

Symposium on alternative low-carbon and zero-carbon fuels

Expectations from a shipowner on using ammonia as marine fuel for zero-emission ships

February 9th, 2021

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- 1 Company introduction
- 2 GHG reduction strategy in the shipping industry
- 3 Projects of ammonia fuel
- 4 Challenges to realize ammonia fueled vessel

CHAPTER 1

▶ Company Introduction

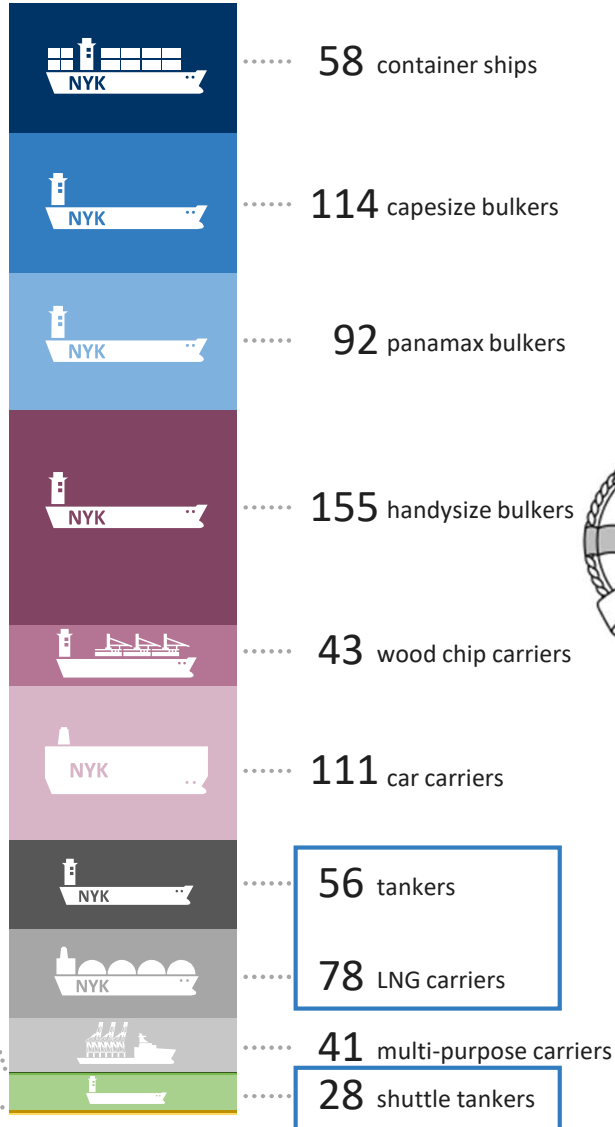
NYK Group Fleet and Facility



Vessel



784 vessels



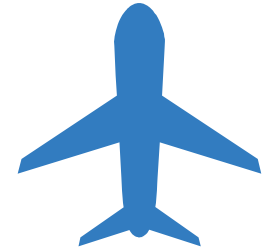
Energy Division



*For the year ended March 31, 2020

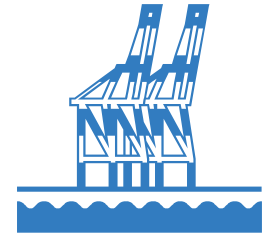
Air Freighter

8 aircrafts
5,227 flights in 2020



Terminal

Operating at
21 ports in 2020



Logistics Center

609 locations
3.1 million m²



*As of March 31, 2020

“Staying Ahead 2022 with Digitalization and Green”



Promoting “Green Business” to Drive Future Growth and Create New Value as a Shipping Company

Hydrogen/Ammonia



Offshore wind power



LNG bunkering



CHAPTER 2

▶ GHG Reduction Strategy in the Shipping Industry

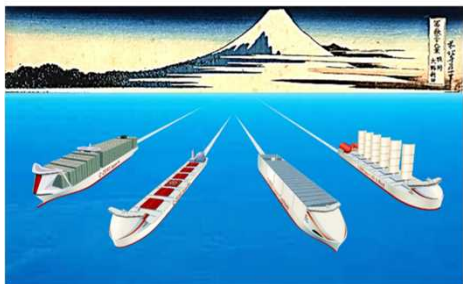
Roadmap for Zero Emission of International Shipping by MLIT ①



Introduction of H2 and NH3 is a key to CO2 reduction.



