ClassNK Alternative Fuels Insight

Version 3.3
July 2026

Issuance of ClassNK Alternative Fuels Insight

- Amidst the pressing need for society-wide reduction of GHG emissions, GHG emission regulations in international shipping, spearheaded by organizations like the IMO and the EU, are further strengthened. Consequently, we are entering an era where **GHG emissions from ships become a cost factor**. In such a business environment, strategically reducing GHG emissions from ships is crucial. This necessitates not only further energy efficiency improvements but also the essential adoption of alternative fuels with lower environmental impacts.
- On the other hand, there is a wide range of alternative fuels available for use in ships. When adopting alternative fuels, it is crucial to **select the appropriate fuel** based on factors such as the ship type, size, and route. Therefore, it is essential to not only consider technical aspects but also to grasp the overall trend of alternative fuels, including factors such as fuel availability and cost projections.
- The "**ClassNK Alternative Fuels Insight**," issued by ClassNK, aims to support your future fuel selection. We hope that the ClassNK Alternative Fuels Insight will be a helpful resource in your efforts to reduce GHG emissions.

Four Steps for Introducing Alternative Fuels

Step 1 Understanding regulations → **Step 2** Understanding trends → **Step 3** Understanding alternative fuels → **Step 4** Understanding costs

A Snapshot of the Current State of Energy Transition in International Shipping

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Demand side

In service:

41,028 ships*1

Conventional fuel ships
39,038 ships
(95%)

Alternative fuel ships*2
1,990 ships
(5%)

A transition of 39,038 ships to alternative fuels is necessary. (Alternative fuel ships can use zero-emission fuels.)

*1 5,000 gross tonnage and above (as of the end of June 2026)
*2 LNG-fueled LNG carriers are included.

Fuel consumption:

230 mil. tons/year*3

Conventional fuel oil
210 mil. tons
(91%)

Alternative fuel
20 mil. tons*4
(9%)

The required amount for a full transition to zero-emission fuels would be...

For methanol	460 mil. tons/year
For ammonia	490 mil. tons/year
For methane/LNG	190 mil. tons/year
For hydrogen	80 mil. tons/year

*3 The annual fuel consumption for ships engaged in international voyages with 5,000 gross tonnage and above (abt. 30,000 ships subject to IMO DCS) in 2024 (conventional fuel oil equivalent)
*4 Conventional fuel oil equivalent (of which 91% is LNG fuel.)

Supply side

Shipyards

Newbuildings:

1,500 ships/year*5

Conventional fuel ships
1,150 ships/y
(77%)

Alternative fuel ships
350 ships/y
(23%)

*5 5,000 gross tonnage and above (2025, adjusted for fractions)

Green fuel producers

- ✓ **Methanol** 3.4 mil. tons/year*6
- ✓ **Ammonia** 7.0 mil. tons/year*6
- ✓ **Methane** 0.01 mil. tons/year*6
- ✓ **Hydrogen** 1.3 mil. tons/year*6

*6 Operational, construction, FID (for all sectors)

Other sectors

- ✓ **Methanol**
  Chemical, etc.
- ✓ **Ammonia**
  Electricity, Agriculture, Chemical, etc.
- ✓ **Hydrogen**
  Electricity, Automobile, Steel, etc.

Much of the green fuels and green chemicals produced are expected to be directed towards demand from other sectors.

While biofuels contribute to GHG emission reductions, the availability of biomass feedstock is limited, leading to competition among sectors.

Correction / Revision Record - 1

Version	Date	Page	Details
1.0	2024.05	-	-
2.0	2024.09	Page 3	Updated figures
2.0	2024.09	Page 15 – Page 25	Updated with information as of June 30, 2024
2.0	2024.09	Page 29	Added explanation
2.0	2024.09	Page 38 – Page 40	Newly added (Result of CII ratings)
2.0	2024.09	Page 42	Updated figures, Added information on methane
2.0	2024.09	Page 43	Updated figures, Added information on methane
2.0	2024.09	Page 44	Newly added (Demand outlook for alternative fuels)
2.0	2024.09	Page 56 – Page 57	Newly added (Green methane production project)
2.0	2024.09	Page 59	Newly added (Steps from installation of onboard CCS systems to certification of captured CO_2 volume)
2.0	2024.09	Page 63	Newly added (GHG emissions assessment of biofuels)
2.0	2024.09	Page 64	Updated with the latest information
2.0	2024.09	Page 65	Updated with the latest information
2.0	2024.09	Page 73 – Page 77	Updated analysis with additional cost simulation example for ammonia-fueled ship
2.0	2024.09	Page 83 – Page 93	Newly added (Appendix)

Correction / Revision Record - 2

ClassNK

Version	Date	Page	Details
2.1	2024.11	Page 3	Updated figures
2.1	2024.11	Page 12	Updated with the latest information
2.1	2024.11	Page 42	Updated figures
2.1	2024.11	Page 46 – Page 57	Updated figures
2.1	2024.11	Page 58	Updated figures
2.1	2024.11	Page 64	Updated with the latest information
2.1	2024.11	Page 65	Updated with the latest information
2.2	2025.02	Page 3	Updated figures
2.2	2025.02	Page 15 – Page 25	Updated with information as of December 31, 2024
2.2	2025.02	Page 44	Updated figures
2.2	2025.02	Page 61	Newly added (Biofuel production)
2.2	2025.02	Page 63	Corrected information
2.2	2025.02	Page 64	Updated with the latest information
2.2	2025.02	Page 69	Updated figures
2.2	2025.02	Page 73 – Page 78	Updated figures

Correction / Revision Record - 3

Version	Date	Page	Details
3.0	2025.05	Page 10	Updated with the latest information
3.0	2025.05	Page 11	Updated with the latest information
3.0	2025.05	Page 13	Newly added (What is the IMO's Mid-term measures and how it works)
3.0	2025.05	Page 38	Updated with the latest information
3.0	2025.05	Page 42	Updated figures
3.0	2025.05	Page 66	Updated with the latest information
3.0	2025.05	Page 72 – Page 88	Updated with the latest information
3.1	2025.07	Page 3	Updated figures
3.1	2025.07	Page 14	Updated with the latest information
3.1	2025.07	Page 16 – Page 26	Updated with information as of June 30, 2025
3.1	2025.07	Page 66	Updated with the latest information
3.2	2026.01	Page 3	Updated figures
3.2	2026.01	Page 17 – Page 27	Updated with information as of December 31, 2025
3.2	2026.01	Page 35 – Page 36	Updated figures
3.2	2026.01	Page 40 – Page 42	Updated with the latest information

Correction / Revision Record - 4

ClassNK

Version	Date	Page	Details
3.2	2026.01	Page 44	Updated figures
3.2	2026.01	Page 45	Updated figures
3.2	2026.01	Page 46	Updated figures
3.2	2026.01	Page 48 – Page 59	Updated figures
3.2	2026.01	Page 60	Updated figures
3.2	2026.01	Page 63	Updated figures
3.2	2026.01	Page 66	Updated with the latest information
3.2	2026.01	Page 67	Updated with the latest information
3.2	2026.01	Page 71	Updated figures
3.2	2026.01	Page 74 – Page 83	Updated figures
3.3	2026.07	Page 3	Updated figures (Number of ships in service)
3.3	2026.07	Page 18 – Page 28	Updated with information as of June 30, 2026
3.3	2026.07	Page 32 – Page 35	Added ethanol
3.3	2026.07	Page 41 – Page 43	Updated with the latest information
3.3	2026.07	Page 64	Updated figures

Correction / Revision Record - 5

Version	Date	Page	Details
3.3	2026.07	Page 65	Newly added (Bioethanol production)
3.3	2026.07	Page 68	Updated with the latest information
3.3	2026.07	Page 69	Updated with the latest information

Table of Contents

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— Step 1

Understanding regulations

When considering the adoption of alternative fuels, understanding the GHG-related regulations that are expected to be strengthened in the future is crucial above all else. In this section, we will introduce the GHG-related regulations of the IMO and the EU, which will play a central role in GHG emission reduction measures in international shipping moving forward.

Key Takeaways

- ✓ Decarbonization is accelerating in international shipping, and new regulations are being introduced one after another to promote the use of zero- and low-emission fuels. These regulations are not mere recommendations; they are becoming critical rules that affect the very foundation of the shipping business.
- ✓ At the center of these regulations are the "Mid-Term Measures" currently under discussion at the IMO, as well as the "EU-ETS" and "FuelEU Maritime" introduced by the EU.
- ✓ As vessels adapt to these environmental regulations, the additional costs associated with compliance are steadily increasing. It is pointed out that future annual regulatory costs could significantly exceed fuel costs, posing a major risk to business management.
- ✓ Since the scope of applicable GHG emissions and the mechanisms for cost burdens differ for each regulation, a thorough understanding of each regulation is essential to minimize costs across the entire fleet.
- ✓ ClassNK ensures smooth compliance by clarifying complex and rapidly evolving regulations.

Step 1 - Understanding regulations

Carbon pricing

In order to further reduce GHG emissions from ships, successive regulations promoting the use of zero- and low-emission fuels are being introduced in international shipping. The IMO is continuously discussing a new regulatory framework for mid-term measures. In Europe, the European Union Emissions Trading System (EU-ETS), a carbon pricing mechanism, has been expanded to include the maritime sector since 2024. In 2025, FuelEU Maritime has been introduced to drive the decarbonization of shipping fuels. With these regulations in place, GHG emissions from ships will become a cost factor, making it crucial for the future of maritime business to strategically reduce GHG emissions from ships.

Introduction schedule of GHG-related regulations*

*Only operational GHG-related regulations are listed here.

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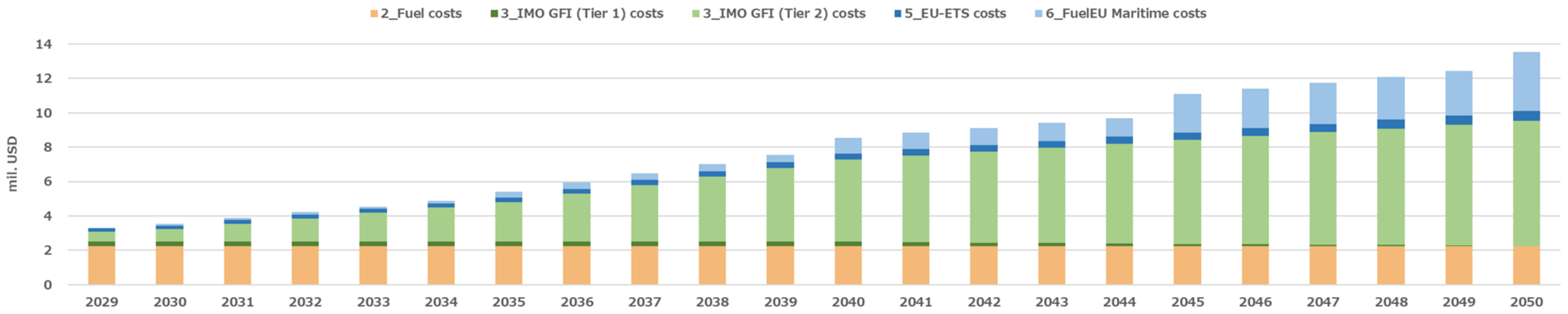
Increase in the cost of GHG emissions

The regulations set by the IMO and the EU are aimed at promoting the transition to zero- or low-emission fuels. Therefore, it is anticipated that the costs associated with regulatory compliance (GHG emission costs) will gradually increase. Understanding the extent to which GHG emission costs will affect the fleet in the future is the first step in considering the adoption of alternative fuels.

Image of increasing GHG emission costs (64,000DWT Bulk carrier: In the case of continued use of conventional fuel oil)



- The figure above illustrates the annual increase in GHG emission costs (annual costs) if a 64,000 DWT Bulk carrier continues to use conventional fuel oil.
- Depending on the specifics of the IMO's mid-term measures scheduled for implementation in 2028*, annual GHG emission costs could soon exceed fuel costs.

