ICFA International Conference on Fuel Ammonia

METI Ministry of Economy, Trade and Industry

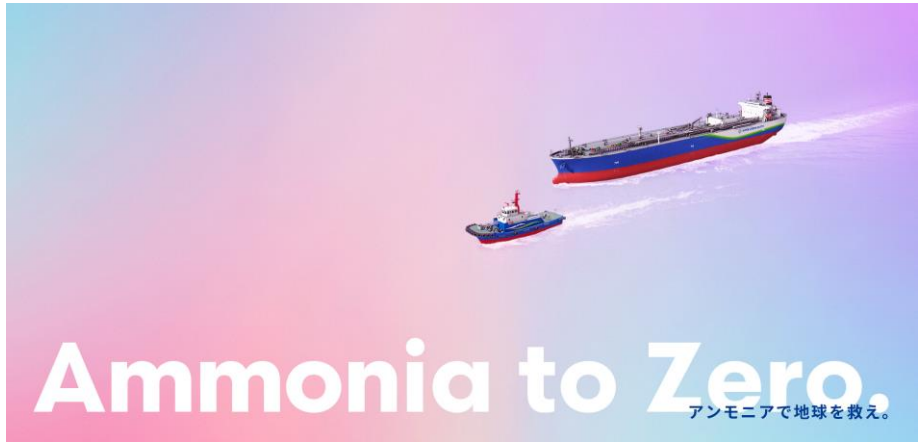
CLEAN FUEL AMMONIA ASSOCIATION

3rd International Conference on Fuel Ammonia

Utilization of clean ammonia fuel to achieve Zero Emissions in the shipping industry

海運産業のゼロエミッション化に向けたクリーンアンモニア燃料の活用について

September 29 2023



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NYK GREEN EARTH

Regulations and Trends in the Shipping Industry

- At IMO MEPC*80 (3rd-7th July) , the 2023 IMO Strategy on Reduction of GHG Emissions from Ships has been adopted.

*Marine Environment Protection Committee

INTERNATIONAL MARITIME ORGANIZATION

New target for GHG reduction in international shipping (compared to 2008)

By 2030:	At least 20%	Striving for 30%
By 2040:	At least 70%	Striving for 80%
By or close to 2050:	Reach Net-zero GHG emissions	

- Oct 2021, the Ministry of Land, Infrastructure and Transport of Japan has announced to achieve Net-Zero emissions by 2050 for international shipping.

MLIT Ministry of Land, Infrastructure, Transport and Tourism

- Sep 2021, NYK has announced Target of Net-Zero Emissions by 2050 for international shipping.

Options of alternative fuels

- Every option has pros & cons
- In shipping, Ammonia/Methanol draw stronger attention
- Need to assess scalability in production, economics, visibility in carbon footprint
- NYK pursues all possible options with more stress on ammonia which is regarded as one of the most realistic from availability & energy density viewpoints
- Continuous use of LNG as a bridge + expand LNG bunkering business

Clean Hydrogen derivatives	Production	Mass Production Timeline		Volume (NH3=100)		Boiling Point(℃)	Pilot Fuel	Challenges
Hydrogen H2	NG reform Electrolysis	2030	○	164	△	-253	Needed	Low energy density Large storage facility required Ultra-cryogenic & possibly high boil-off
Ammonia NH3	H2/N2 synthesis	2030	○	100	○	-33	Needed	Toxicity Safety measures →what we are tackling in the Ammonia-fueled Ships Development Project
Methanol CH3OH	H2/CO/CO2 synthesis	2040-	△	88	○	65	Needed	limited availability of "clean"CO2 DAC still costly Possible competition between SAF/Methanol/Methane for CO/CO2
e-methane CH4	H2/CO2 synthesis	2040-	△	66	○	-162	Needed	