Roadmap to Zero Emission from International Shipping



(March 2020)

Japanese maritime industry worked together with Ministry of Land, Infrastructure, Transport and Tourism

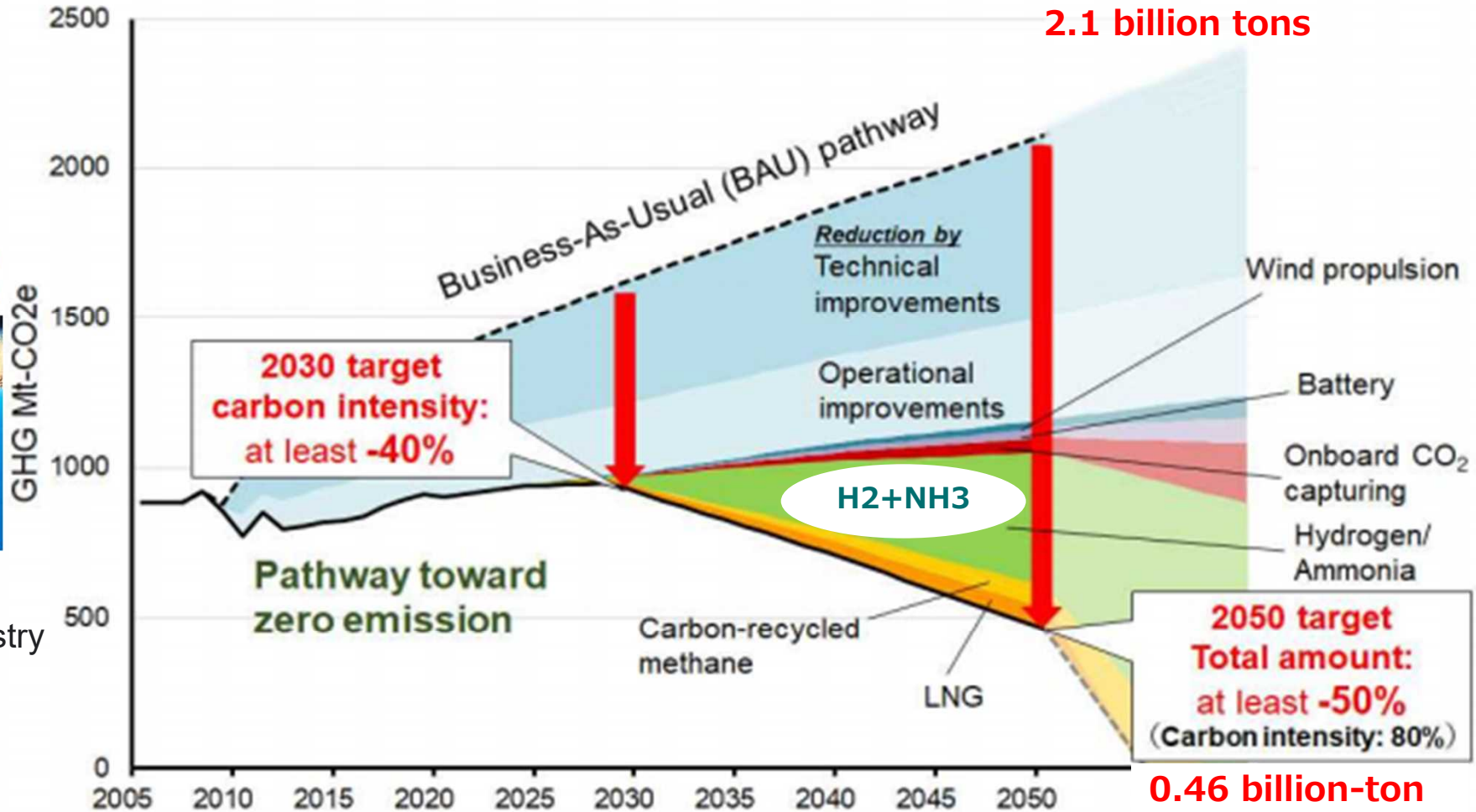


Figure 4.3.2-5: Trends in GHG Emissions and Reduction (Emission Pathway II: the Expansion of Hydrogen and/or Ammonia Fuels)

