Development of Ammonia fueled vessels

～Delivery of A-tug and our next plan～

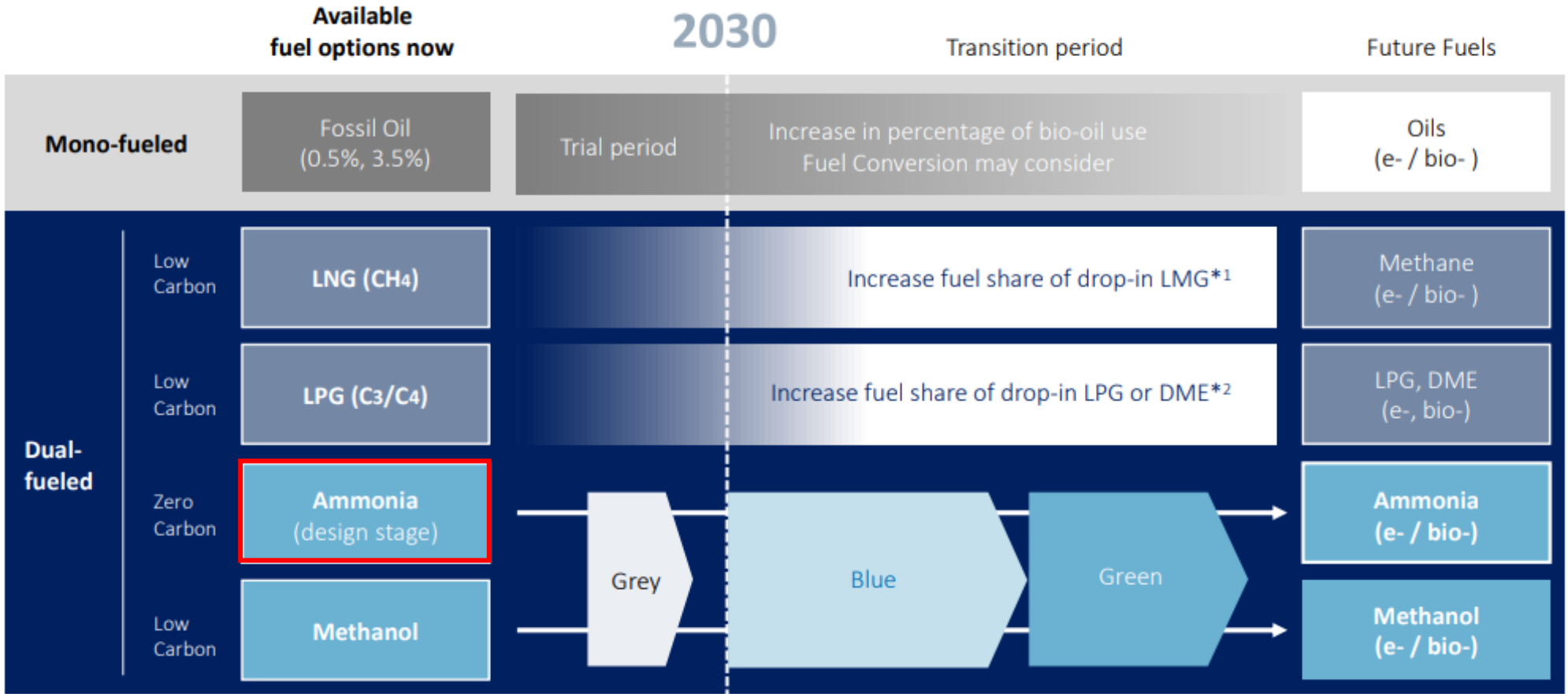
AEA Annual Conference 2024
NYK Group Americas,
Fumiya Fujimori

NYK Line Overview

❑ NYK operates 800+ vessels globally.

Fuel Transition plan

❑ Introducing LNG/LPG fuel during this decade. Ammonia is an important piece for our 2030 onwards decarbonization.



*1 LMG: Liquefied renewable Methane Gas
*2 DME: Dimethyl ether

Development of Ammonia-Fueled Vessels

❑ **We are receiving Japanese Government Funding for two Ammonia fueled vessel development projects.**

Government fund to NYK consortium

Green Innovation Fund

NEDO / METI Ministry of Economy, Trade and Industry / MLIT Ministry of Land, Infrastructure and Transport

Approx. 8.4 billion yen

NYK LINE (NIPPON YUSEN KAISHA) / 株式会社IHI原動機 IHI Power Systems Co., Ltd. / NSY / ClassNK / J-ENG Japan Engine Corporation

① Ammonia-fueled Tugboat (A-Tug)

- ❑ Retrofit of LNG fueled tug boat ”Sakigake”
- ❑ 4 stroke ammonia-fueled engine (IHI-PS)
- ❑ **Successfully delivered in Aug 2024**

② Ammonia-fueled MGC (AF-MGC)