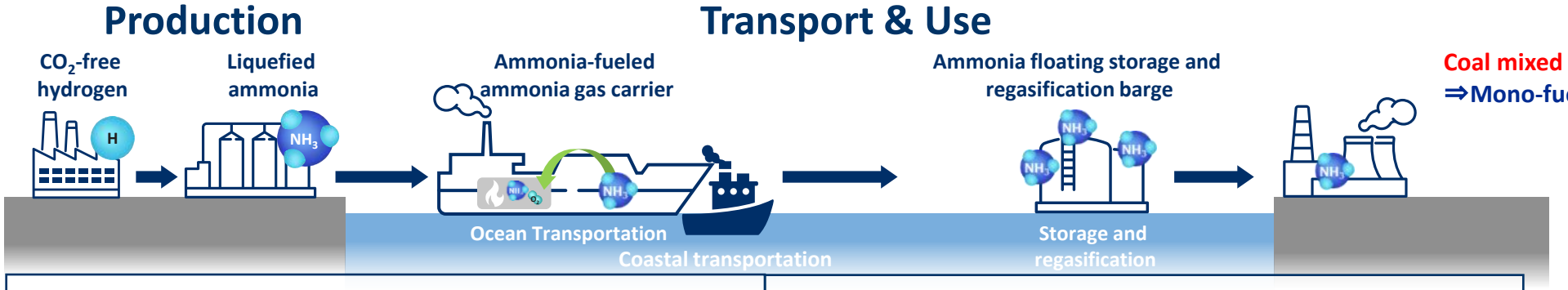
Ammonia as alternative fuel

- As of NYK's Medium-Term Management Plan, NYK is focusing on introducing ammonia as a marine fuel to achieve Net-Zero by 2050.

Strength of Ammonia	1. No CO2 emission 2. Scalable 3. High liquefaction temperature 4. Extensive cargo handling experience 5. Potential as hydrogen carrier 6. High momentum for coal mixed combustion
Challenge of introducing Ammonia	1. Toxicity 2. Initial price spike 3. No rules for using as marine fuel 4. Flame resistance

The area shipping company can contribute

Biz Scope: Entire Supply Chain of Ammonia



Production

- Participation in upstream production projects of clean fuels

Transport & Use

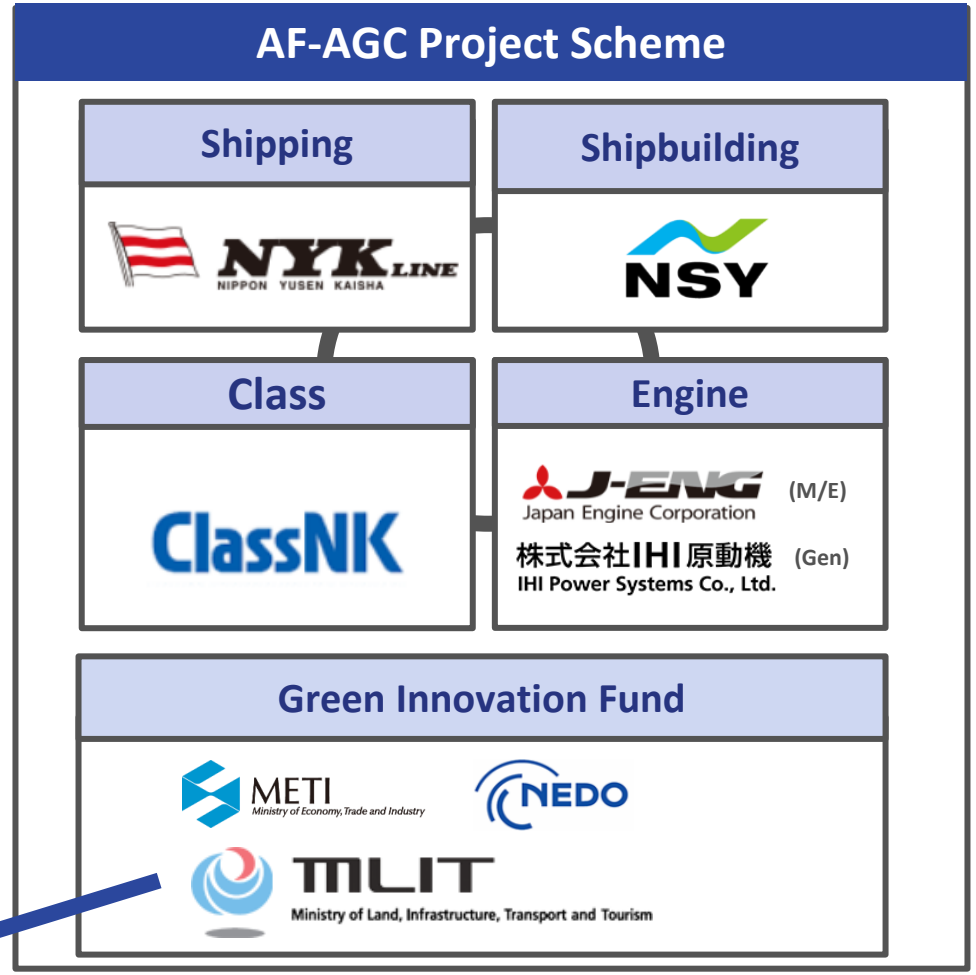
- Ocean and coastal transport
- Bunkering
- Floating Storage