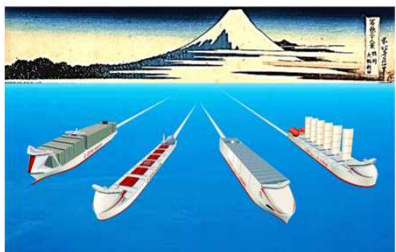
Roadmap for Zero Emission of International Shipping by MLIT ②



Expected scenario of hydrogen and ammonia introduced toward 2050



Roadmap to Zero Emission from International Shipping



(March 2020)

Japanese maritime industry worked together with Ministry of Land, Infrastructure, Transport and Tourism

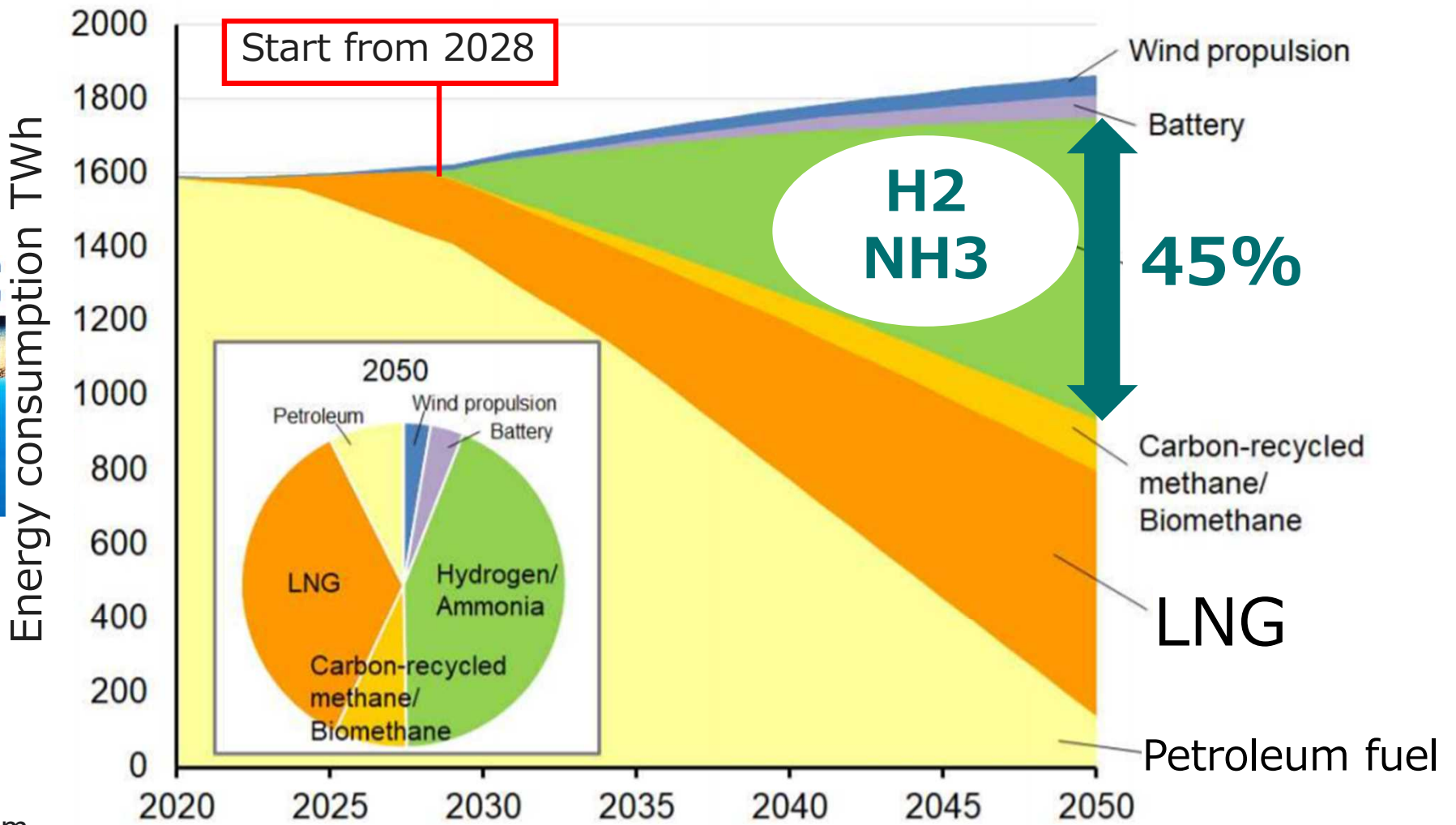


Figure 4.3.2-6: Energy Consumption by Fuel

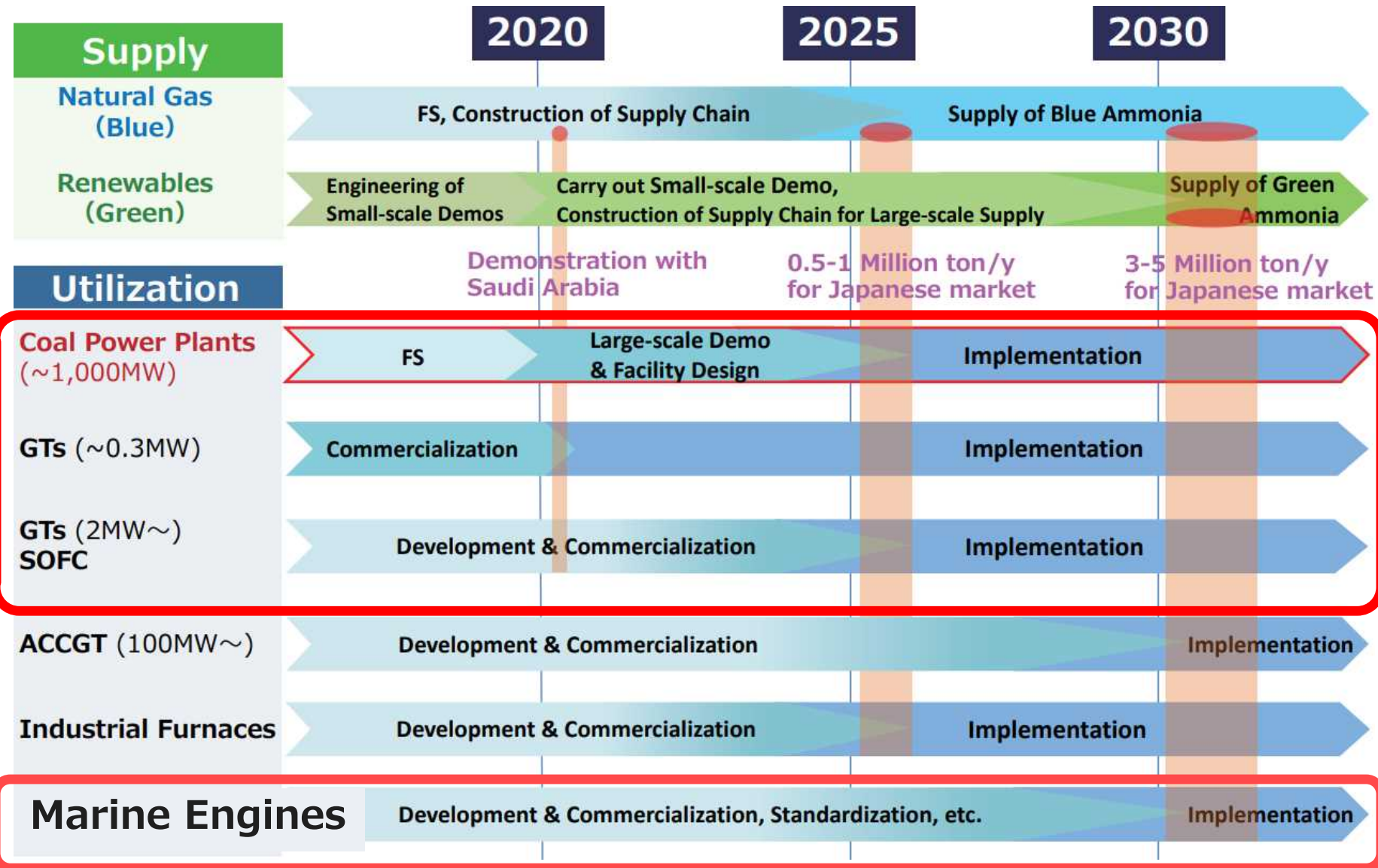
(Emission Pathway II: the Expansion of Hydrogen and/or Ammonia Fuels)

