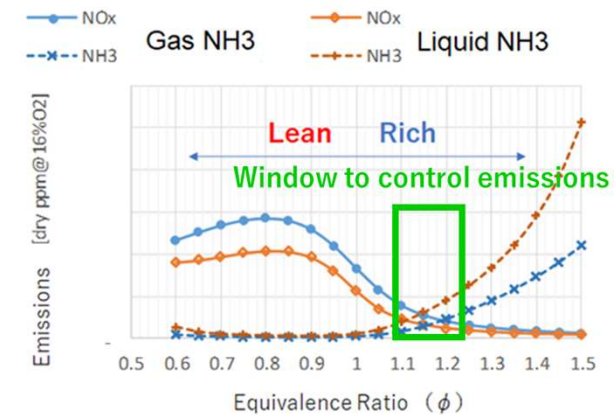
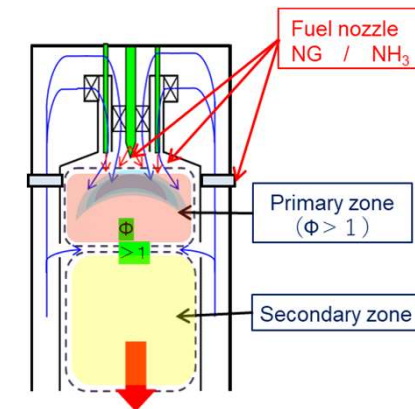
Kobayashi,
Tohoku University



Flame of combustor test rig at 1 bar

Emission control

- Emission control(NO_x , N_2O , NH_3)
- Rich-Lean 2-Stage Combustor



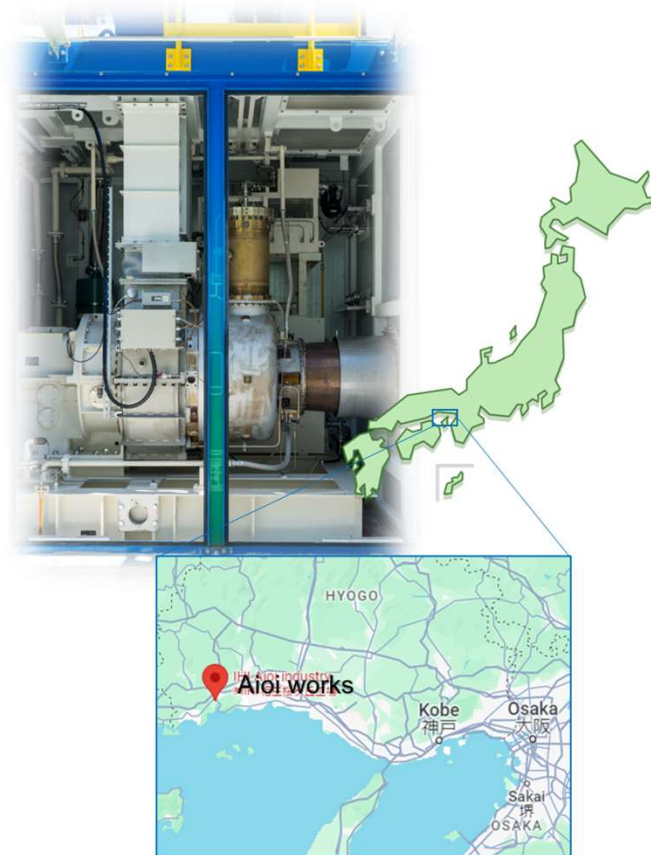
2024~ Long-term durability test at IHI Aioi factory



- Achieved 2,000 hours of operation
- Operated using 2,250 tons of blue ammonia



NEDO: JPNP21020



Technology deployment to large gas turbine

Joint Development Agreement with GE Vernova for Ammonia-Fired F-Class Gas Turbine

Up to 100%

Two-stage combustion system

- ✓ Configured to burn up to 100% of ammonia @ normal operation with 99+% GHG reduction
- ✓ Start-up with Natural Gas or carbon neutral fuel

