Maritime Ammonia Insights

The integrated role of low carbon ammonia in maritime strategy

August 8, 2023

Mitsui O.S.K. Lines

MOL

Mitsui O.S.K. Lines

1. MOL's Environmental Vision

Our Business

Supporting and Changing the World from the Blue Oceans

MOL at a Glance

Fleet Composition

(number of vessels)

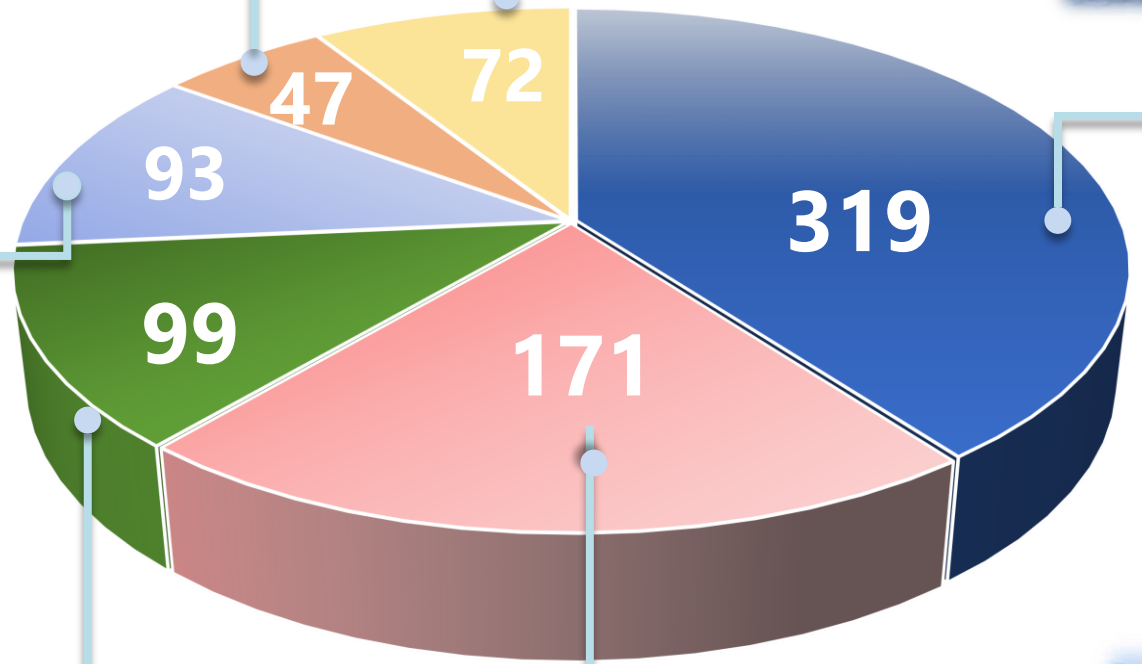
(as of March, 2022)

CONTAINER SHIPS(*)

BULK CARRIERS

OTHERS

CAR CARRIERS (PCC)



LNG CARRIERS/ FSRU/FSU

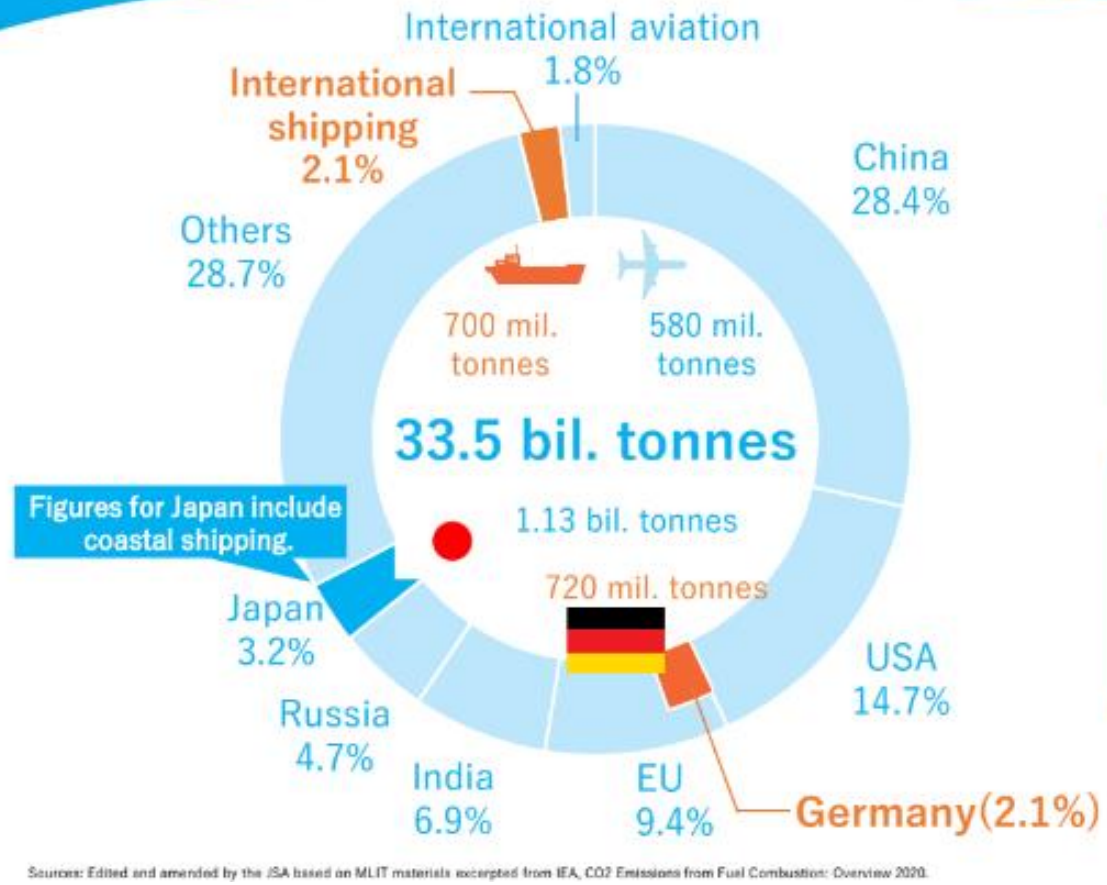
TANKERS

Over 800 ships

Current Status of Decarbonization at Shipping Industry

Introduction
Shipping and GHG emissions

CO2 emissions of the global shipping fleet are equivalent to the entire emissions in Germany.