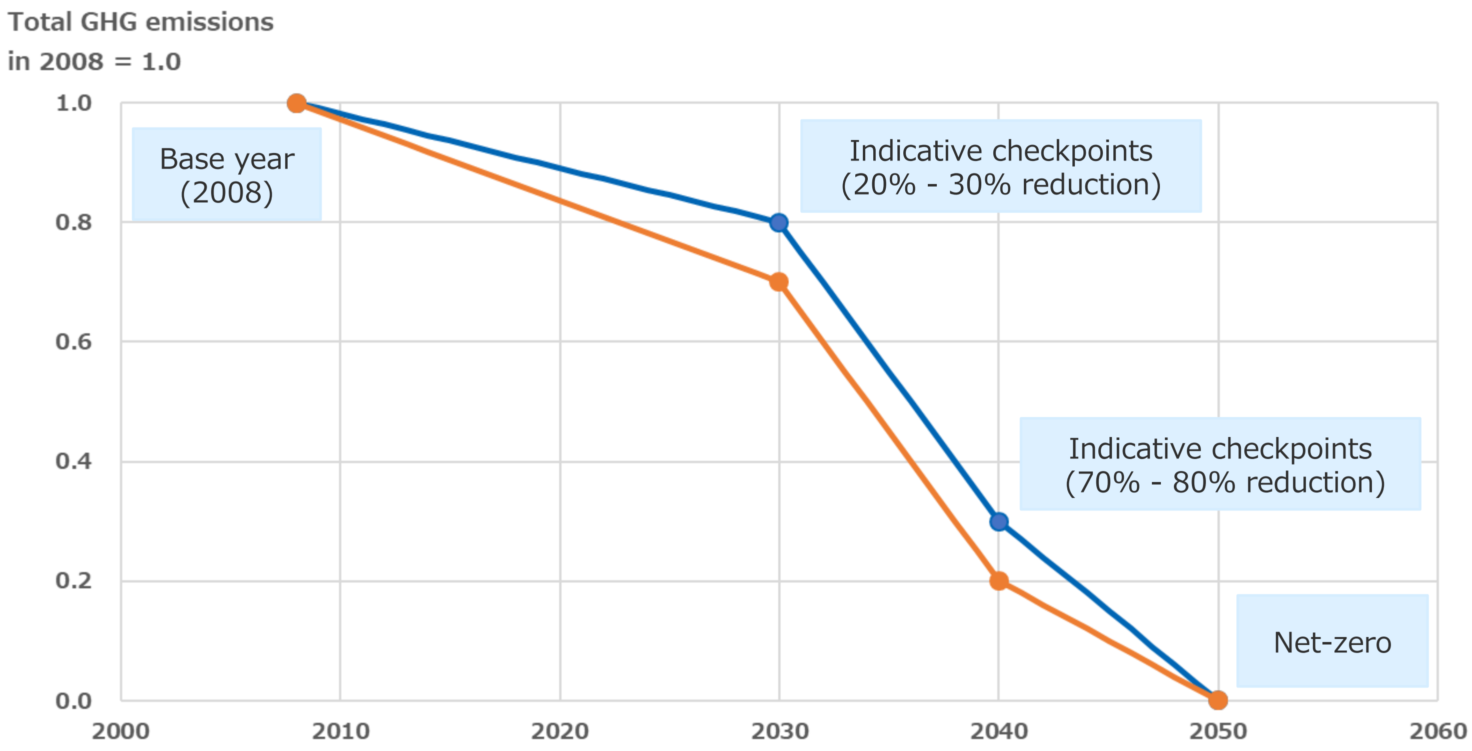
  ***The above figure shows the results of estimations based on the mid-term measures approved at the 83rd session of the IMO Marine Environment Protection Committee (MEPC 83).**
- Especially noteworthy is the difference between the EU regulations (EU-ETS and FuelEU Maritime), which only regulate GHG emissions from EU-related voyages, and the IMO regulations, which cover GHG emissions from all voyages. Consequently, the introduction of the IMO regulations (mid-term measures) is expected to have a significantly larger impact on the burden of GHG emission costs.

Detailed cost simulations are provided in Step 4. ➡

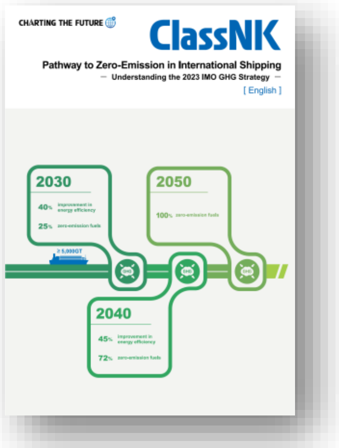
IMO GHG Strategy

In July 2023, the IMO revised its initial strategy on the reduction of GHG emissions from ships and adopted the "2023 IMO GHG Strategy," which includes the goal of achieving net-zero GHG emissions by or around 2050. Serving as the foundation for future discussions on reducing GHG emissions from international shipping, understanding this strategy is crucial for the shipping industry. ClassNK has published a white paper titled "Pathway to Zero-Emission in International Shipping - Understanding the 2023 IMO GHG Strategy -" to facilitate understanding of this strategy.

IMO GHG reduction goal



White Paper "Pathway to Zero-Emission in International Shipping - Understanding the 2023 IMO GHG Strategy -"



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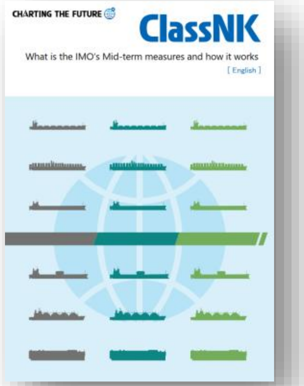
IMO mid-term measures

The IMO is continuously engaged in discussions to introduce new regulations (mid-term measures) aimed at promoting the use of zero- and low-emission fuels. These mid-term measures will have a significant impact on the maritime industry. ClassNK has published a document titled “What is the IMO’s Mid-term measures and how it works” that clearly outlines the key points of the mid-term measures.

A guidebook for understanding the IMO mid-term measures

What is the IMO’s Mid-term measures and how it works



(English)

What is the IMO’s Mid-term measures and how it works <Contents>	
0.	Introduction
1.	**2023 IMO GHG Reduction Strategy**
2.	**Overview of the Mid-term measures for GHG Reduction**
3.	**GHG intensity regulations for fuels used (GFI regulations)**
	3.1 Base Target and Direct Compliance Target for the GFI regulations
	3.2 Requirements for ships
	3.3 IMO GHG Registry
4.	**Promotion of decarbonization through the IMO Net-Zero Fund**
5.	**Timeline for GFI regulation compliance**
6.	**Next steps**
7.	**ClassNK support**
	7.1 ClassNK Transition Support Services
	7.2 ClassNK ZETA

Step 1 - Understanding regulations

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European regional regulations

In Europe, the implementation of the European Union Emissions Trading System (EU-ETS) in the maritime sector began in 2024, and FuelEU Maritime was introduced in 2025. When assigning ships to European routes, it is essential to accurately understand the contents of these regulations in order to minimize regulatory compliance costs as much as possible. ClassNK has issued "FAQs on the EU-ETS for Shipping" and "FAQs on the FuelEU Maritime," each explaining the overview of the regulations and the essential preparations for compliance in a Q&A format specific to European regional regulations.

FAQs to understand EU’s GHG-related regulations

FAQs on the EU-ETS for Shipping (Edition 3.0)

(English)

FAQs on the FuelEU Maritime (5th Edition)

(English)

— Step 2

Understanding trends

When considering the adoption of alternative fuels, it is important to understand the trends and future prospects of these options. Demand-side trends also influence the fuel supply-side. In this section, we will introduce the adoption trends of alternative fuels, including their utilization across different ship types and sizes.

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Key Takeaways

- ✓ ClassNK periodically publishes a summary of adoption trends for alternative-fuelled vessels.
- ✓ The analysis covers vessels of 5,000 gross tonnage and above. These vessels are subject to the IMO DCS and the CII, and will also fall under the scope of the IMO mid-term measures. In addition, LNG carriers are excluded from the analysis in order to present the adoption trends of alternative-fuelled vessels more clearly.
- ✓ **During the first half of 2026, the wait-and-see stance on adopting alternative-fuelled vessels became increasingly pronounced. Alternative-fuelled vessels accounted for 18.9% of the orderbook as of the end of June 2026, down from 20.8% at the end of December 2025.**
- ✓ **The breakdown of alternative-fuelled vessel orders was as follows: LNG-fuelled vessels accounted for 65%, LPG-fuelled vessels for 26%, methanol-fuelled vessels for 4%, ammonia-fuelled vessels for 3%, and hydrogen-fuelled vessels for 2%. Of particular note is the decline in methanol-fuelled vessels, whose share of orders fell sharply from 14% in the second half of 2025 to 4%.**
- ✓ **Looking at individual ship types, the share of alternative-fuelled vessels in the orderbook decreased for all ship types other than LPG carriers and vehicle carriers. The decline was most notable for containerships, with the share standing at 65.1% as of the end of June 2026, down from 71.7% at the end of December 2025.**

Step 2 - Understanding trends

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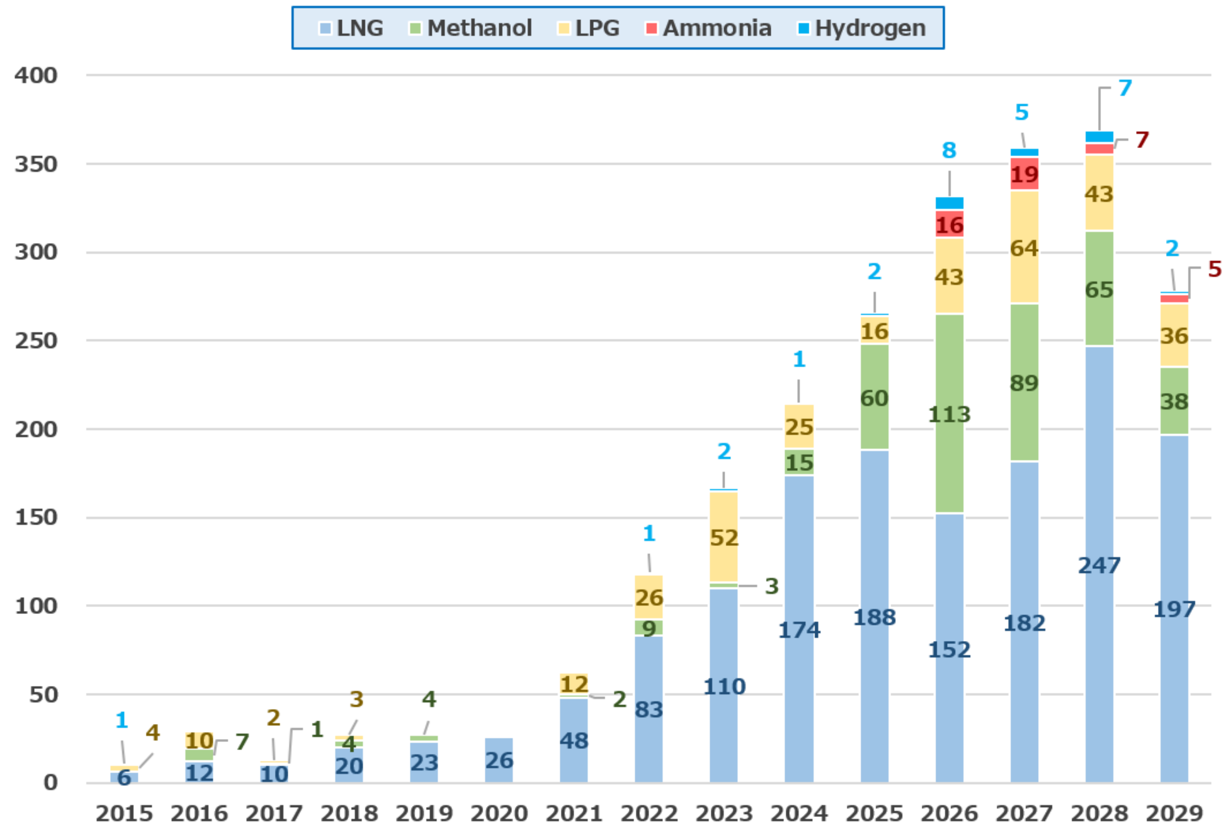
Trends in alternative fuel ships