Retrofittable

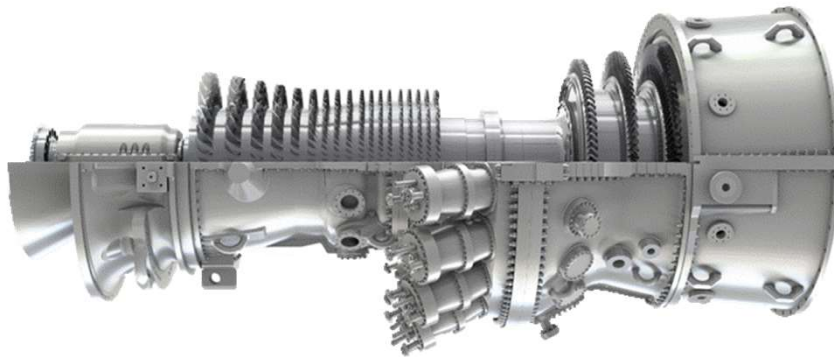
Reduced investment & same life as existing

- ✓ Utilize existing power plant assets with smaller modification for fuel conversion from natural gas to ammonia
- ✓ Target to maintain component durability and existing F-class life

NOx emission

Comply with stringent emission requirement

- ✓ New combustion technology with conventional NOx after treatment systems
- ✓ Target to meet Japan's regulation for NOx



GEV 7F gas turbine



IHI's Large-scale Combustion Test facility (LCT)

GE Vernova - IHI collaboration & milestones



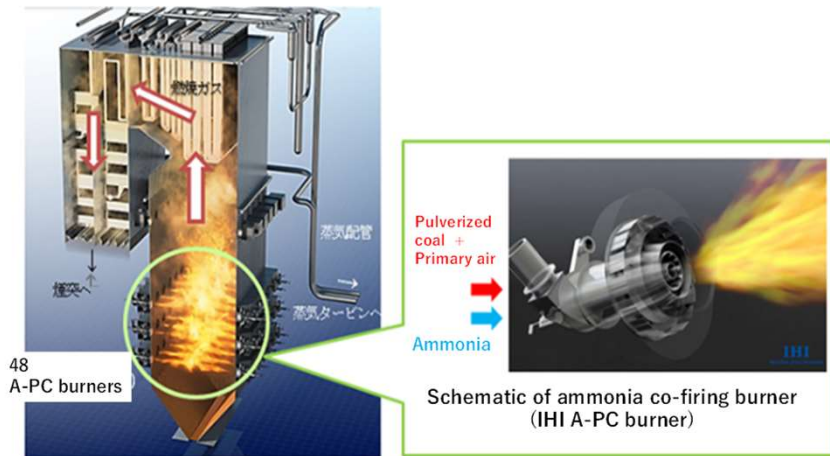
Ammonia Firing Thermal Power Generation

IHI and JERA Joint Demonstration Project in 2024

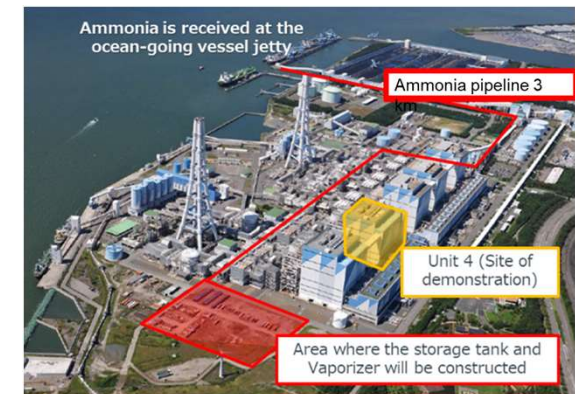
- 1GW Coal-Fired Power Plant with 20% Ammonia firing
- Annual Ammonia Consumption: 0.5 million tons
- Annual CO2 Reduction: 1 million tons

Key Contributions

- Accelerating a Speedy and Smooth Energy Transition
- Maximizing Utilization of Existing Infrastructure
- Achieving Significant CO2 Reduction
- Establishing a Large-Scale Ammonia Hub

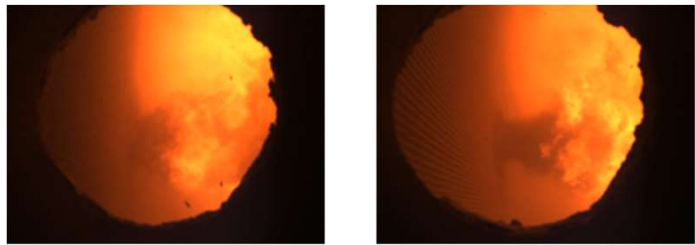
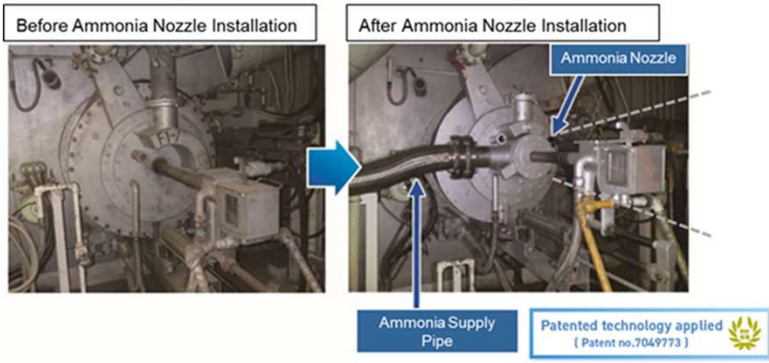