Tsubame BHB	AFAGC	A-FSRB	AFT	ARLFV	ABV
Efficiency improvement of ammonia production	Ammonia-fueled Ammonia Gas Carrier	Ammonia Floating Storage Regasification Barge	Ammonia-fueled Tugboat	Ammonia-fuel Ready LNG-Fueled Vessel	Ammonia-Bunkering Vessel
	Subsidized		**Subsidized**		
Production	Transportation & Demand Creation	Storage	Demand Creation	Demand Creation	Supply Creation

Subsidized
by Japanese Government

Ammonia-fueled Ships: Tugboat & Deep sea

- Ammonia-fueled ships under development by NYK-led consortium
- With financial support from Japanese Government – Green Innovation Fund
- Tugboat as an entry project & extend the lessons learned to deep sea ships AFAGC
- Intensive risk assessment carried out in full consideration of toxicity nature of NH3
- Contribution to the rule making process in IMO



※the above scheme is only for AFAGC

IMO INTERNATIONAL MARITIME ORGANIZATION

Ammonia-fueled Ships: Tugboat & Deep sea

Project Cost	**Total: JPY12.3 billion / Subsidy: JPY 8.4 billion (maximum)**
Period	**FY2021～2027**

Ammonia Fueled Tugboat (2024 delivery)	**AFAGC – Ammonia Fueled Ammonia Gas Carrier** (2026 delivery)
• Target co-firing rate over 80% • Modification of LNG powered tug • AiP obtained in July 2022 	• Target co-firing rate :60 to 95%(M/E) • Target co-firing rate :80%(G/E) • AiP obtained in Sept 2022 
May 2023 IHI Power System commenced NH3 combustion test in the prototype 4-stroke NH3 engine 	May 2023 J-Engine commenced NH3 combustion test in the test rig of the 2-stroke engine 

Safety study efforts for ammonia-fueled vessels

- NYK, as a shipping company, contributing to the design of safe ammonia-fueled vessels having discussion with consortium partners (shipyards, manufacturers, and ship classification).

Safety constraints	Example of countermeasures
Prevention of injury and fatality	1.Space isolation 2.Remote monitoring 3.Continuous ventilation 4.Continuous leak detection 5.Detoxifier 6.Double pipes
Prevention of environmental damage	1.Detoxifier
Holding seaworthiness*	1.Arrangement of safety valves 2.Auto shut down, Auto change over

*a vessel is in a good enough condition to travel safely on the sea

HAZID(A-Tug)April 2022

HAZID(AF-AGC)July 2022

Ammonia to Zero.

アンモニアで地球を救え。

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produced by 日本郵船