Sources: Edited and amended by the JSA based on MLIT materials excerpted from IEA, CO2 Emissions from Fuel Combustion: Overview 2020.

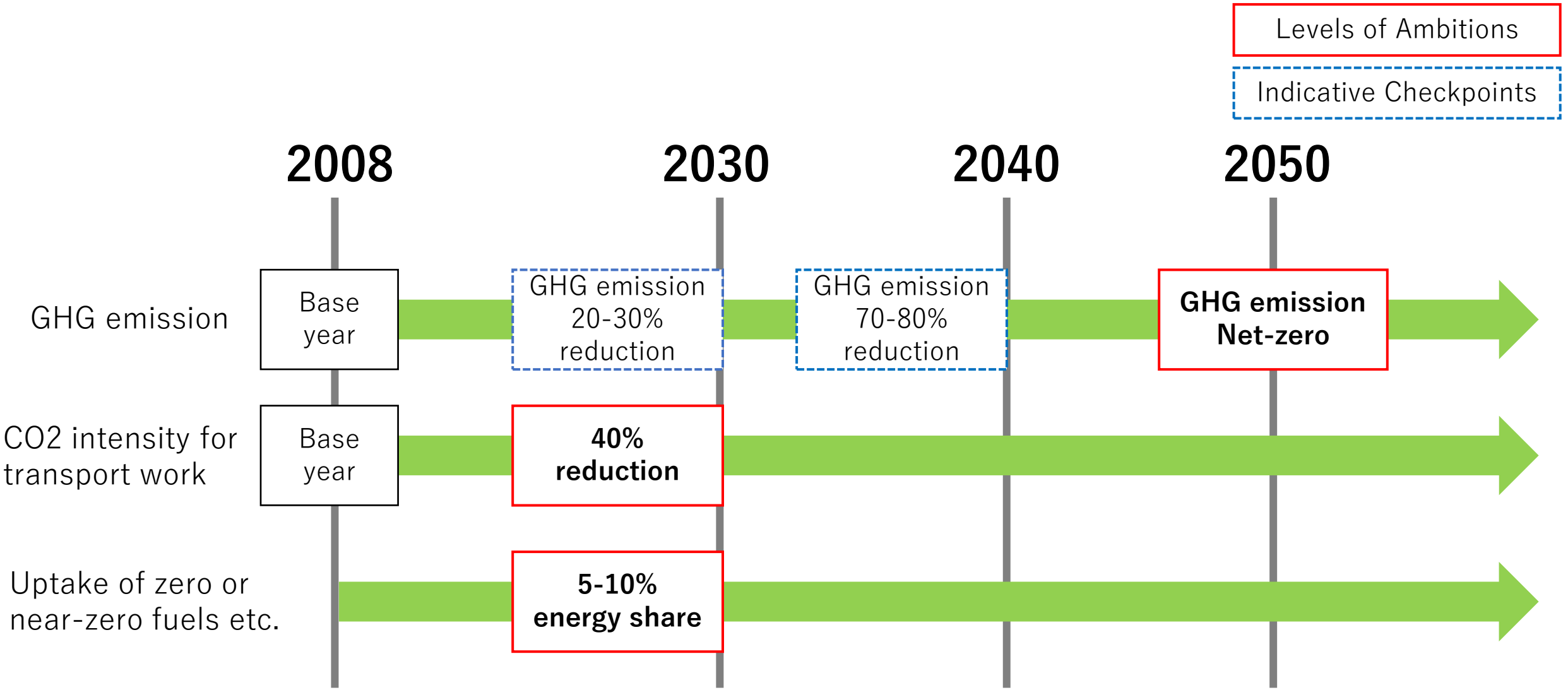
While transport efficiency of shipping is great, **about 50,000 ships engage in international maritime transport to cover cargoes worldwide.**

As the saying goes, "Many a little makes a mickle," and the total CO2 emissions of these 50,000 merchant vessels is large at about 700 million tonnes per year, which is almost the same as that of all of Germany*.