JERA Hekinan Power Station



NEDO:JPN16002

Flame image and emissions in 1GW power plant



Burner and flame Image through furnace side window (left: coal firing, right: 20% firing)

Emissions, averages of 4 hours operation at 100% load

Operation mode	Ammonia 20% firing	Coal firing	Measurement point
CO ₂ (dry, 6% O ₂)	10.8%	13.4%	GAH inlet
NO _x (dry, 6% O ₂)	106ppm	132ppm	SCR Inlet
N ₂ O	N.D.	N.D.	SCR Inlet
Unburnt NH ₃	N.D.	N.D.	SCR Inlet
SO _x (wet)	397ppm	502ppm	FGD Inlet
Unburnt Carbon in fly ash	1.8%	1.6%	FGD Inlet
N ₂ O<0.3ppm, NH ₃ <1ppm (below the limit of measurement.)			

Commercial ammonia-fueled engine and tugboat

- Three-Month Operation in Tokyo Bay, Starting August 2024
- Verification of Comprehensive Engine Performance
Output, Efficiency, Emissions, etc.
- Verification of Onboard Operations
Fuel Handling and Safety Management Systems



Ammonia-fueled Engine (28ADF,2200PS)



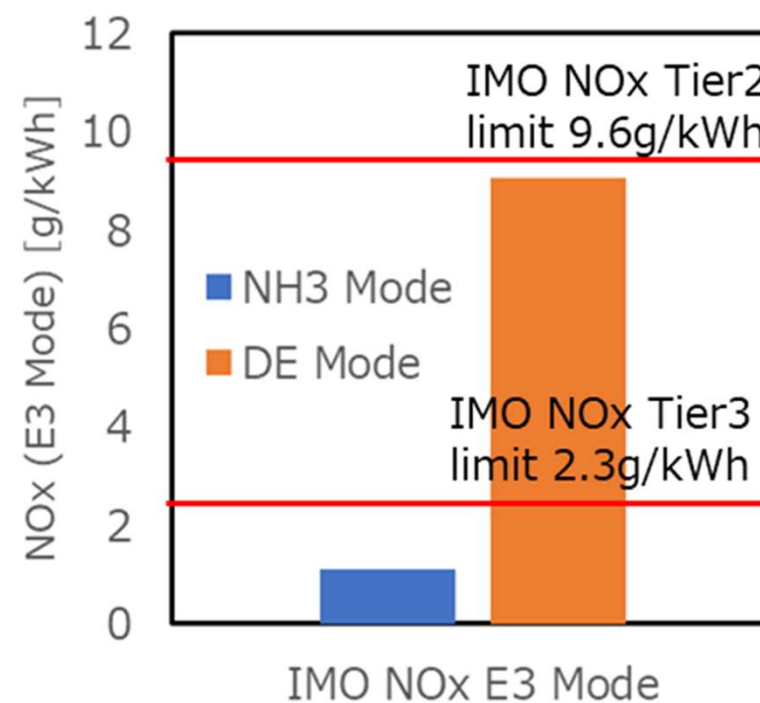
Ammonia-fueled Tugboat (Sakigake, NYK Line)
NEDO : JPNP21031