- ❑ Building new vessel with NIHON SHIPYARD
- ❑ 2 stroke ammonia-fueled engine (J-Engine)
- ❑ **Targeting delivery Nov 2026**

A-Tug (Ammonia fueled tug boat)

- Vessel Name: Sakigake
- Built : 2015 (as LNG fueled tug)
- LOA : 37.2m
- Breadth : 10.20m
- Depth : 4.40m
- Engine : Dual Fuel (MGO/Ammonia)

※4stroke Ammonia Engine by IHI Power Systems

A-tug Timeline of development

1. World's First Commercial-Use Ammonia Fueled Vessel

- On 23rd August, A-Tug "Sakigake" has completed the conversion from LNG-Fueled Vessel at Keihin Dock Co. Ltd.
- A-Tug is the world's first commercial-use ammonia-fueled vessel, currently on a harbor tugboat business in Yokohama.

2. World's First Truck to Ship Ammonia Bunkering

- On 17th July, A-Tug has completed the world's first Tuck to Ship Ammonia Bunkering with JERA and Resonac.

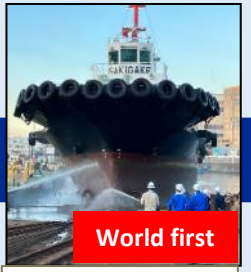
Development of A-tug

World first

July 2022
Obtained world first AiP for Ammonia-fueled Tugboat


World first

May 2023
succeeded 80% combustion test (4-stroke NH3 engine)


World first

October 2023
conversion of LNG fueled started (at Keihin Dock)


World first

February 2024
Main Engine installed to A-Tug


World first

July 2024
Truck to Ship Ammonia Bunkering

World first

Aug 2024
A-Tug Delivered on 23rd Aug

A-tug Construction

❑ Footage of construction.

A-tug Sea Trial

- Footage of sea trial done just before the delivery.

A-tug Our approach to Ammonia challenges

Toxicity

- ✓ Intense discussion with class for safety methodology.
- ✓ Design of vessel
  - Isolating Hazardous area
  - Interlocking system
  - Water curtain
  - Remote operation at E/R
- ✓ Crew operation related
  - Establishing Safety Manual
  - Selecting safety equipment
  - Educating crew (handling ammonia/evacuation)
  - Man Entry Matrix

Flame Retardancy

- ✓ Identified the optimal parameters to achieve stable combustion with intense testing by Engine Maker.
- ✓ Achieved **max 95% co-firing rate at** land-based test.

N_2O Emission

- ✓ Exhaust Gas Treating device was installed.
- ✓ Creative design was necessary to fit the large device in limited space.

AF-MGC (Ammonia Fueled Medium Gas Carrier)

- ❑ Delivery Target : Nov 2026
- ❑ LOA : 180.00m
- ❑ Breadth : 32.00m
- ❑ Engine : Dual Fuel (VLSFO/Ammonia)

※2stroke Ammonia Engine by J-ENG

AF-MGC Development

Development of Ammonia-Fueled Medium Gas Carrier

Jul. 2022
Safety verification process, including HAZID*
*HAZID: Hazard identification study

Sep. 2022
Acquisition of AiP** with risk assessment for world's first approval of an alternative design
**AiP: Approval in principle

May 2023
4st engine (IPS)
Successful combustion test with a co-firing rate of 80% using a prototype engine

May 2023
2st engine (J-ENG)
Successful combustion test in a test rig

December 2023 Contracts signed for construction

Reached a level sufficient for a social implementation, particularly in safety and environmental performance

Further development plan to 2027

2024

Further deepening R&D

By single-cylinder and full-scale engine tests, try to maximize the co-firing rate and GHG reduction

Jun. 2024
Completion of ammonia supply facilities (J-ENG)

2025

Assembly and final testing of full-scale engines

Develop ammonia fuel engines that are both economical and environmentally friendly

Apr. 2025
Start of full-scale engine tests (J-ENG)
Aug. 2025
Engine Delivery (IPS)
Oct. 2025
Engine Delivery (J-ENG)

2026

Trial & Delivery at JMU Ariake Shipyard

Implement offshore trials to verify the vessel's performance

Nov. 2026
Delivery of Vessel

2027

Implementation of demonstration voyages

Final confirmation of the vessel's performance, operation manual, etc

~Mar.2027
Implementation of demonstration voyages

Advantage in safe & efficient operation using ammonia as fuel

AF-MGC： Efforts on Rule-Making

World's First Machine Room Safety Accreditation for AF- MGC to be granted by ClassNK

- Our consortium has been thoroughly working on ship's specification to protect crews from toxic risks.
- **World's first** MRS (Machine Room Safety) Notation is to be granted by ClassNK, **which means the highest level of safety beyond the minimum design requirements.**
- Our consortium continuously works on development of AF-MGC and contributes to establishment of safety rules for ammonia-fueled vessels.

Ammonia to Zero.

アンモニアで地球を救え。

NYK GREEN EARTH

produced by 日本郵船