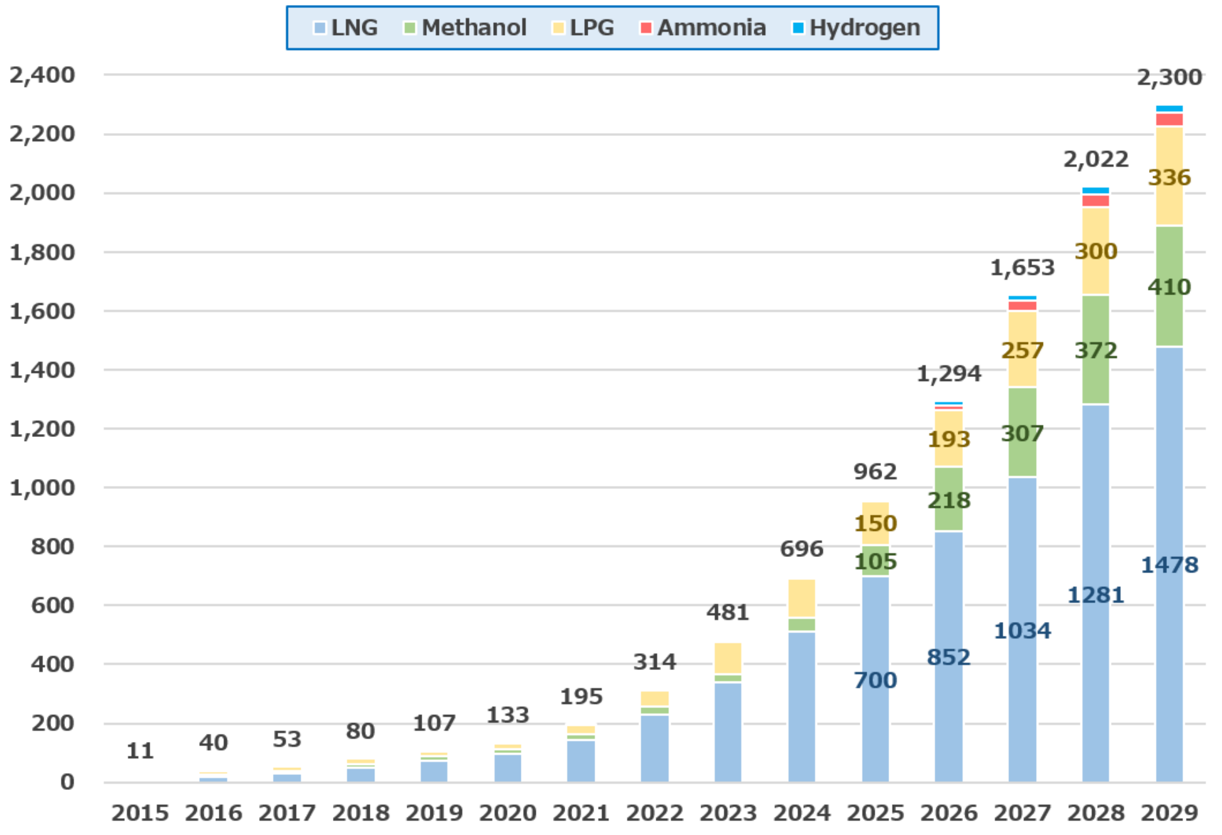
"Newbuilding" alternative fuel ship trend



- ✓ As of the end of June 2026 (Orderbook is included after 2026.)
- ✓ 5,000 gross tonnage and above
- ✓ LNG carriers are excluded from LNG-fueled ships.
- ✓ Alternative fuel ready ships are not included.

"In service" alternative fuel ship trend*

*Cumulative number of ships delivered since 2015, without considering scrapping



- ✓ As of the end of June 2026 (Orderbook is included after 2026.)
- ✓ 5,000 gross tonnage and above
- ✓ LNG carriers are excluded from LNG-fueled ships.
- ✓ Alternative fuel ready ships are not included.

Source: The figures and tables presented in this section are created by ClassNK based on data from Clarkson Research Services Limited.

Step 2 - Understanding trends

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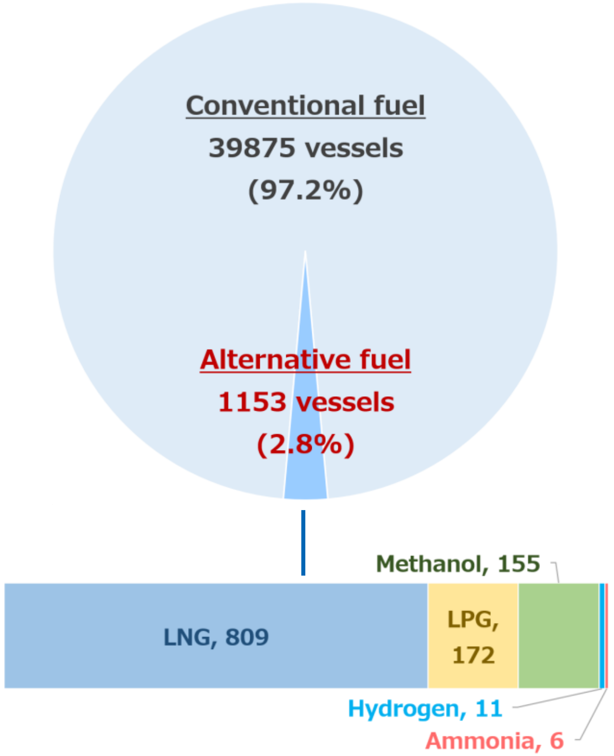
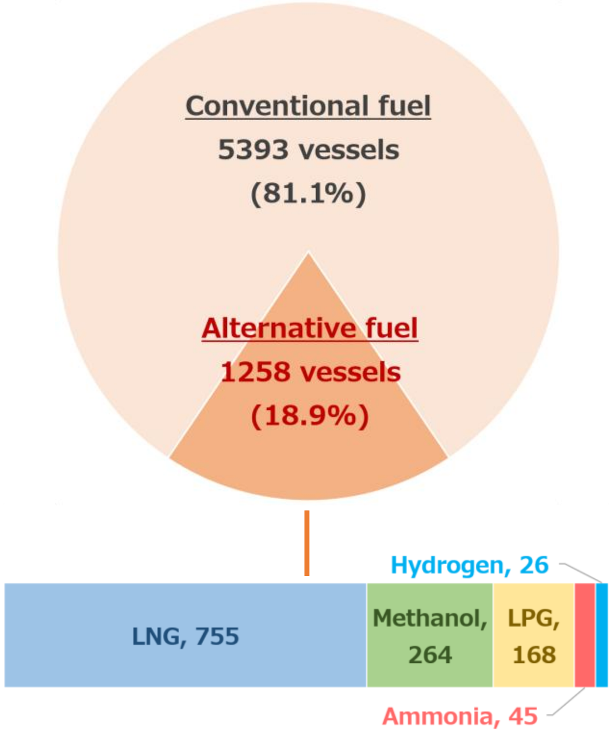
Trends in alternative fuel ships

Share of alternative fuel ships

In service —

On order —





- ✓ As of the end of June 2026
- ✓ 5,000 gross tonnage and above
- ✓ LNG carriers are excluded from LNG-fueled ships.
- ✓ Alternative fuel ready ships are not included.

Details of alternative fuel ships (Dec. 2025 → Jun. 2026)

In service —

	As of Dec. 31, 2025	As of Jun. 30, 2026
Number of vessels	1,008 vessels (2.5%)	1,153 vessels (2.8%)
Total GT	74,697,151 GT (4.5%)	85,480,206 GT (5.0%)

Over the six-month period, the fleet grew by 145 vessels, or 10.8 million GT. By fuel type, LNG-fuelled vessels accounted for the largest share with 62 deliveries, while **methanol-fuelled vessels also increased in number, with completions rising from 38 vessels in the second half of 2025 to 48.**

On order —

	As of Dec. 31, 2025	As of Jun. 30, 2026
Number of vessels	1,184 vessels (20.8%)	1,258 vessels (18.9%)
Total GT	117,141,829 GT (35.5%)	126,023,912 GT (32.0%)

Continuing the trend from the second half of 2025, **the share of alternative-fuelled vessels in the orderbook declined in both vessel numbers and gross tonnage.** Orders comprised LNG-fuelled vessels (65%), LPG-fuelled vessels (26%), methanol-fuelled vessels (4%), ammonia-fuelled vessels (3%), and hydrogen-fuelled vessels (2%).

Step 2 - Understanding trends

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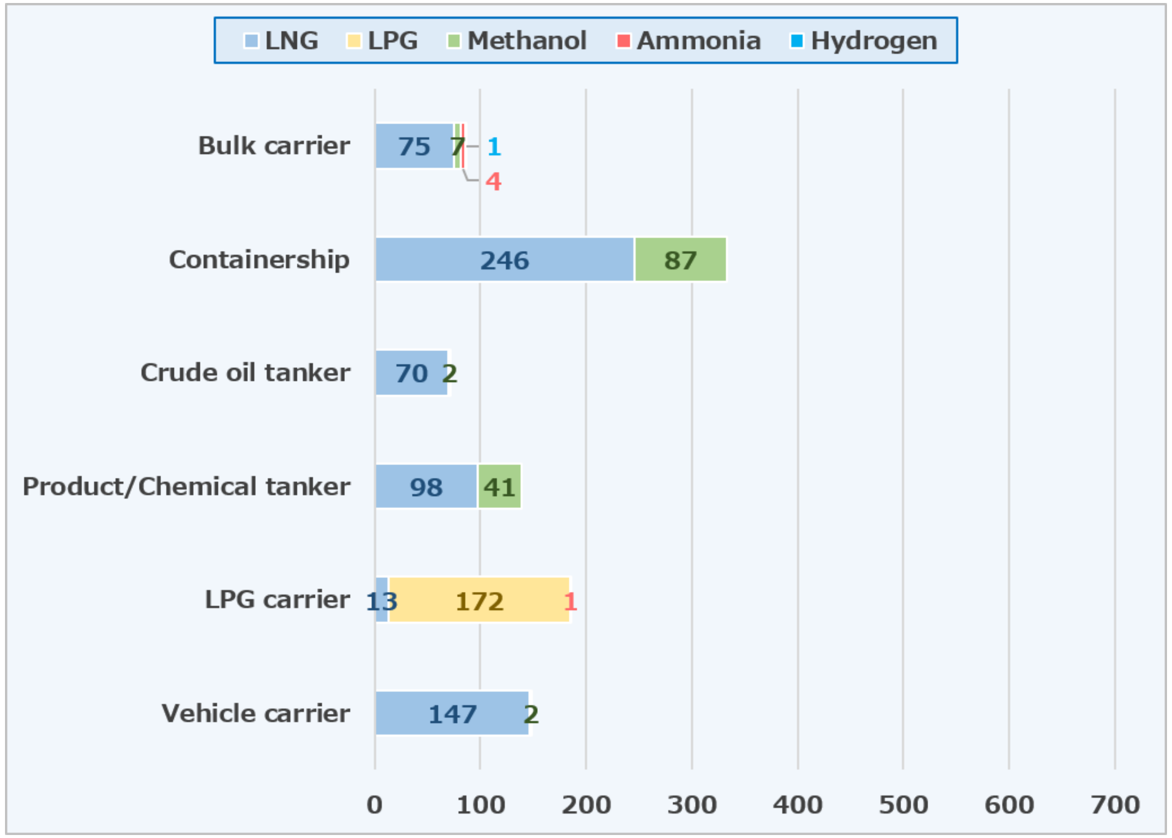
Trends in alternative fuel ships (by ship type)