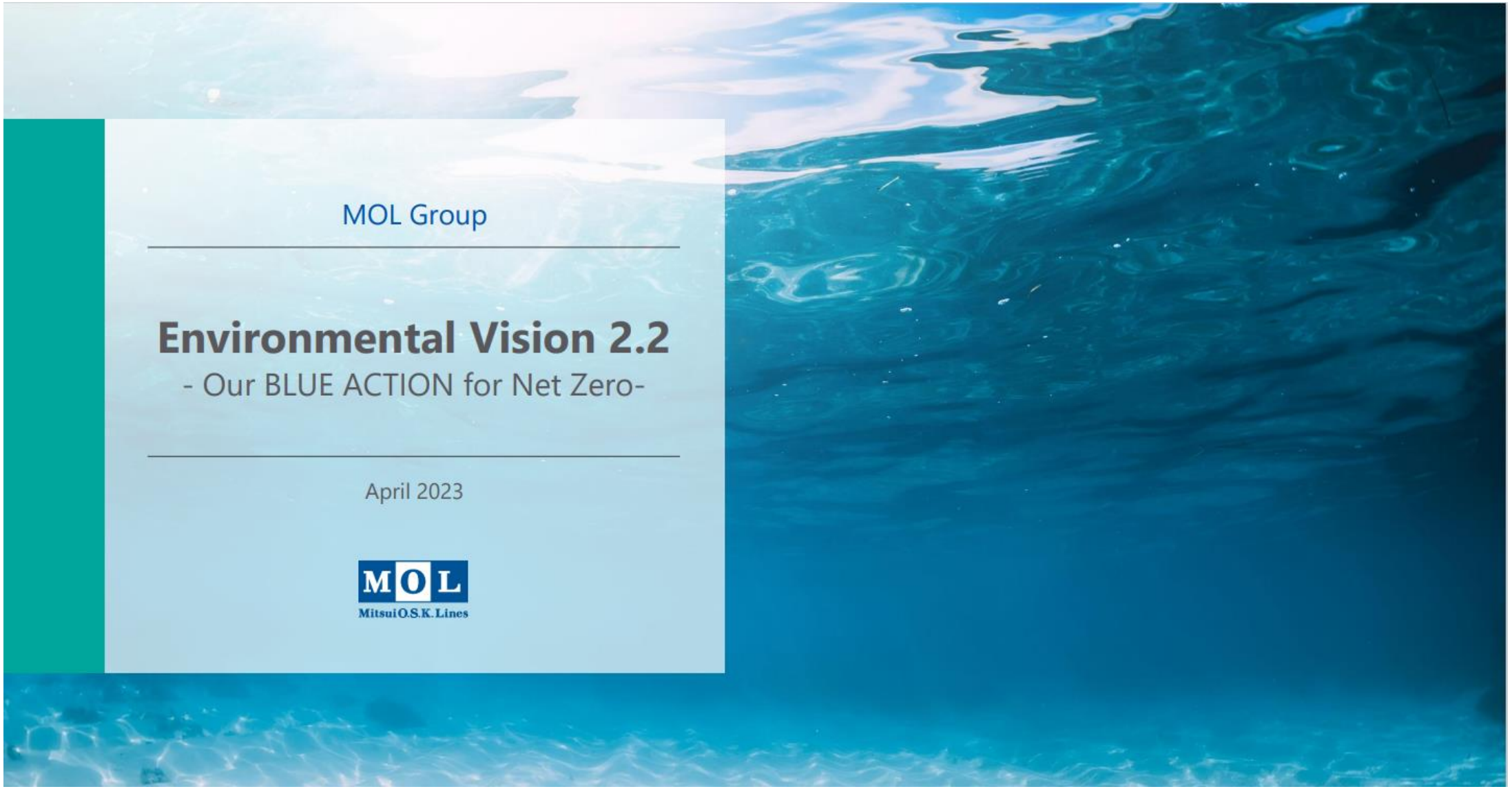
Germany: The largest economy in Europe and the world's sixth largest emitter of CO2

Source: The Japanese Shipowners' Association HP
https://drive.google.com/file/d/1zmttD0W5fe5R0RZc9ZBXIHZ7hlYL0cgm/view

2023 IMO GHG Reduction Strategy on International Shipping



MOL Environmental Vision 2.2



Positioning of Environmental Vision 2.2

Safety & Value
(Providing added value through safe transportation and social infrastructure businesses)

Environment
(Conservation of the marine and global environment)

Human & Community
(Contributing to the growth and development of people and communities)

Innovation
(Innovation for development in marine technology)

Governance
(Governance and compliance to support businesses)

Safety Vision (planned)

MOL Group Environmental Vision 2.2

Climate change countermeasures | Preservation of marine environments | Protection of biodiversity | Prevention of air pollution

Human Capital Vision

DX Vision

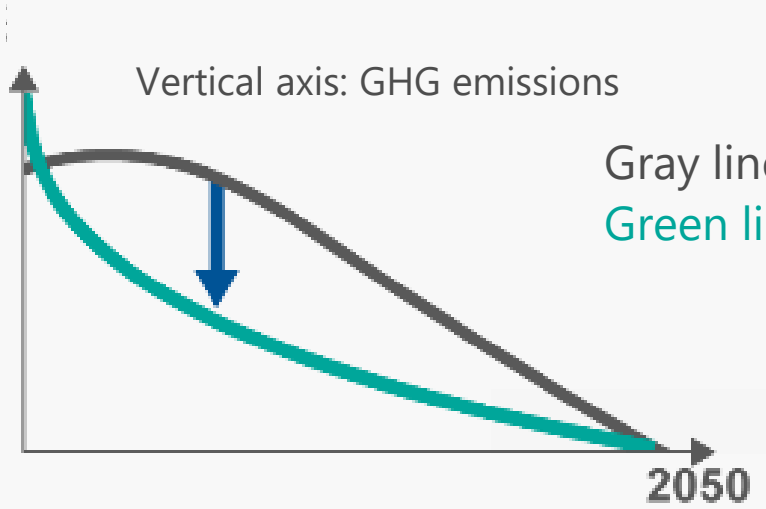
Three Basic Principles of Corporate Governance

What we should do now ? (Awareness of “Carbon budget”)

- Setting a target of achieving net-zero by 2050 has become the norm for businesses. Under such circumstances, we will lead the global movement toward decarbonization by prioritizing measures that can reduce emissions immediately without postponing measures that can be achieved prior to 2050.

- We will promote emission reductions that can be implemented now, such as immediately starting the use of LNG, a low-emission alternative marine fuel, and setting a quantitative contribution target for the short to medium term for carbon dioxide removal (removal of CO2 from the atmosphere).