IMO Symposium (Feb 9th 2021)

Roadmap of Ammonia Supply Chain by CFAA



Clean Fuel Ammonia Association in Oct 2020

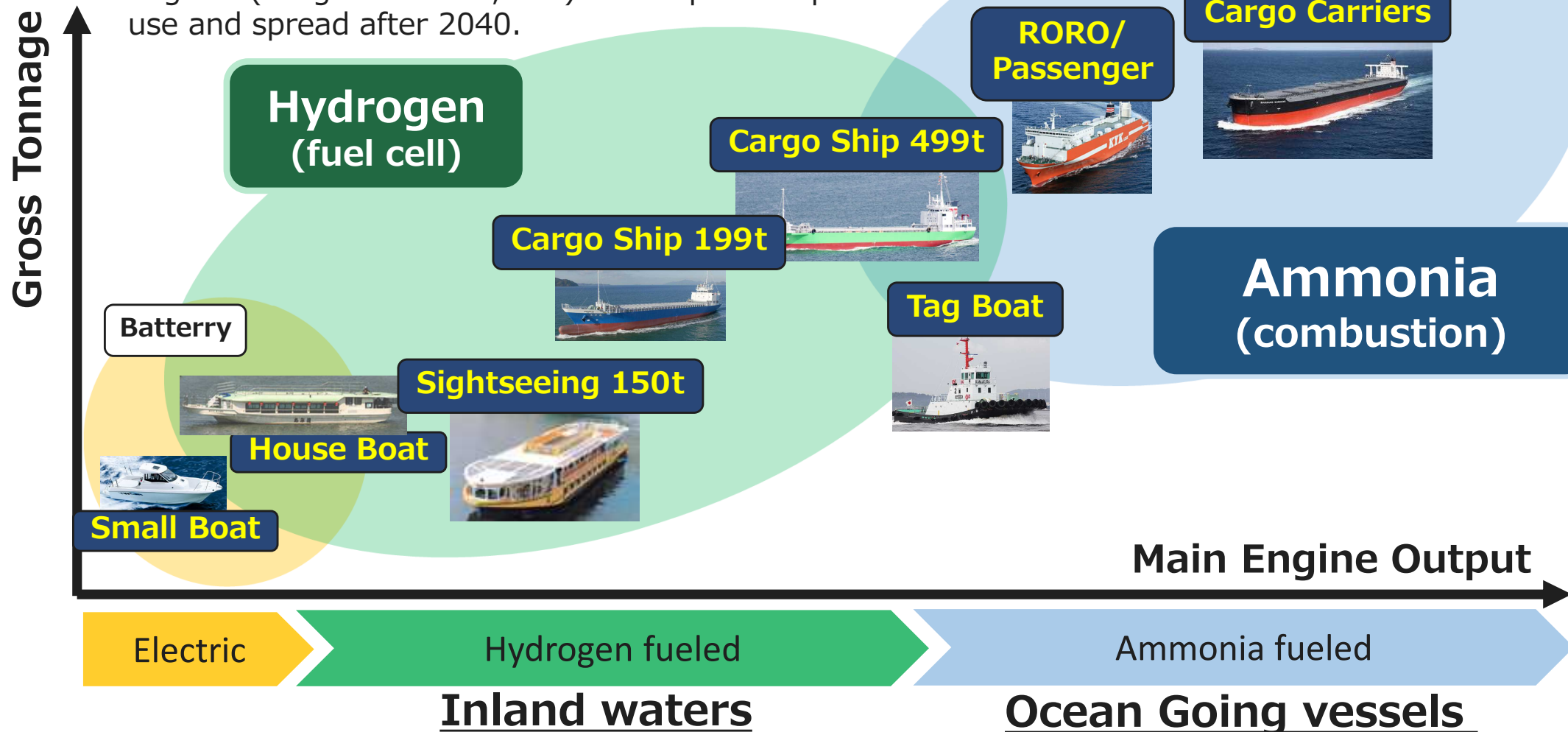


NYK's forecast for hydrogen and ammonia in 2030s



Due to engine output size, ammonia combustion is expected to be suitable for ocean going vessels

NYK predicts that liquefied hydrogen fuel combustion engines (H2 gas turbines, etc.) will be put into practical use and spread after 2040.