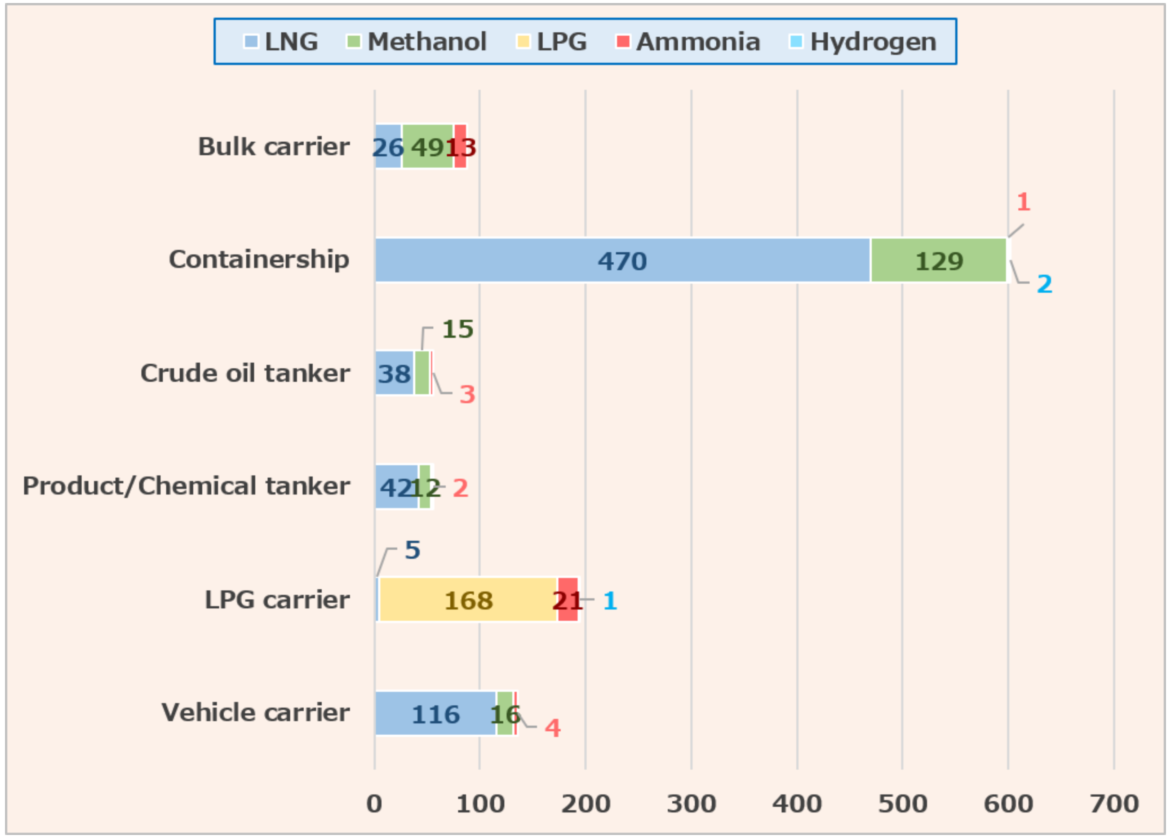
In service —



✓ As of the end of June 2026 / 5,000 gross tonnage and above / Alternative fuel ready ships are not included.

➢ Excluding LPG carriers, LNG fueled vessels account for the majority across all sectors, while methanol vessels are also operating, notably in containerships.

On order —



✓ As of the end of June 2026 / 5,000 gross tonnage and above / Alternative fuel ready ships are not included.

➢ Containerships continue to lead the shift toward alternative fuels. By fuel type, LNG remains dominant across most ship types, with only a few exceptions.

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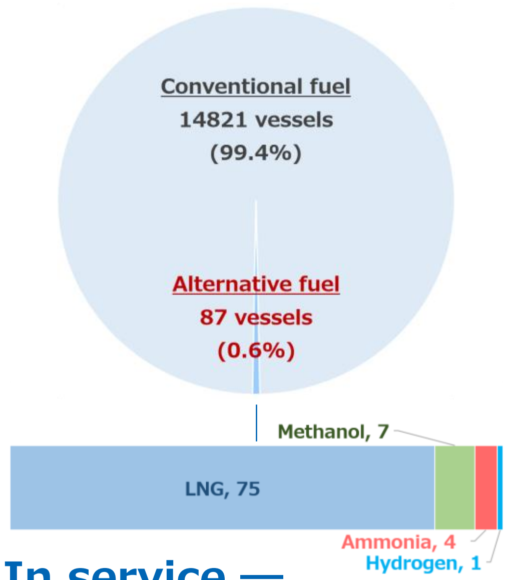
Trends in alternative fuel ships (by ship type)

Bulk carriers

In service —



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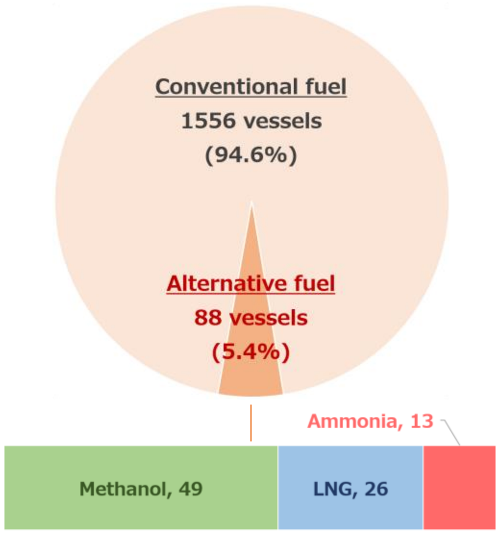

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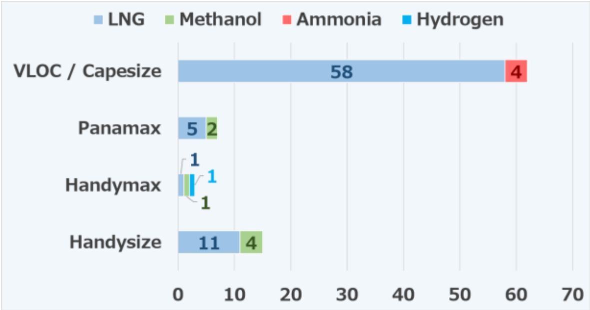

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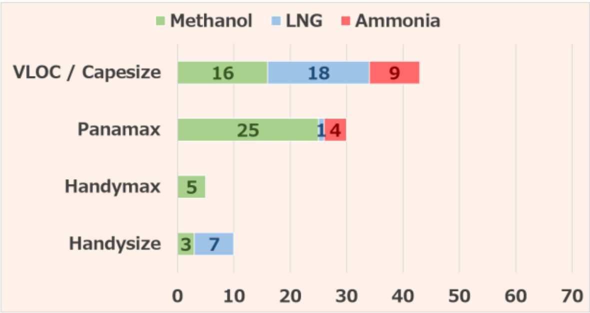

Details of alternative fuel ships (Dec. 2025 → Jun. 2026)

In service —

	As of Dec. 31, 2025	As of Jun. 30, 2026
Number of vessels	72 vessels (0.5%)	87 vessels (0.6%)
Total GT	6,591,108 GT (1.1%)	7,392,598 GT (1.2%)

Over the six-month period, the fleet grew by 15 vessels, or 0.8 million GT. By fuel type, methanol-fuelled vessels were the most numerous with 6 deliveries, while 4 LNG-fuelled vessels and 4 ammonia-fuelled vessels were also delivered. (Note: Some reports indicate that the ammonia-fuelled vessels are actually ammonia-ready vessels.)

On order —

	As of Dec. 31, 2025	As of Jun. 30, 2026
Number of vessels	97 vessels (6.4%)	88 vessels (5.4%)
Total GT	7,582,545 GT (10.3%)	7,244,379 GT (8.7%)

Over the six-month period, the orderbook decreased by 9 vessels, or 0.3 million GT. New orders were limited to 13 vessels, of which ammonia-fuelled vessels accounted for the largest number at 6. While bulk carriers lag behind in the shift to alternative fuels, they rank second only to LPG carriers in ammonia adoption, helping drive its uptake.

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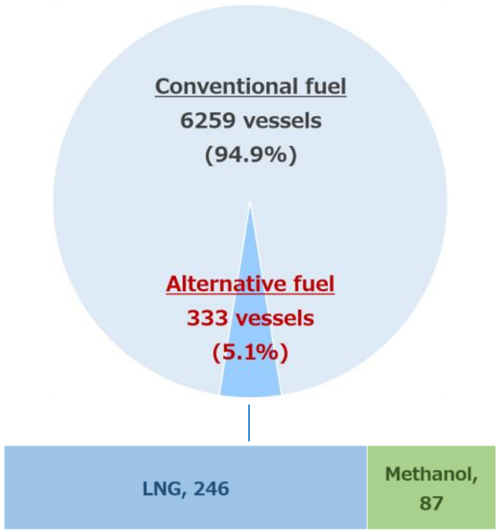
Trends in alternative fuel ships (by ship type)

Containerships

In service —



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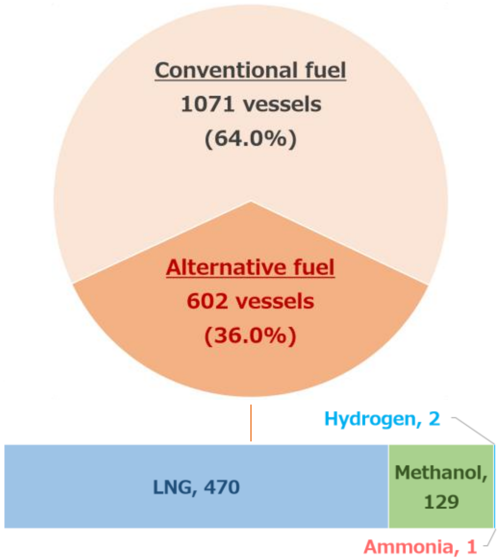

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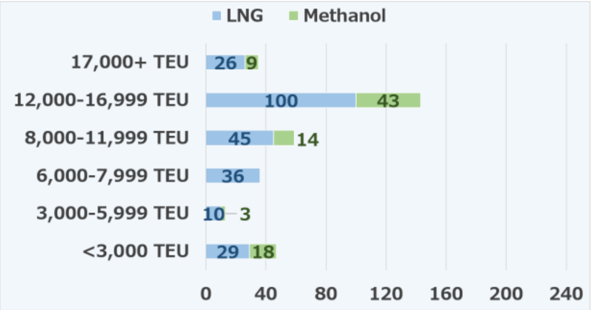
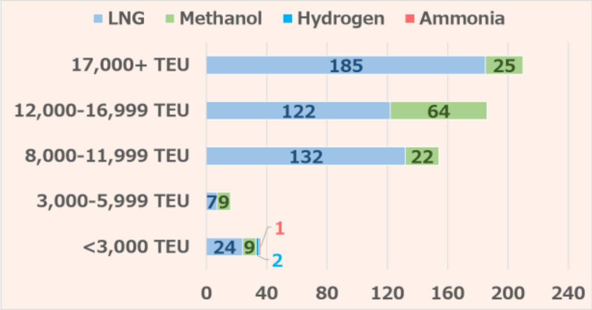


On order —



Details of alternative fuel ships (Dec. 2025 → Jun. 2026)

In service —

	As of Dec. 31, 2025	As of Jun. 30, 2026
Number of vessels	290 vessels (4.5%)	333 vessels (5.1%)
Total GT	33,706,066 GT (9.8%)	38,781,221 GT (11.0%)

Over the six-month period, the fleet grew by 43 vessels, or 5.1 million GT. **By fuel type, methanol-fuelled vessels accounted for 29 deliveries and LNG-fuelled vessels for 13.**

On order —

	As of Dec. 31, 2025	As of Jun. 30, 2026
Number of vessels	559 vessels (45.3%)	602 vessels (36.0%)
Total GT	79,302,773 GT (71.7%)	84,493,712 GT (65.1%)

Over the six-month period, the orderbook grew by 43 vessels, or 5.2 million GT. New orders reached 77 vessels, of which LNG-fuelled vessels accounted for 75, while methanol-fuelled vessels were limited to just 2. **Among containerships, which had actively adopted methanol, the return to LNG is becoming increasingly pronounced.**

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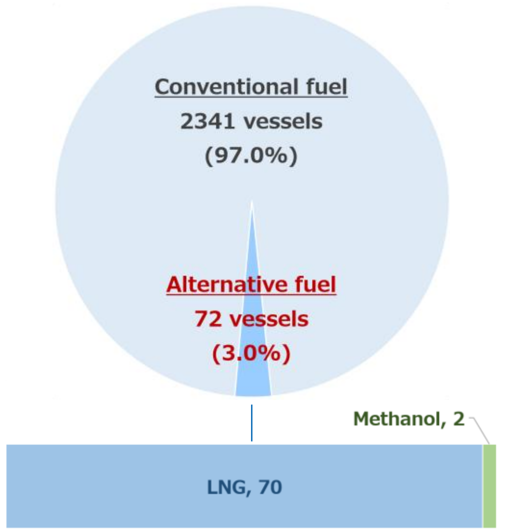
Trends in alternative fuel ships (by ship type)