Contributions with an awareness of carbon budgets

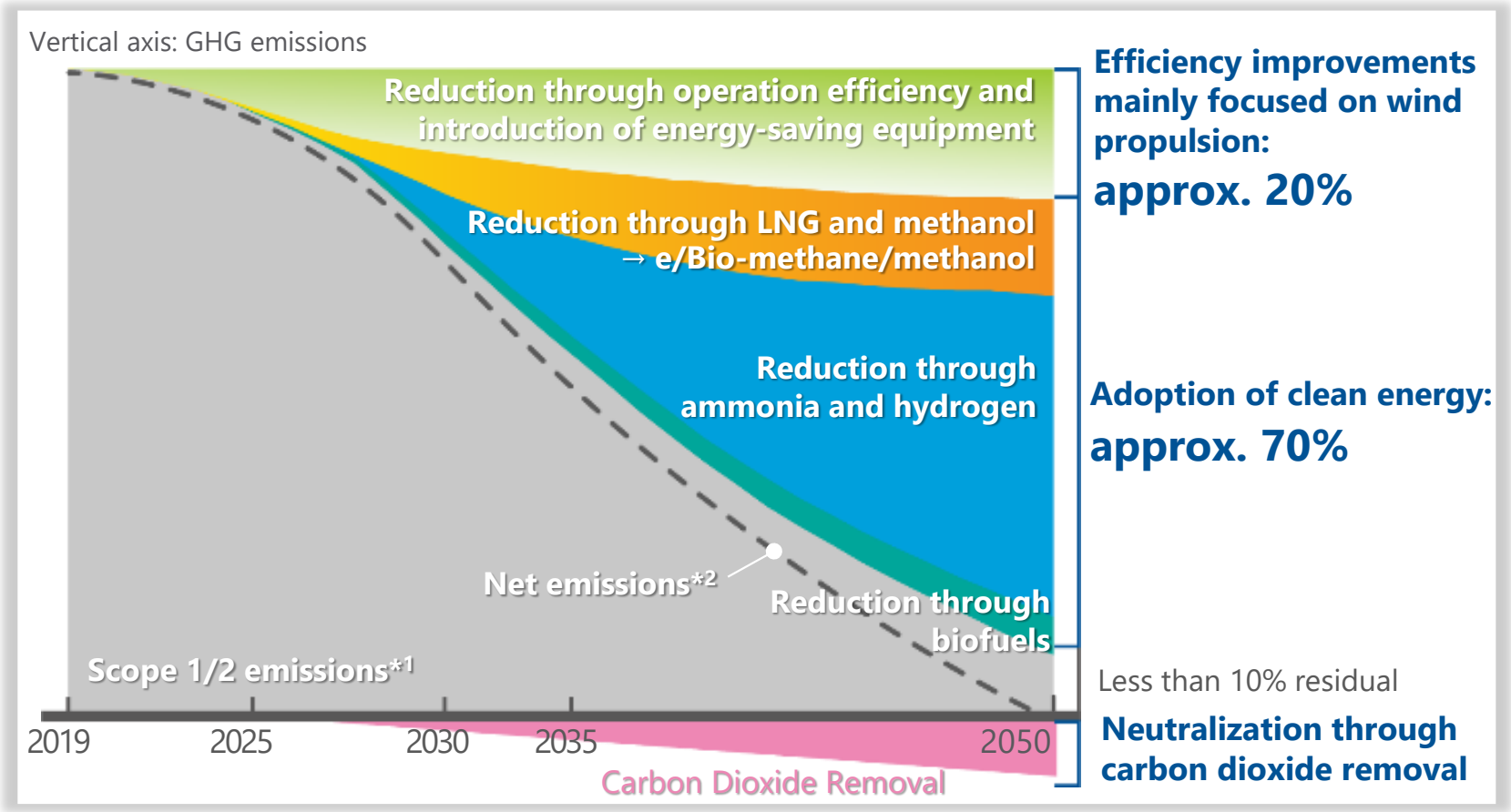


Gray line: Estimated curve under current CO2 emissions
Green line: 1.5 °C global carbon budget

Reference：“Mind the Gap”, Energy Transition Commission, 2022

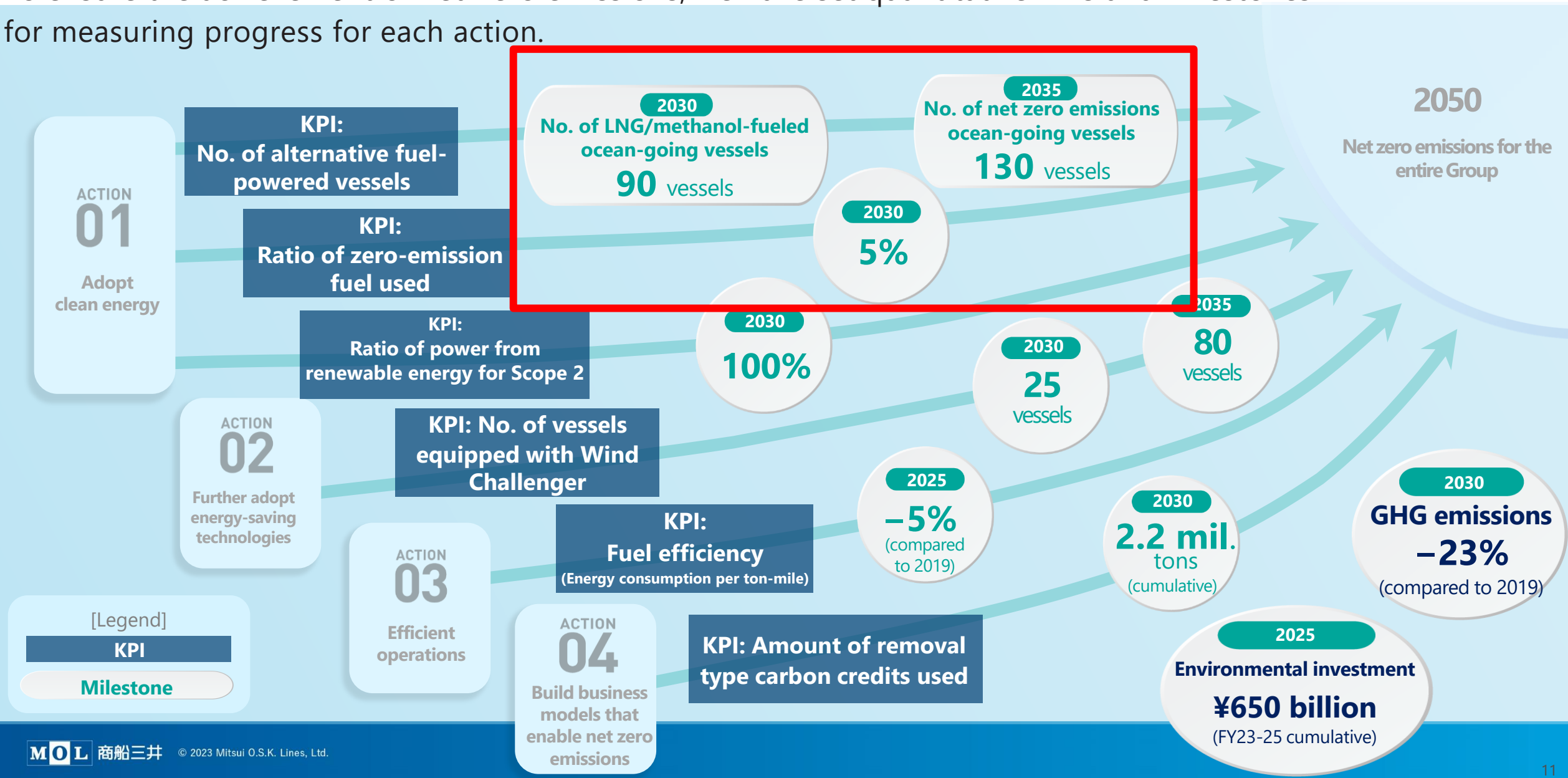
Clarifying the “Pathway to Net Zero Emissions”