Results of GHG reduction ratio and NOx emission

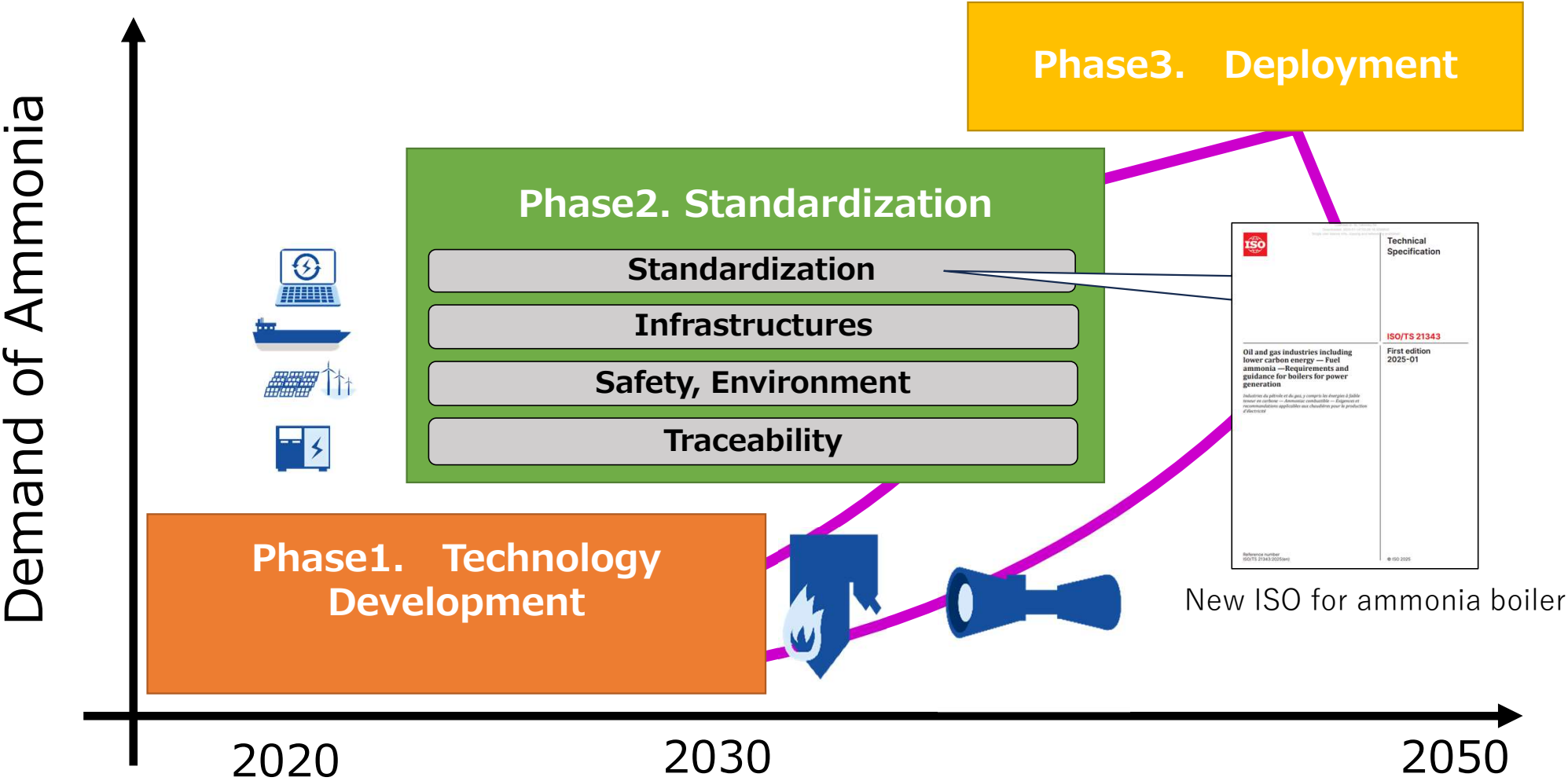
**GHG reduction ratio
@ voyage test**

Engine load	NH3 firing ratio	GHG reduction
100%	95.2%	94.0%
75%	94.8%	94.4%
50%	93.4%	93.0%
25%	91.1%	90.3%

**NOx emission in IMO E3 mode
@ shop test**



Roadmap for Ammonia Social Implementation IHI



Summary

IHI has **achieved key technology milestones** across a range of ammonia utilization technologies including:

- **20% Ammonia firing on a 1000MW boiler (2024)**
- **100% Ammonia mono-firing on the 2MW gas turbine demonstrator** and subsequent Joint Development Agreement with GE Vernova. **New Test Facility completed June 2025** to accelerate full scale technology validation and commercialization
- **90+% Ammonia firing on 4 stroke Maritime Engines (2024)**

These technologies will play a key role in the energy transition from traditional thermal power to renewables, hydrogen and ammonia. **IHI is now actively pursuing upstream, mid stream and downstream opportunities** globally

Acknowledgment:

The results on gas turbine, boiler technology and engine were obtained from projects, JPNP16002, JPNP21020(Green Innovation Fund Project) and JPNP21031(Green Innovation Fund Project) led by the New Energy and Industrial Technology Development Organization (NEDO).