CHAPTER 3

▶ Projects of Ammonia Fuel

Joint R&D for Use of CO2-free Ammonia as Fuel



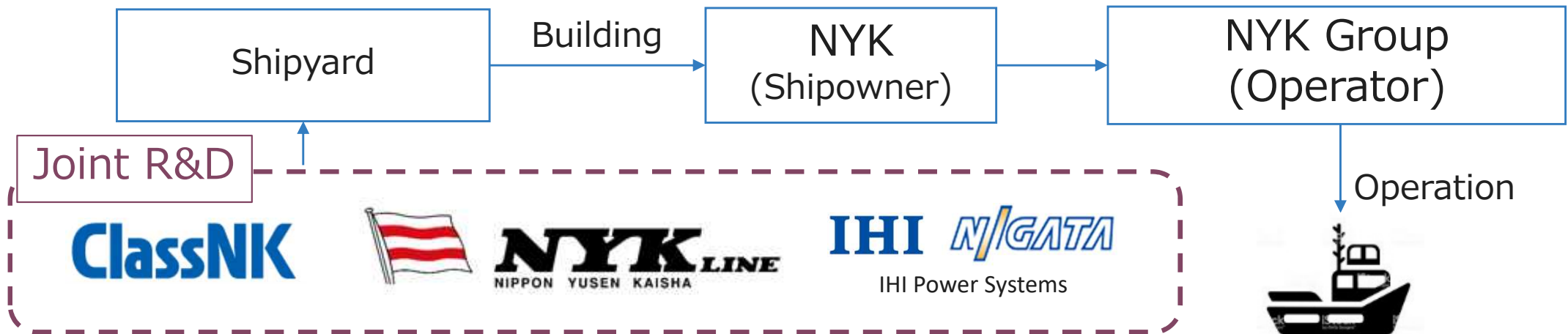
NYK started three joint R&D projects from Aug 2020 for use of CO2-free ammonia as an alternative fuel for vessels.

| Project | Partner | Image |
|---|---|---|
| <p>A-Tug (<u>Ammonia-fueled Tug</u>)</p> | <p>IHI N/GATA IHI Power Systems ClassNK</p> |  |
| <p>AFAGC (<u>Ammonia-fueled Ammonia Gas Carrier</u>)</p> | <p> NIHON SHIPYARD</p> |  |
| <p>A-FSRB (<u>Ammonia Floating Storage Regasification Barge</u>)</p> | <p>ClassNK</p> |  |

Joint R&D > Ammonia fueled tugboat



Joint R&D project to put the ammonia fueled tugboat into practical use



LNG fueled tugboat "Sakigake" built in 2015



SOx Reduction 100%
NOx Reduction approximately 80%
CO2 Reduction approximately 30% (※Compared to heavy oil)

Ammonia fueled tugboat



(image)

Joint R&D > Use of Ammonia in Marine Transportation



Supply Chain of CO2-Free ammonia



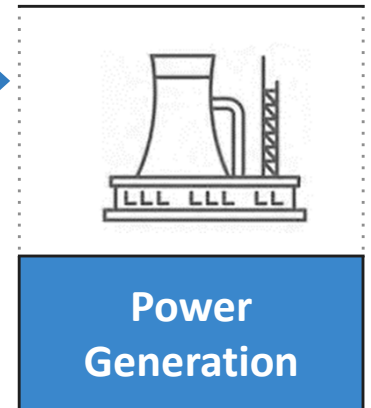
AFAGC

Ammonia-Fueled Ammonia Gas Carrier



A-FSRB

Ammonia Floating Storage and Regasification Barge



Stable supply chain of ammonia fuel

AFAGC: Contribute to the early realization of zero emissions for oceangoing vessels

A-FSBR: Contribute to the early introduction of ammonia fuel as an alternative to land facilities

CHAPTER 4

► Challenges to realize ammonia fueled vessel

Challenges of ammonia fueled vessel

- To use ammonia as marine fuel, both technical and commercial challenges need to be overcome.