Crude oil tankers

In service —



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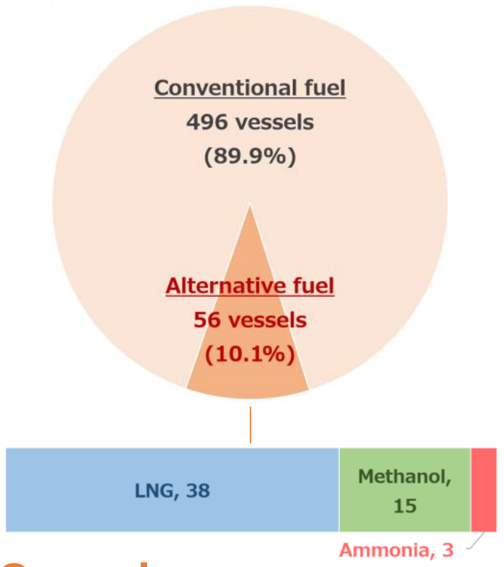

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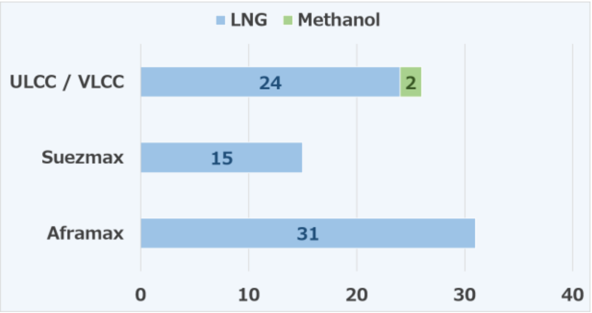

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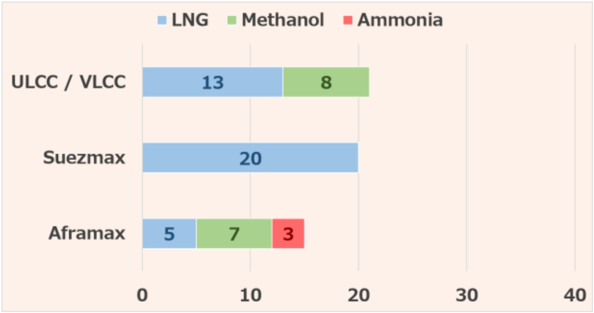

Details of alternative fuel ships (Dec. 2025 → Jun. 2026)

In service —

	As of Dec. 31, 2025	As of Jun. 30, 2026
Number of vessels	65 vessels (2.8%)	72 vessels (3.0%)
Total GT	6,648,521 GT (2.7%)	7,476,044 GT (3.0%)

Over the six-month period, the fleet grew by 7 vessels, or 0.8 million GT. **All newly delivered vessels were LNG-fuelled.**

On order —

	As of Dec. 31, 2025	As of Jun. 30, 2026
Number of vessels	51 vessels (14.4%)	56 vessels (10.1%)
Total GT	5,209,093 GT (13.1%)	5,916,690 GT (8.9%)

Over the six-month period, the orderbook grew by 5 vessels, or 0.7 million GT. New orders totalled 8 vessels, of which **LNG-fuelled vessels accounted for 7, while methanol-fuelled vessels were limited to just 1.**

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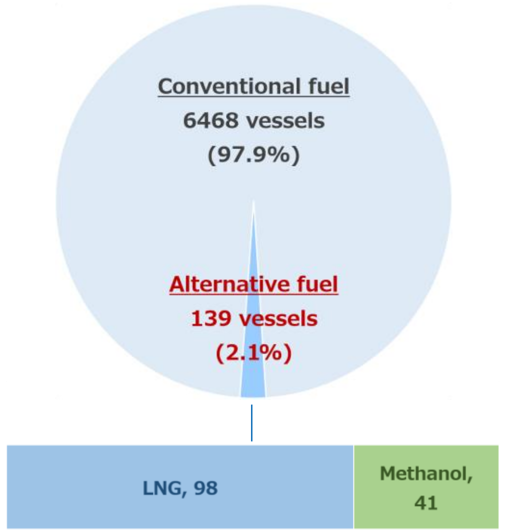
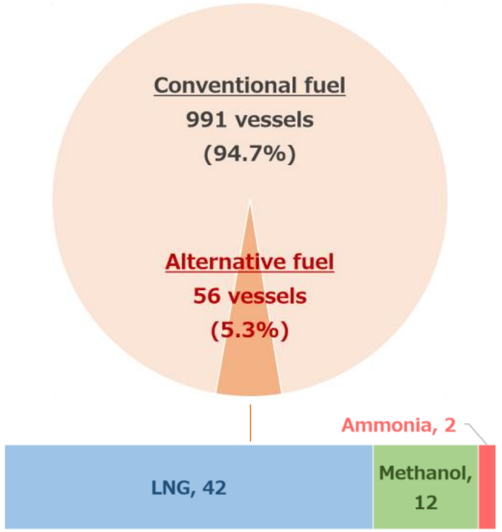
Trends in alternative fuel ships (by ship type)

Product/Chemical tankers

In service —



On order —



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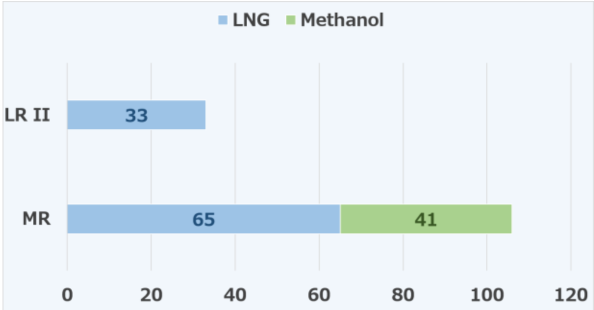
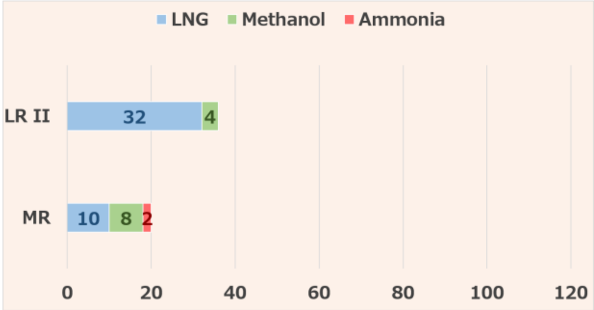


On order —



Details of alternative fuel ships (Dec. 2025 → Jun. 2026)

In service —

	As of Dec. 31, 2025	As of Jun. 30, 2026
Number of vessels	122 vessels (1.9%)	139 vessels (2.1%)
Total GT	3,519,837 GT (2.3%)	4,210,588 GT (2.7%)

Over the six-month period, the fleet grew by 17 vessels, or 0.7 million GT. **By fuel type, LNG-fuelled vessels accounted for 11 deliveries and methanol-fuelled vessels for 6.** All 6 methanol-fuelled vessels were MR-size tankers.

On order —

	As of Dec. 31, 2025	As of Jun. 30, 2026
Number of vessels	61 vessels (6.1%)	56 vessels (5.3%)
Total GT	2,656,557 GT (9.4%)	2,615,384 GT (8.5%)

Over the six-month period, the orderbook decreased by 5 vessels, or 0.04 million GT. New orders totalled 9 vessels, all of which were LNG-fuelled. **This marks a complete reversal from the second half of 2025, when all vessels ordered were methanol-fuelled, indicating that the shift back to LNG is spreading to product/chemical tankers as well.**

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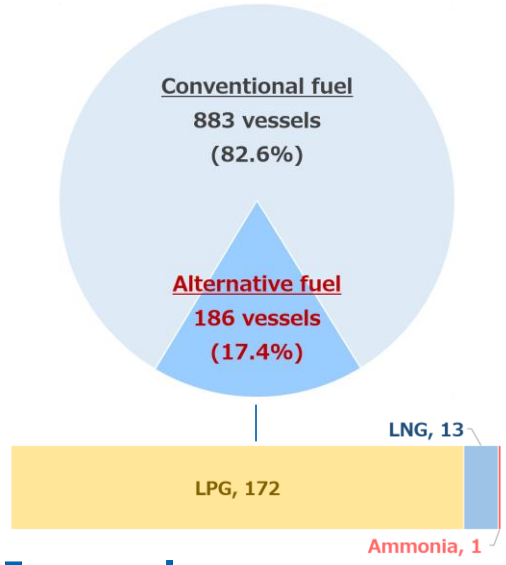
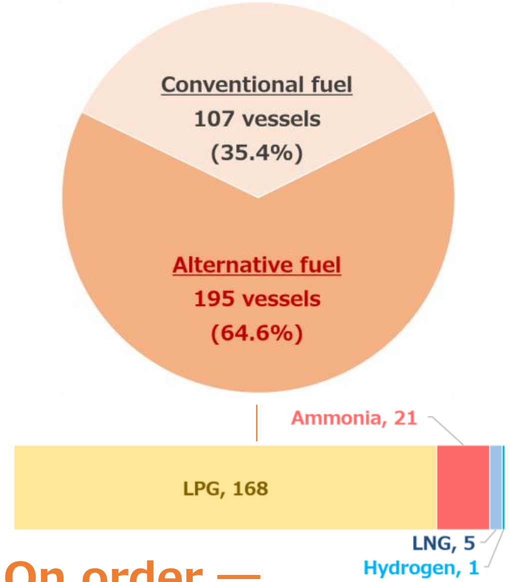
Trends in alternative fuel ships (by ship type)

LPG carriers

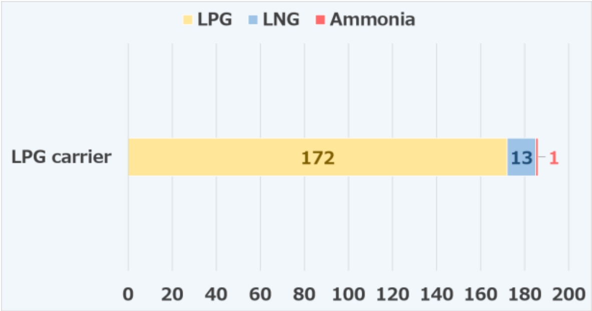
In service —



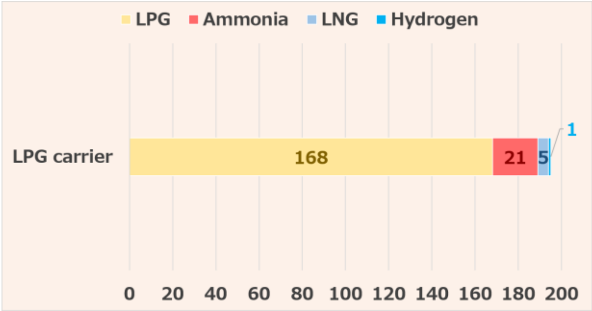
On order —



In service —



On order —



Details of alternative fuel ships (Dec. 2025 → Jun. 2026)

In service —

	As of Dec. 31, 2025	As of Jun. 30, 2026
Number of vessels	162 vessels (15.9%)	186 vessels (17.4%)
Total GT	6,898,438 GT (22.3%)	7,920,960 GT (24.1%)

Over the six-month period, the fleet grew by 24 vessels, or 1.0 million GT. By fuel type, LPG-fuelled vessels accounted for the largest number at 22 deliveries. Of particular note is the delivery of 1 ammonia-fuelled vessel, suggesting that the implementation of ammonia as fuel is steadily progressing.

On order —

	As of Dec. 31, 2025	As of Jun. 30, 2026
Number of vessels	163 vessels (59.1%)	195 vessels (64.6%)
Total GT	6,544,929 GT (61.8%)	8,197,723 GT (68.5%)

Over the six-month period, the orderbook grew by 32 vessels, or 1.7 million GT. New orders reached 57 vessels, a substantial increase from the 10 vessels in the second half of 2025. By fuel type, LPG-fuelled vessels accounted for the vast majority at 52.