The “Pathway to Net Zero Emissions” specifically shows reduction pathways for achieving net zero by 2050.
This time, we enhanced the resolution to visualize the degree of contribution of each action.
By doing so, we present the transition plan for the MOL Group to achieve net zero more clearly .



Establishing KPI & Milestones

To ensure the achievement of net-zero emissions, we have set quantitative KPIs and milestones for measuring progress for each action.



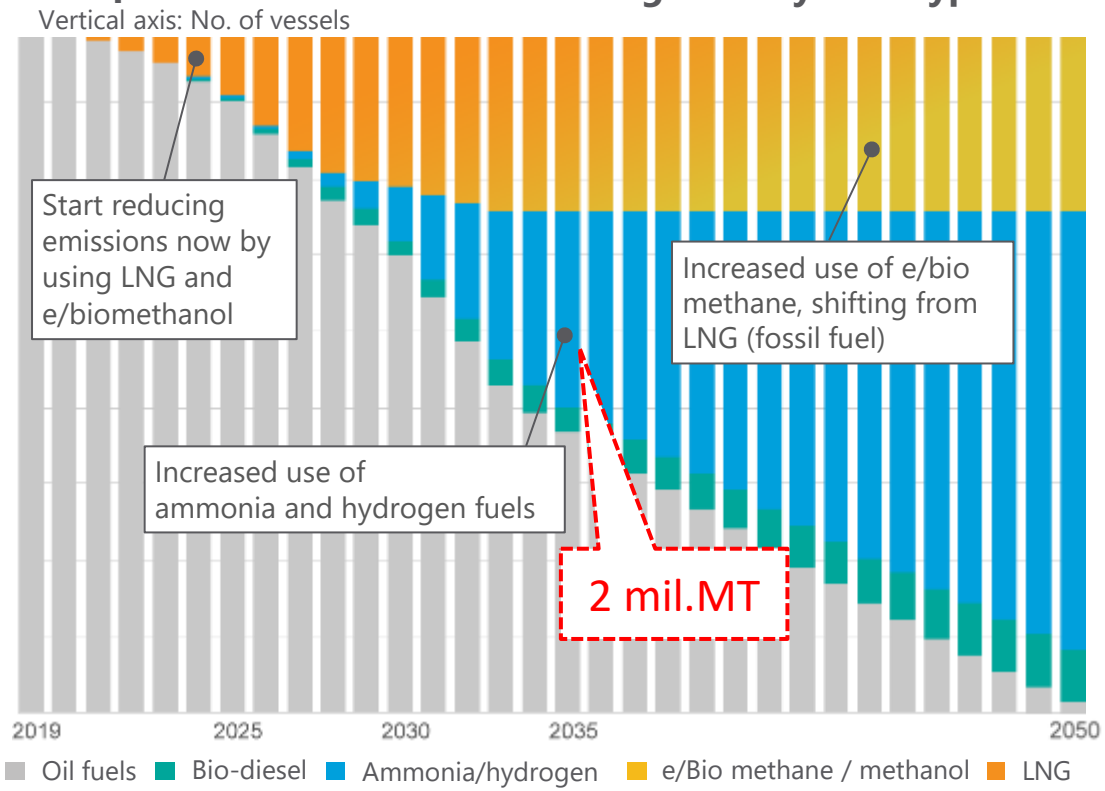
Adopt Clean Energy

- We will phase out the usage of heavy oil, which is highly carbon-intensive, and shift to low-carbon and decarbonized fuels.
- Based on the premise that the optimal fuel differs depending on the type of vessel and shipping route, we have begun considering adopting a variety of fuels.
- In addition to preparing alternative fuel-powered vessels, we will take measures to procure clean-energy fuels.