Technical Challenges

Pilot fuels

NOx

Generator

Commercial Challenges

Fuel cost

Fuel storage

Fuel Supply chain

Safety

- Working with various partners including other sectors is necessary to solve the challenges.

Power generation fuel



METI

Ministry of Economy, Trade and Industry

(2020s~)

Marine fuel



MLIT

Ministry of Land, Infrastructure, Transport and Tourism

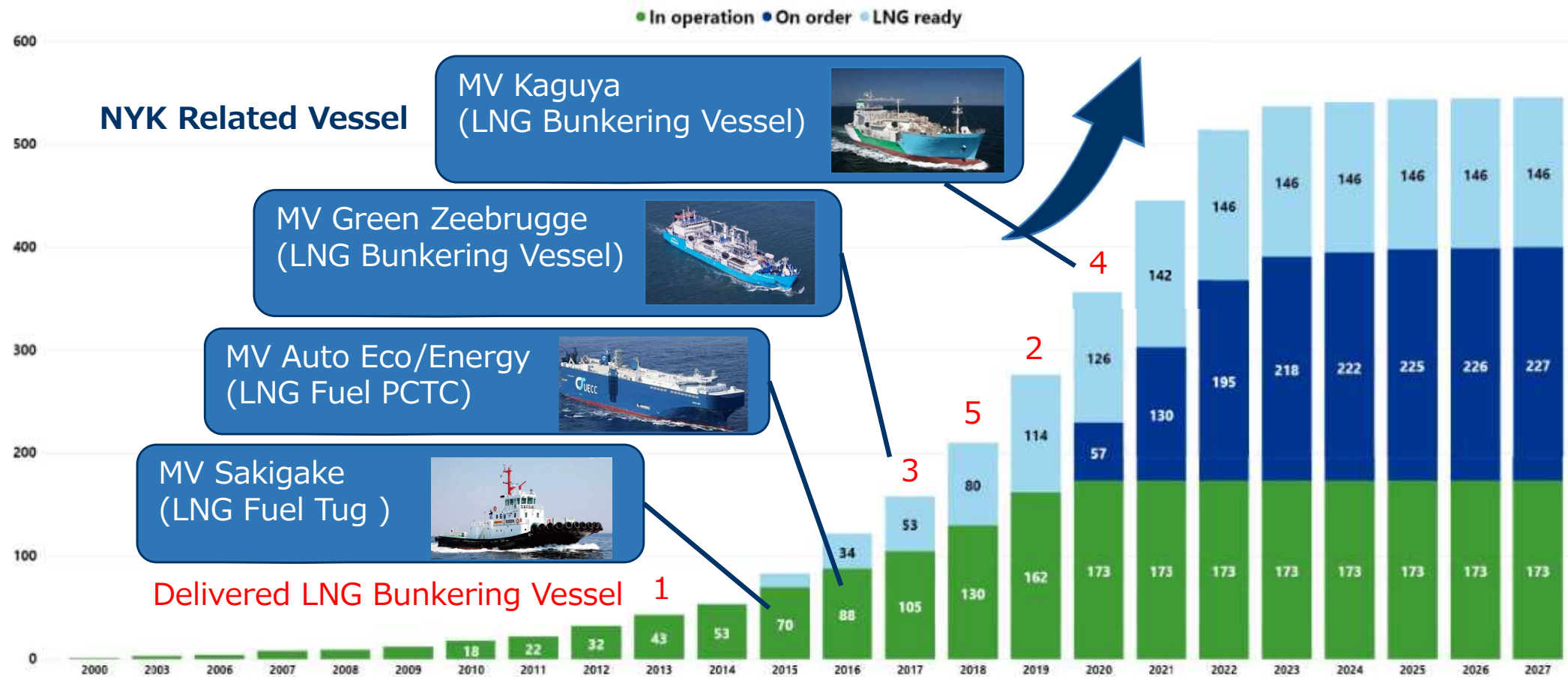
(2028~)

LFV vs LBV "Chicken & Egg" Situation finished

It takes a long time to finish "chicken & egg" situation when introducing a new type of marine fuel.