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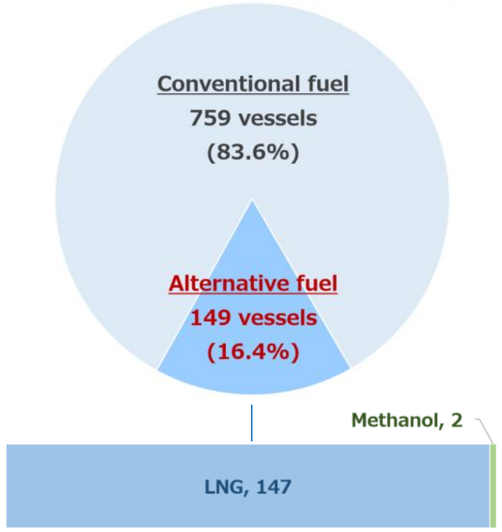
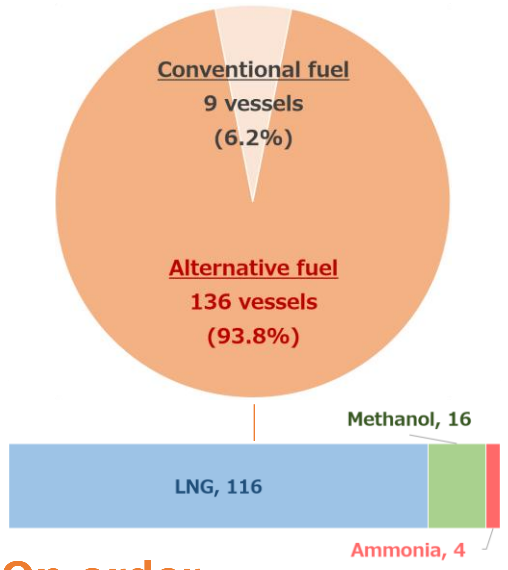
Trends in alternative fuel ships (by ship type)

Vehicle carriers

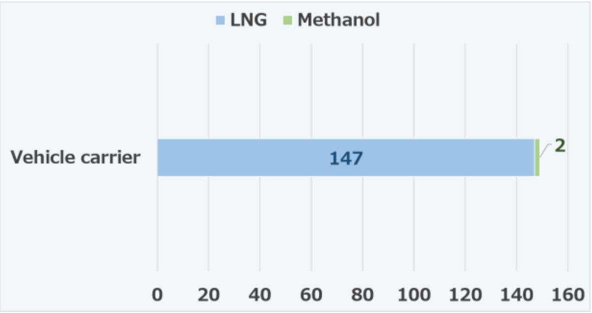
In service —



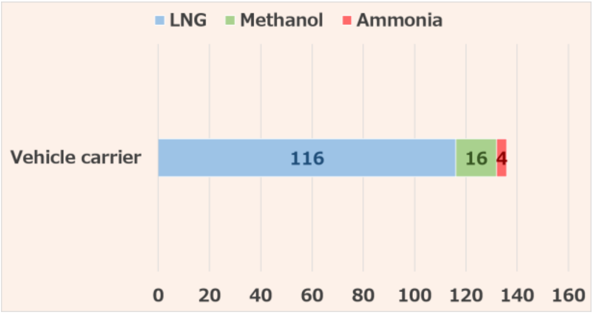
On order —



In service —



On order —



Details of alternative fuel ships (Dec. 2025 → Jun. 2026)

In service —

	As of Dec. 31, 2025	As of Jun. 30, 2026
Number of vessels	127 vessels (14.6%)	149 vessels (16.4%)
Total GT	9,083,330 GT (19.1%)	10,752,660 GT (21.4%)

Over the six-month period, the fleet grew by 22 vessels, or 1.7 million GT. **All newly delivered vessels were LNG-fuelled.**

On order —

	As of Dec. 31, 2025	As of Jun. 30, 2026
Number of vessels	129 vessels (89.0%)	136 vessels (93.8%)
Total GT	7,833,754 GT (86.9%)	8,307,507 GT (93.0%)

Over the six-month period, the orderbook grew by 7 vessels, or 0.5 million GT. **New orders reached 28 vessels, a substantial increase from the 3 vessels in the second half of 2025. All vessels ordered were LNG-fuelled.**

Step 2 - Understanding trends

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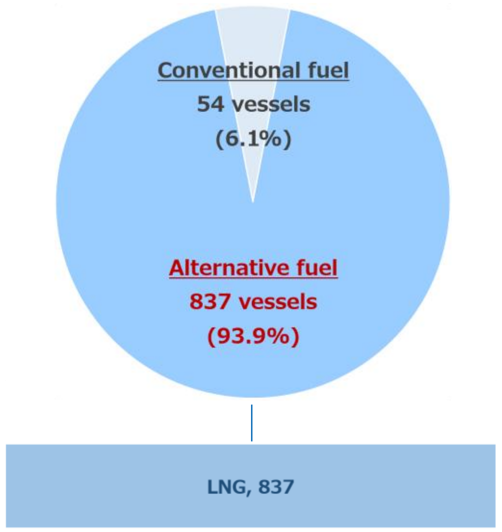
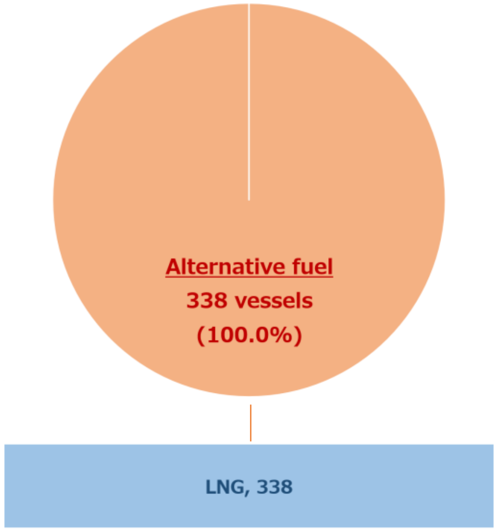
Trends in alternative fuel ships (by ship type)

LNG carriers (for reference)

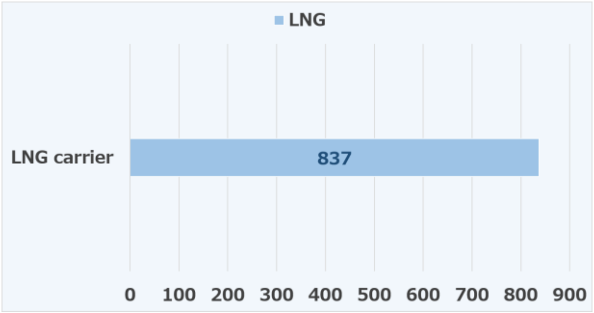
In service —



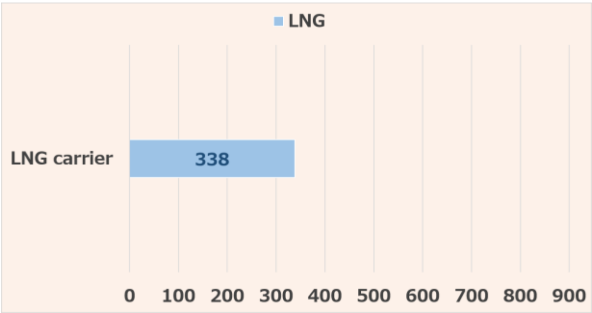
On order —



In service —



On order —



Details of alternative fuel ships (Dec. 2025 → Jun. 2026)

In service —

	As of Dec. 31, 2025	As of Jun. 30, 2026
Number of vessels	803 vessels (93.7%)	837 vessels (93.9%)
Total GT	83,807,489 GT (92.4%)	87,807,173 GT (92.7%)

Over the six-month period, the fleet grew by 34 vessels, or 4.0 million GT. All newly delivered vessels were LNG-fuelled, with no deliveries of vessels using other alternative fuels.

On order —

	As of Dec. 31, 2025	As of Jun. 30, 2026
Number of vessels	321 vessels (100.0%)	338 vessels (100.0%)
Total GT	33,306,593 GT (100.0%)	34,809,146 GT (100.0%)

Over the six-month period, the orderbook grew by 17 vessels, or 1.5 million GT. New orders reached 62 vessels, a substantial increase from the 37 vessels in the second half of 2025. All vessels ordered were LNG-fuelled.

— Step 3

Understanding alternative fuels

When considering the adoption of alternative fuels, it is important to understand the characteristics of each fuel, such as their properties and GHG emissions, and to grasp factors like cost and projected supply. In this section, we will outline the attributes of various alternative fuels envisaged for use in international shipping, providing insights into their costs, supply prospects, and other relevant factors.

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Key Takeaways

- ✓ Each alternative fuel envisaged for use in international shipping has the potential to become zero-emission or carbon-neutral fuel.
- ✓ Due to differences in calorific value, alternative fuels require larger fuel tank capacities compared to conventional fuel oil, potentially resulting in reduced distance covered with the same fuel tank capacity. Therefore, comprehensive fleet-wide consideration, including planned routes, is necessary when adopting alternative fuel ships.
- ✓ The GHG emissions of each alternative fuel differ significantly not only during combustion but also throughout their lifecycle. Therefore, it is important to fully understand the scope of GHG emissions targeted by regulations and to weigh the pros and cons of each fuel under regulation.
- ✓ The cost of zero-emission or carbon-neutral fuels is generally considered to be lower for biomass-derived fuels than for green hydrogen-derived fuels. However, biomass-derived fuels face supply constraints, requiring careful attention to their availability.
- ✓ ClassNK has conducted surveys on the production volumes of biodiesel and zero-emission/carbon-neutral fuels. Considering their demand in international shipping, current production volumes are vastly insufficient, necessitating rapid expansion of production scale.

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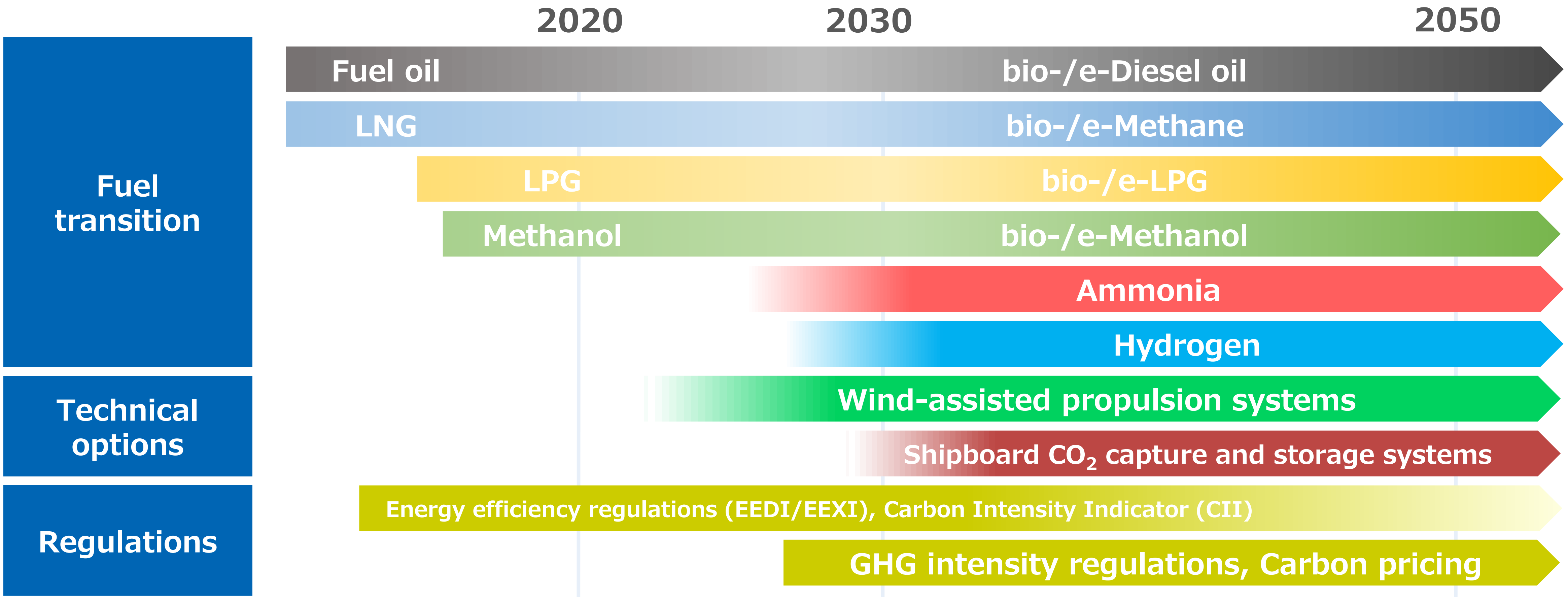
Fuel transition, technological options, and regulations in international shipping

Various alternative fuels are envisioned for use in shipping, and it remains uncertain which fuel will become predominant. Depending on the manufacturing method, each fuel has the potential to become zero-emission or carbon-neutral throughout its lifecycle, and it is essential to consider the manufacturing technology trends, cost projections, and supply trends of each fuel when selecting fuels.