Introduction of alternative fuels
Milestones

- **2030 Ratio of zero-emission fuel used: 5%**
- **2030 No. of LNG/methanol-fueled ocean-going vessels: 90**
- **2035 No. of net zero emissions ocean-going vessels: 130**

Composition of MOL's Ocean-Going Fleet by Fuel Type

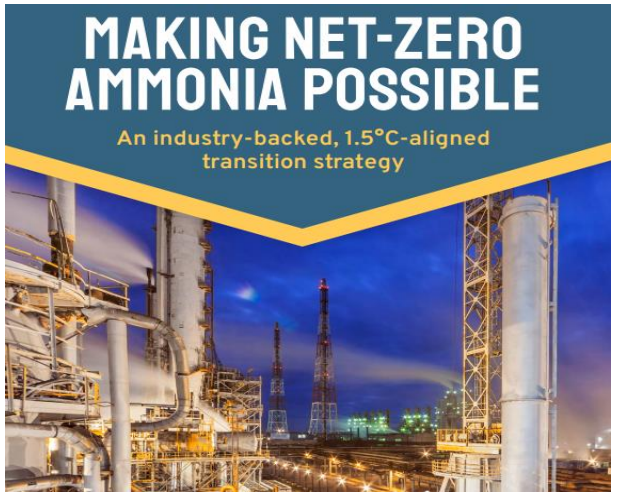


Leads strategic energy transition showing demand signal
- with international initiative & Partners -

MOL joined First Movers Coalition's Shipping Sector as the First Japanese Company Jan. 2023.

Ocean shipping companies participating in the sector have committed to use zero-emission fuels for at least 5% of their deep-sea shipping by 2030.

First Movers Coalition



MISSION POSSIBLE PARTNERSHIP

Global Centre for MARITIME DECARBONISATION

https://www.mol.co.jp/en/pr/2023/23008.html

Ammonia Energy Conference 2022

In the 19th Ammonia Energy Conference 2022 organized by the Ammonia Energy Association (Note 1), at which MOL Executive Officer Tomoaki Ichida delivered the keynote speech on its clean alternative fuel strategy and participated in a panel discussion on the establishment of a clean ammonia supply chain, discussing the importance of collaboration and specific actions among stakeholders.

MOL Executive Officer Ichida delivered the keynote speech

Use of Wind Power for shipping

- A wind propulsion device developed by MOL
- First vessel to start operation in the fall of 2022
- We expect the first vessel to cut emissions by 5 to 8%

Wind power utilization
Milestone

No. of vessels equipped with Wind Challenger
2030: 25 vessels
2035: 80 vessels

WIND CHALLENGER
Innovative Sails for a Sustainable Future

2022	2024	2025	**2030**	**2035**	2050
First vessel	Second vessel	3 vessels	**25 vessels**	**80 vessels**	**Entering a New Stage of Wind Power Utilization**
			Annual production of 10 units		

Initiative for Carbon dioxide removal

Nature-based Solutions

By supporting projects such as forest and mangrove restoration, we will contribute not only to decarbonization but also to other co-benefits, such as the protection of biodiversity and the improvement of livelihood of local communities.

Mangrove Restoration & Conservation Project

Since January 2022, we have been participating in a blue carbon project aimed at restoring and conserving mangroves in South Sumatra, Indonesia. The project aims to reduce CO2 emissions by about 5 million tons through forest conservation activities and to absorb/store another 6 million tons of CO2 through afforestation of mangroves and other plants on about 9,500ha of bare land in the next three decades.

Technology-based Solutions

By engaging with CO2 removal technology projects now, we will contribute to innovation and cost reduction of underfunded elements of nascent technologies.

Effort to scale up and catalyze the market

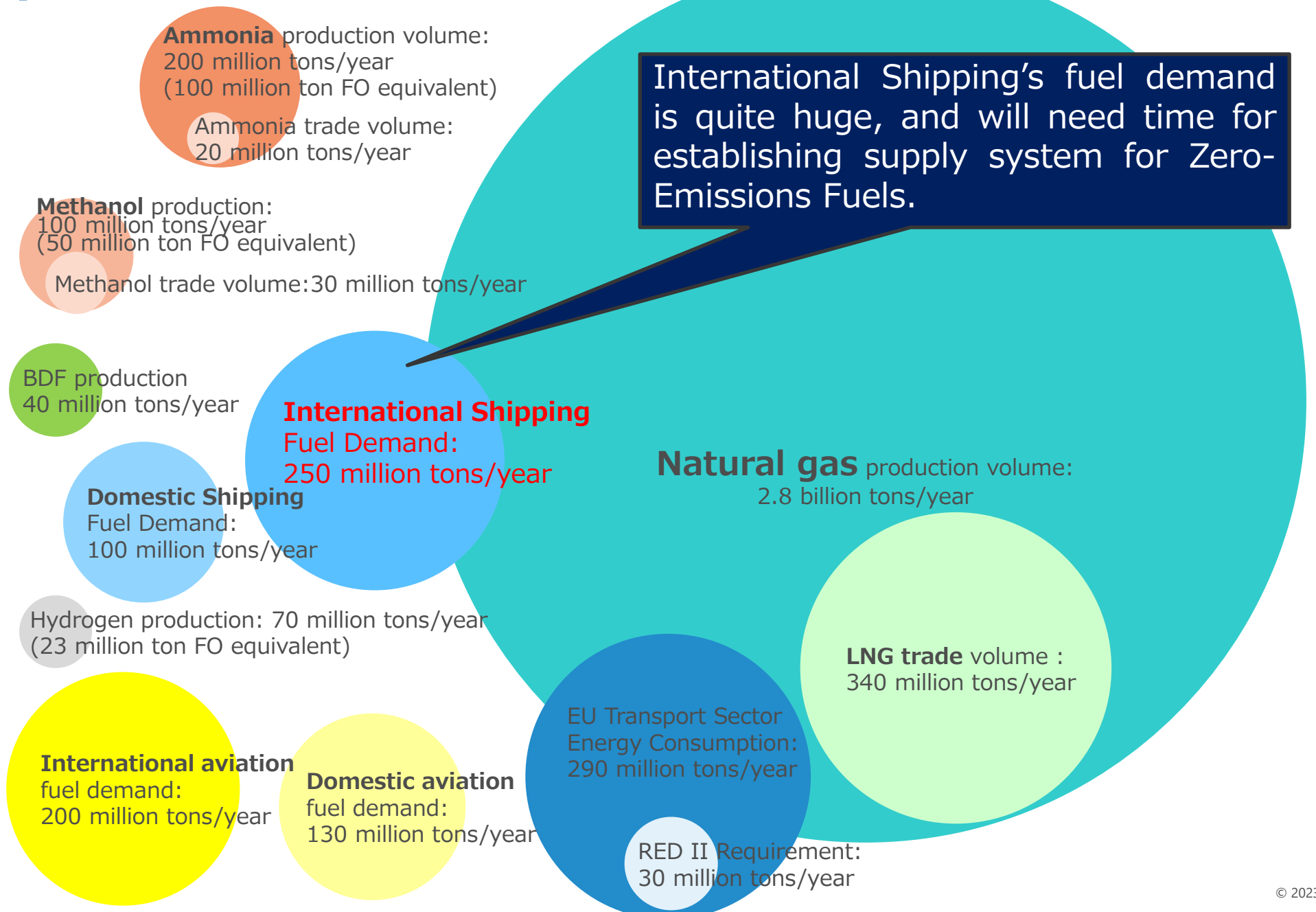
In May 2022, we participated in the NextGen CDR Facility, which aims to proliferate and promote carbon removal technologies, as a founding buyer. We are committed to purchasing at least 50,000 tons of CO2 removals utilizing CDR technologies by 2030.