<Example: LNG as marine fuel>

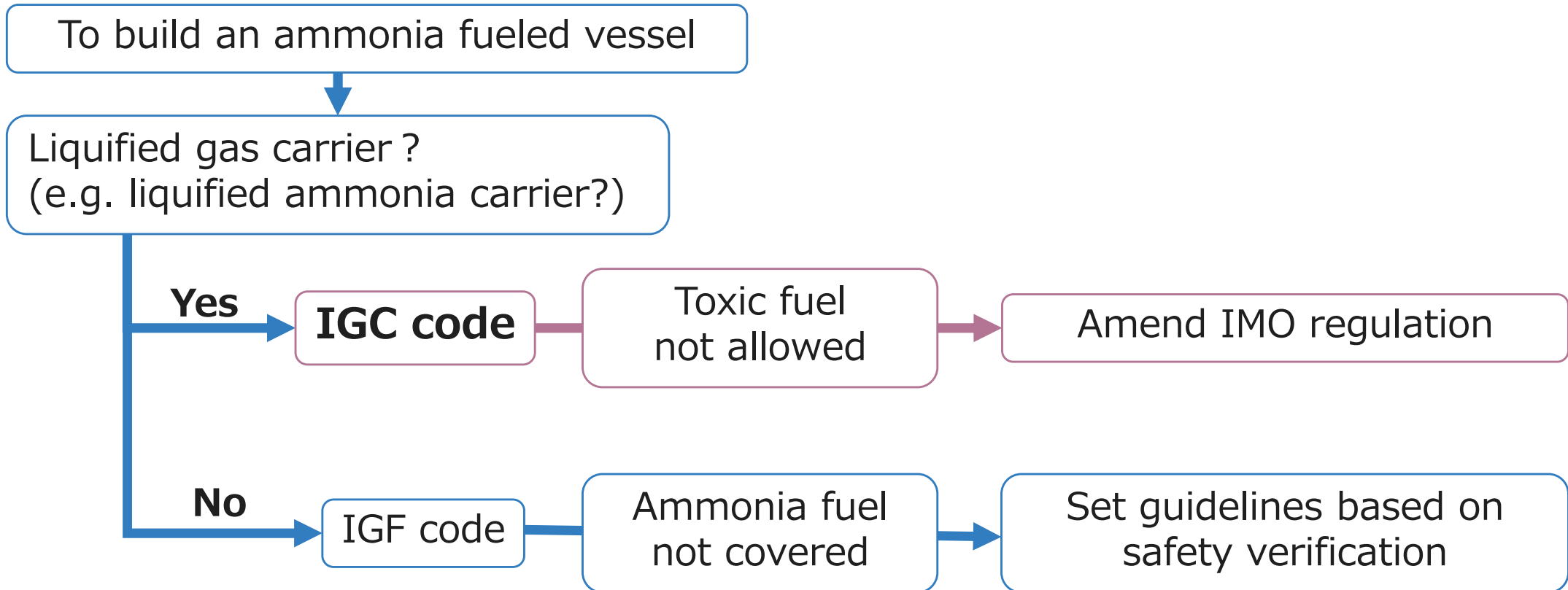
[LNG Fueled Vessels (LFV) (excluding LNG carriers) & LNG Bunkering Vessels (LBV)]



Showing delivery year of existing orders only. Future contracts will increase the number of LNG fuelled ships delivered in 2022 and onwards.

Chart of safety standards for ammonia fuel

How can we establish safety requirements for toxic and corrosive ammonia fuel?



Different types of ship need different actions.

IGC Code

The International Code of the Construction and Equipment of Ships Carrying Liquefied Gases in Bulk

- This standard is for the safe carriage by sea in bulk of liquefied gases to minimize **the risk to the ship, to its crew and to the environment.**
- Liquefied gas carriers are not allowed to use toxic fuels. (including ammonia fuel)

IGF Code

The International Code of Safety for Ship Using Gasses or Other Low-flashpoint Fuels

- This standard is for the safe use of gas fuels.
- The current standard mainly covers LNG fuel. (not including ammonia)

There is already a new movement to optimize these standards for the use of next-generation marine fuels.

Contribution to GHG Reduction in International Shipping



IMO ACTION TO
**REDUCE GREENHOUSE
GAS EMISSIONS** FROM
INTERNATIONAL SHIPPING

Contribution to the realization of GHG reduction targets
through technical development of the Japan Maritime Cluster



Multi-country approval based on alternative design

Other countries where ships call



免責事項

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