Timeline for fuel transition, etc.



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Fuel properties - 1

As alternative fuels vary significantly in energy density (per weight and volume) depending on the fuel type, the required fuel amount and necessary fuel tank capacity can differ greatly compared to conventional fuel oil. Accurately understanding the physical properties of each fuel is the first step in considering the adoption of alternative fuels.

List of fuel properties (Overview)

Fuel type	HFO	LNG (Methane)	LPG		Methanol	Ethanol	Ammonia	Hydrogen
			Propane	Butane				
TtW CO_2 emission (/MJ) [HFO = 1]	1	0.74	0.84	0.86	0.89	0.92	0	0
TtW GHG emission (/MJ) [HFO = 1]	1	0.82	0.84	0.86	0.91	0.93	0.03	0.01
Required to obtain the same amount of energy Fuel ton [HFO = 1]	1	0.84	0.87	0.88	2.02	1.50	2.16	0.34
In liquid form Fuel tank capacity [HFO = 1]	1	1.91	1.67	1.41	2.45	1.82	3.04	4.59
Flammability (Lower Explosive Limit)	0.7 vol%	4.4 vol%	1.7 vol%	1.4 vol%	6.0 vol%	3.1 vol%	15. vol%	4.0 vol%
Toxicity (TLV-TWA*)	-	-	-		200 ppm	-	25 ppm	-
Cyrogenic (Boiling point)	- (Liquid at normal temp.)	-161℃	-42℃	-0.5℃	- (Liquid at normal temp.)	- (Liquid at normal temp.)	-33℃	-253℃

*TLV-TWA: Threshold Limit Value Time Weighted Average

Source: CO_2 emission and GHG emission are calculated by ClassNK based on emission factors specified in the IMO LCA guidelines, etc.

- ✓ While CO_2 and GHG emission reductions are limited for on-board use of LNG, LPG, methanol, and ethanol, significant reductions are expected for ammonia and hydrogen.
- ✓ The fuel tank capacity of each alternative fuel is greater than that of conventional fuel oil. To get the same energy as conventional fuel oil, LNG requires a fuel tank capacity 1.91 times larger than that of conventional fuel oil, methanol 2.45 times larger, ammonia 3.04 times larger, and hydrogen 4.59 times larger.
- ✓ Ammonia does not explode unless it is present in the atmosphere at concentrations of 15.0 vol% or higher, making it less explosive than other alternative fuels.
- ✓ Both methanol and ammonia are toxic, with ammonia being of particular concern due to its extremely high toxicity.
- ✓ When storing alternative fuels in liquid form, especially LNG and hydrogen, extremely low temperatures are required.

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Fuel properties - 2

Here, we focus on the environmental aspects as we introduce the characteristics of each fuel.

List of fuel properties (Environment-related)

Fuel type	HFO	LNG (Methane)	LPG		Methanol	Ethanol	Ammonia	Hydrogen
			Propane	Butane				
TtW CO_2 emission (/MJ) [HFO = 1]	1	0.74	0.84	0.86	0.89	0.92	0	0
TtW GHG emission (/MJ) [HFO = 1]	1	0.82	0.84	0.86	0.91	0.93	0.03	0.01
Emissions	✓ NOx ✓ SOx ✓ PM	✓ NOx ✓ Methane slip	✓ NOx		✓ NOx ✓ Methanol slip ✓ Formaldehyde	✓ NOx ✓ Ethanol slip ✓ Acetaldehyde	✓ NOx ✓ Ammonia slip ✓ N_2O	✓ NOx ✓ Hydrogen slip

Source: CO_2 emission and GHG emission are calculated by ClassNK based on emission factors specified in the IMO LCA guidelines, etc.

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Fuel properties - 3

Here, we focus on the design aspects as we introduce the characteristics of each fuel.

List of fuel properties (Design-related)

Fuel type	HFO	LNG (Methane)	LPG Propane	LPG Butane	Methanol	Ethanol	Ammonia	Hydrogen
In liquid form Energy density per unit volume [HFO = 1]	1	1.91	1.67	1.41	2.45	1.82	3.04	4.59
Liquid density [ton/m^3]	0.96	0.42	0.5	0.6	0.79	0.79	0.68	0.07
Liquefaction temp. (Boiling point)	-	-161℃	-42℃	-0.5℃	65℃	78℃	-33℃	-253℃
Lower calorific value [MJ/kg]	40.2	48.0	46.3	45.7	19.9	26.8	18.6	120.0
Engine type (2 stroke)	Diesel	Diesel/ Otto	Diesel		Diesel	Diesel	Diesel	Diesel
Engine type (4 stroke)	Diesel	Otto	-		Diesel	Diesel	Diesel/ Otto	Otto
Onboard storage methods	Gravity tank	Type A/B/C Membrane	Type A/B/C		Gravity tank	Gravity tank	Type A/B/C Membrane	Low-temp. (Type C, Membrane) High pressure (Type 1/2/3/4)

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Fuel properties - 4

Here, we focus on the safety aspects as we introduce the characteristics of each fuel.

List of fuel properties (Safety-related)

Fuel type	HFO	LNG (Methane)	LPG		Methanol	Ethanol	Ammonia	Hydrogen
			Propane	Butane				
Flammability [Vol%]	0.7 - 5	4.4 - 17	1.7 – 10.8	1.4 – 9.4	6 - 50	3.1 – 27.7	15.4 – 33.6	4 - 77
Flash point	>60℃	-187.7℃	-104℃	-60℃	9℃	12℃	132℃	-
Ignition point	>400℃	595℃	470℃	365℃	440℃	400℃	630℃	560℃
Minimum ignition energy	-	0.3 mJ	0.26 mJ	0.26 mJ	0.14 mJ	0.23 mJ	680 mJ	0.017 mJ
Toxicity [ppm] (ACGIH, TLV-TWA*1)	-	-	-		200	-	25	-
Toxicity [ppm] (ACGIH, TLV-STEL*2)	-	-	-	-	250	1000	35	-

*1 Toxicity criteria established by American Conference of Governmental Industrial Hygienist (ACGIH). TLV-TWA (Threshold Limit Value Time Weighted Average) represents the concentration that is believed not to cause adverse health effects to workers who are repeatedly exposed to it during an average workday of 8 hours or a workweek of 40 hours.
*2 Toxicity criteria established by American Conference of Governmental Industrial Hygienist (ACGIH). TLV-STEL (Threshold Limit Value Short Term Exposure Limit) represents the concentration that is believed not to cause adverse health effects to workers if exposed continuously for 15 minutes, provided that their daily exposure does not exceed the TLV-TWA.

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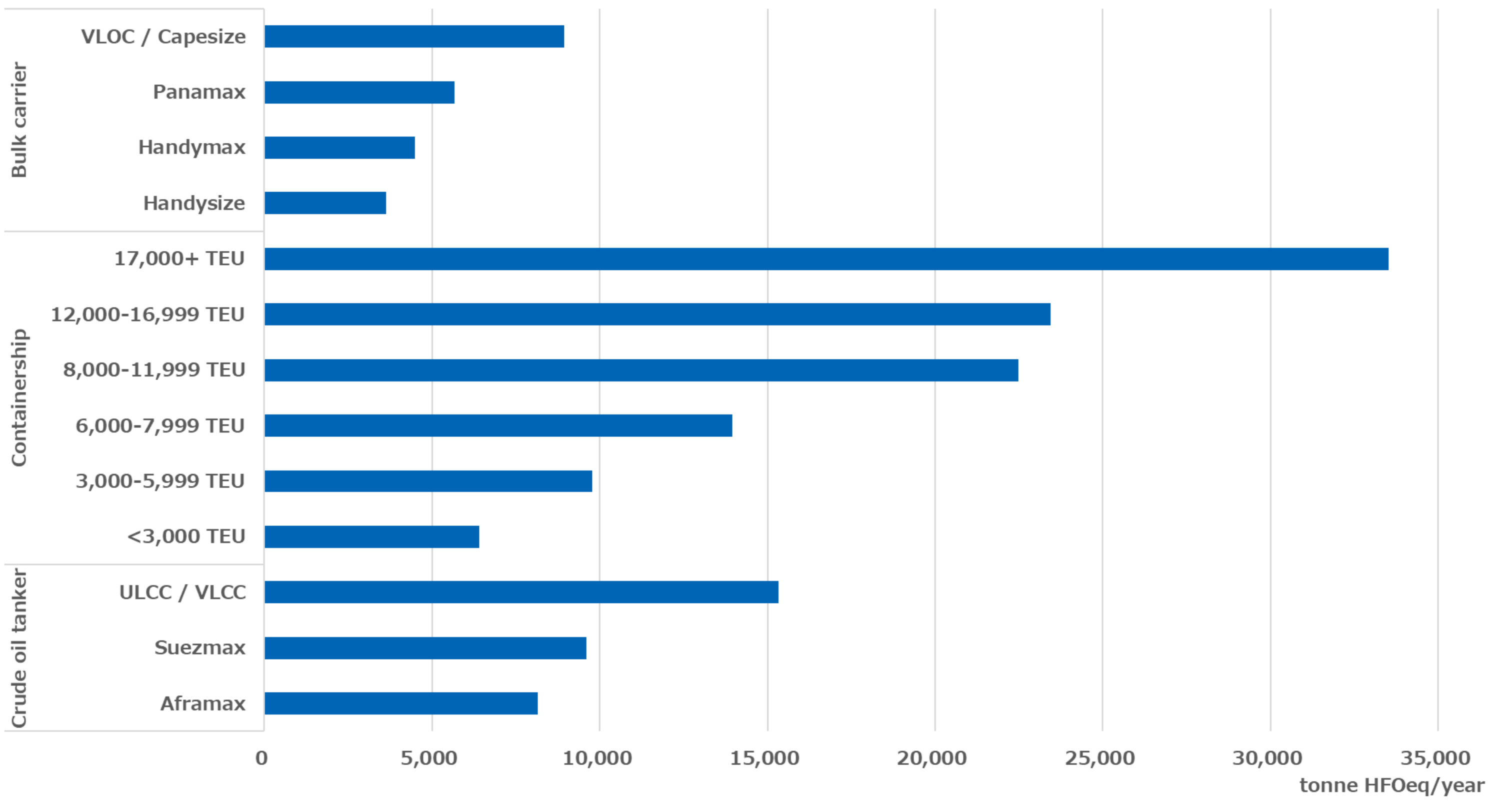
Understanding fuel consumption - 1

Alternative fuels have different calorific values compared to conventional fuel oil, resulting in changes in the required fuel volume (in tonnes) when transitioning to alternative fuels. It is important to understand the estimated required fuel volume for each fuel type depending on the ship type and size when considering the adoption of alternative fuels.