2. MOL’s strategies for ammonia

Key challenges for each alternative fuel candidate

		Leverage existing infrastructure	demand sectors other than shipping for blue and green	LCA evaluation of GHG reduction (Ratio of reduction to VLSFO)
LNG	**(Fossils)**	You need only LNGBV	Japanese Gas Providers and some oil major companies	▼17%
	synthetic methane			With zero emis on the ocean side discussion ongoing
	biomethane			Depending on the source of supply ZERO OR NEGATIVE
Ammonia	**(Fossils)**	Need to develop production and supply infrastructure	Actual demand for co-firing of coal-fired power plants in Japan and South Korea. Europe also to import ammonia as H2 carrier Many development projects	GHG Emissions Increase in comparison to VLSFO
	Green/Blue Ammonia			Zero Emissions
Methanol	**(Fossils)**	Need to develop production and supply infrastructure	Demand for decarbonization in the chemical industry is weak, but some development Project exists	GHG Emissions Increase in comparison to VLSFO
	synthesis Methanol			Same with synthetic methane
	Bio Methanol			Same with biomethane

Scale of production demand for “fuel” @ 2019



Adding value to supply chains - Hydrogen / NH3 -

- Upstream -

MOL

- Downstream -

Green H2/NH3

Renewable energy

Electrolysis

Natural Gas

Reforming

Producing Ammonia

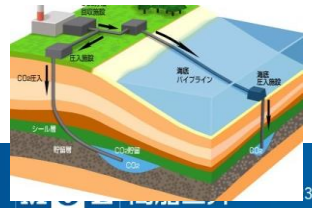
Storage

CCS

LCO2 Transportation

Blue H2/NH3

CCS (Carbon dioxide Capture and Storage)



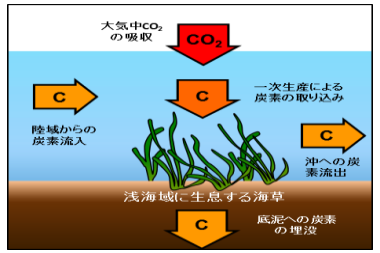
LCO2 Carrier

H2/NH3 Carrier

H2/NH3 Powership

H2/NH3 FSRU

Blue Carbon



Power Plant

NH3 Cape-Size Bulker

NH3BV

Carbon Business

Transportation and utilization of NH3 as fuel

MoU to buy NH3-burning Main Engine (Oct 2022)

https://www.mol.co.jp/en/pr/2021/21089.html

- **MAN Energy Solutions, Mitsui E&S Machinery and MOL** signed an MoU for the purchase of the state-of-the-art ammonia-burning main engine (ME-LGIA)
- Delivery is expected to be made in **2025,** subject to the development progress of the engine
- Started **joint development with TSUNEISHI SHIPBUILDING and MITSUI E&S SHIPBUILDING** for the construction of an ocean-going liquefied gas carrier fueled by ammonia this June.

Design Development of "J-Flex" NH3 Carrier (Nov 2021)

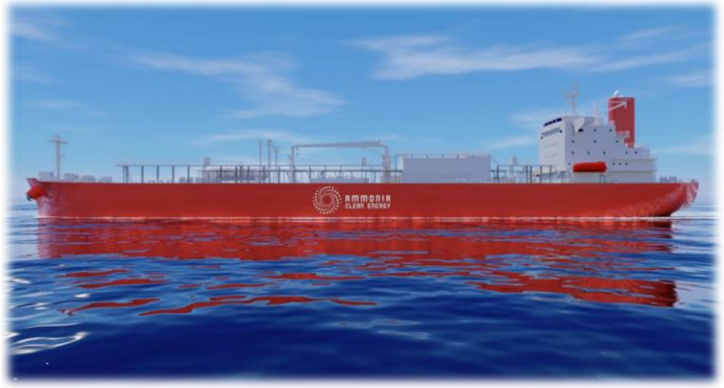
https://www.mol.co.jp/en/pr/2021/21098.html

- MOL, **Mitsubishi Shipbuilding(MSB) and Namura Shipbuilding** agreed to design the large-scale ammonia carrier ("J-Flex"), which should have larger capacity than conventional VLGCs.
- The optimum design for coal fired plants in Japan to achieve lower unit freight cost
- The ships designed to run on ammonia fuel, with energy saving devices for greener shipping

Concept Study of NH3 FSRU (Feb 2022)

https://www.mol.co.jp/en/pr/2022/22015.html

- MOL/MSB to develop the **large scale (VLGC+α) ammonia FSRU**, and already completed the initial concept study.
- **MOL/MSB signed an MoU with Kansai Electric** to aim to deploy the FSRU.



MOL Teams up with JERA to Study Transport of Ammonia Fuel

https://www.mol.co.jp/en/pr/2022/22131.html

MOL and JERA Co., Ltd. (JERA) have signed a memorandum of understanding (MoU) to launch a study of transporting ammonia for use as fuel, including shipments to JERA's Hekinan Power Station in Aichi Prefecture, which is slated to start commercial operation in the late 2020s.

Outline of Study

- Developing fuel-ammonia carriers suitable for domestic thermal power plants and receiving stations
- Building a fuel ammonia transportation and receiving systems
- Installing and operating propulsion engines that use ammonia as ship fuel
- Working with related parties to foster the formation of rules related to the reception of fuel

Design of a large NH3-powered bulk carrier

https://www.mol.co.jp/en/pr/2023/23007.html

Outline of Study

- Jointly determined the size and specifications of the vessel with co-operation of Mitsubishi Shipbuilding Co., Ltd. for design of the vessel
- Obtained “Approval in Principle” from NK, in Jan 2023
- The AiP covers a "210,000 DWT Cape size" bulker, a highly versatile class of ship
- Feature two ammonia fuel tanks on deck to maximize the cruising range for various routes and to make the most effective use of cargo space

Joint Study of NH3 Marine Fuel S/C in Singapore

https://www.mol.co.jp/en/pr/2021/21041.html

Outline of Study

- Physical supply of NH3 to merchant ships in Singapore
- MOL takes the lead in NH3BV, floating storage facility, safety guideline and operation manual
- Teaming up with Pavilion/Total (the main partners in LNGBV project)
- Obtained "Approval in Principle" from ABS, in Jan 2022

Constructing Supply Chains for Clean Ammonia

Investment in Clean Hydrogen-Ammonia Production in Louisiana (Jun 2023)

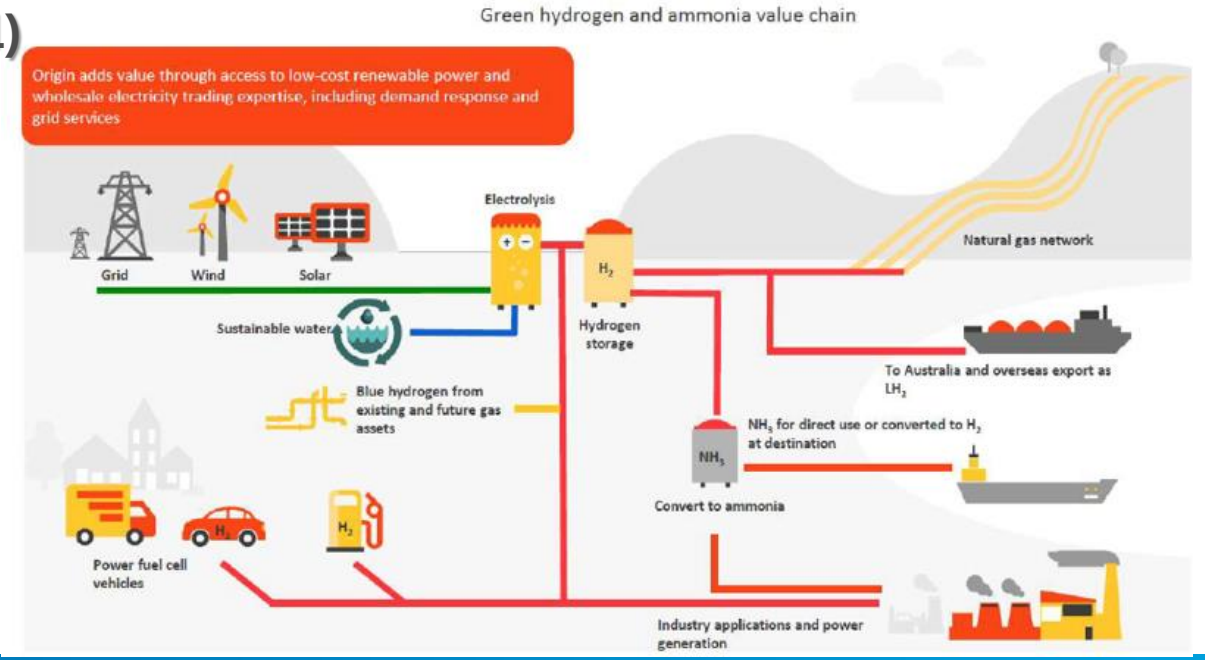
https://www.mol.co.jp/en/pr/2023/23080.html

- Strategic investment in clean hydrogen-ammonia production and export facility in Ascension Parish, Louisiana, with Clean Hydrogen Works
- MOL is well-positioned to help develop safe, sustainable, and efficient solutions to ship its clean hydrogen-ammonia to emerging clean energy markets across the globe.

MoU for Green NH3 Supply Chain in Tasmania (Aug 2021)

https://www.mol.co.jp/en/pr/2021/21069.html

- F/S of a supply chain, with an Australian energy major Origin Energy
- Green ammonia to be produced at Bell Bay, Tasmania (OE is on another technical F/S)
- MOL to be responsible for marine transportation (including study of NH3 propulsion), plus demand research in East Asia



Thank you for your attention !