Image of annual fuel consumption (For conventional fuel vessels aged 10 years or less) — Bulk carrier, Containership, Crude oil tanker



Required amount of fuel when transitioning to alternative fuels (tonnes) [Relative to conventional fuel oil]

LNG	0.84 times
LPG	0.87 times
Methanol	2.02 times
Ammonia	2.16 times
Hydrogen	0.34 times

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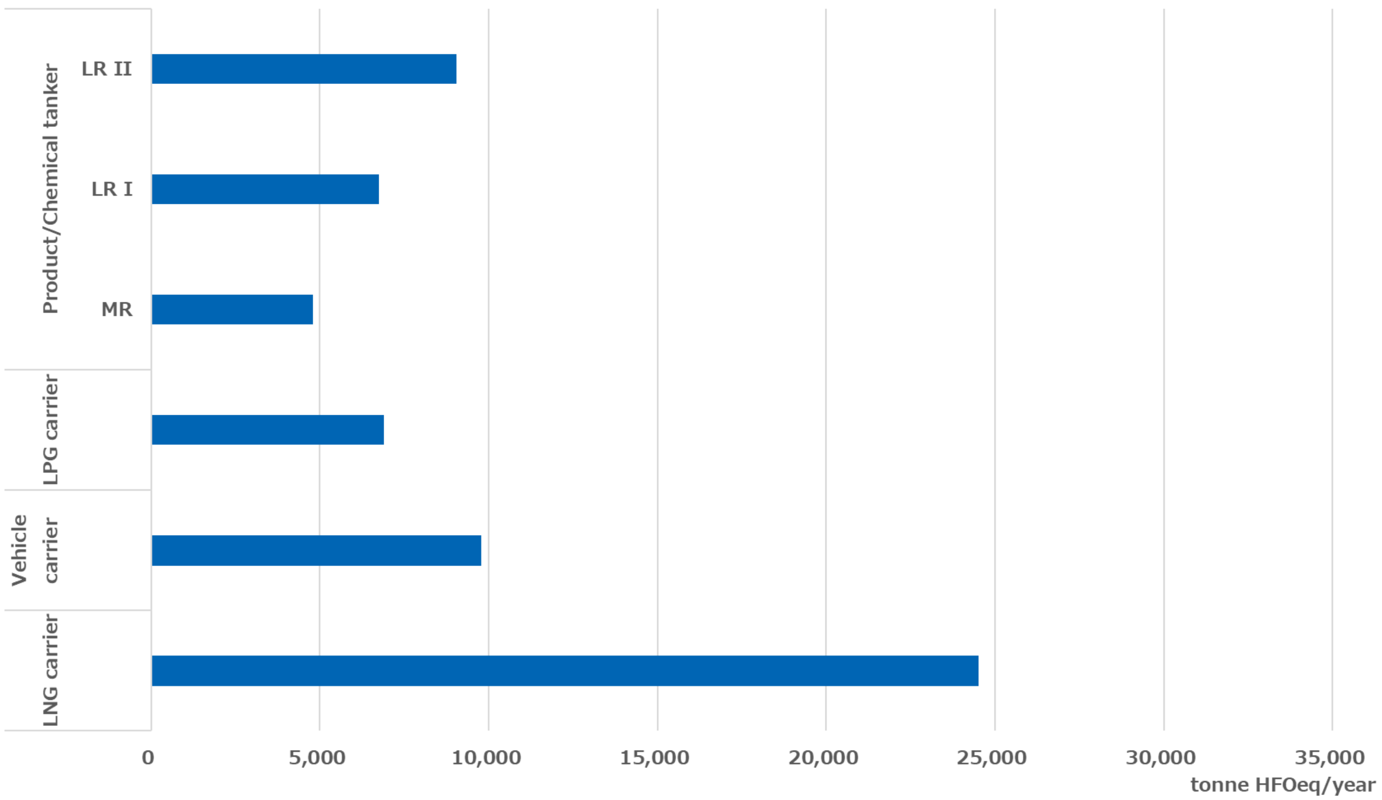
Understanding fuel consumption - 2

Alternative fuels have different calorific values compared to conventional fuel oil, resulting in changes in the required fuel volume (in tonnes) when transitioning to alternative fuels. It is important to understand the estimated required fuel volume for each fuel type depending on the ship type and size when considering the adoption of alternative fuels.

Image of annual fuel consumption (For conventional fuel vessels aged 10 years or less) — Product/Chemical tanker, LPG carrier, Vehicle carrier, LNG carrier



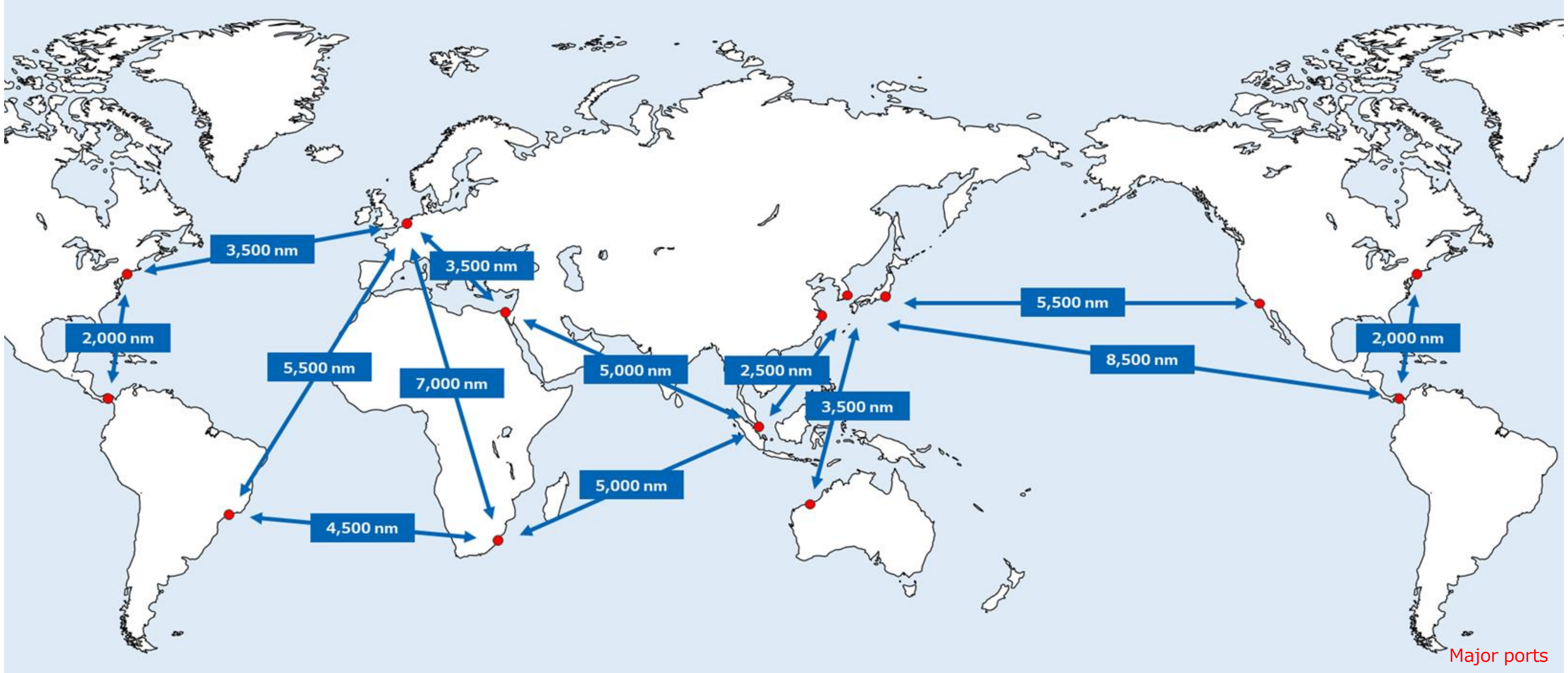
Required amount of fuel when transitioning to alternative fuels (tonnes) [Relative to conventional fuel oil]

LNG	0.84 times
LPG	0.87 times
Methanol	2.02 times
Ammonia	2.16 times
Hydrogen	0.34 times

Route selection

Alternative fuel ships cover shorter distances and require different fuel amounts (in tons) compared to conventional fuel ships, even with the same fuel tank capacity. When considering the adoption of alternative fuel ships, it is important to select routes considering the type of fuel and bunkering locations.

Voyage distance on major routes



The amount of fuel required for a 206,000 DWT bulk carrier to sail one way (laden) from Japan to Australia over a distance of 3,500 nm.

- Fuel oil :500 tons
- LNG :420 tons
- LPG :435 tons
- Methanol :1,010 tons
- Ammonia :1,080 tons
- Hydrogen :170 tons

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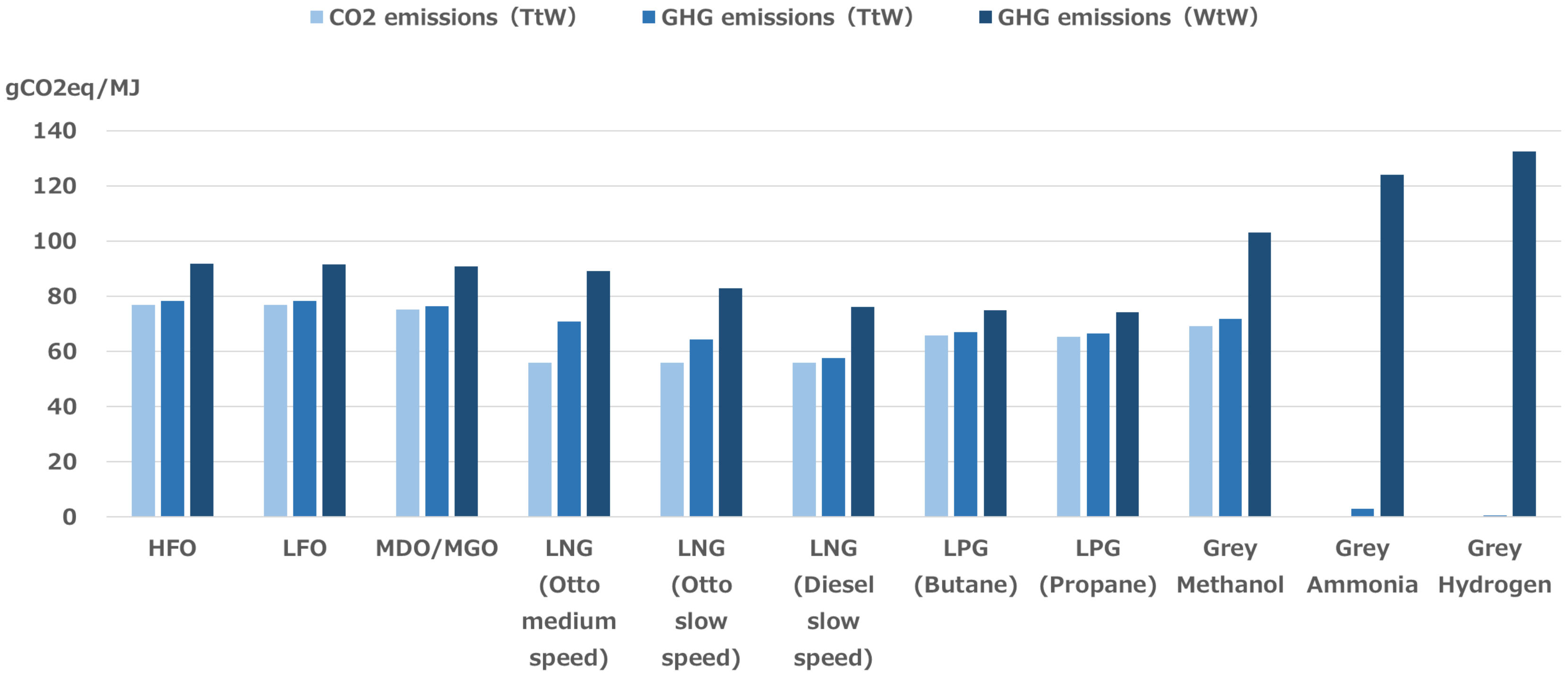
"CO_2 emissions (TtW)" vs. "GHG emissions (TtW)" vs. "GHG emissions (WtW)"

The scope of emissions targeted by regulations varies, including "CO_2 or GHG" and "Tank-to-Wake or Well-to-Wake." To minimize regulatory compliance costs, it is important to understand the default values of emission factors in each regulation and the differences in emissions for each fuel. (TtW: Tank-to-Wake, WtW: Well-to-Wake)

Emissions per unit of energy



Source: Calculated by ClassNK based on emission factors specified in the FuelEU Maritime regulation

Emissions targeted by each regulation

The emissions targeted by regulations within the IMO and the EU include the following:

- ✓ CII :**CO_2 (TtW)**
- ✓ EU-ETS :**GHG (TtW)** (2026-)
- ✓ FuelEU Maritime :**GHG (WtW)**
- ✓ IMO mid-term measures :**GHG (WtW)**

Most emission cost-competitive fuel

The fuel with the lowest emissions in each emission scope is as follows* (excluding zero-emission/carbon-neutral fuels):

- ✓ For CO_2 (TtW) :**LNG**
- ✓ For GHG (TtW) :**LNG**
- ✓ For GHG (WtW) :**LPG**

*When compared using the emission factors specified in the FuelEU Maritime regulation

Comparison of CII ratings resulting from fuel transition

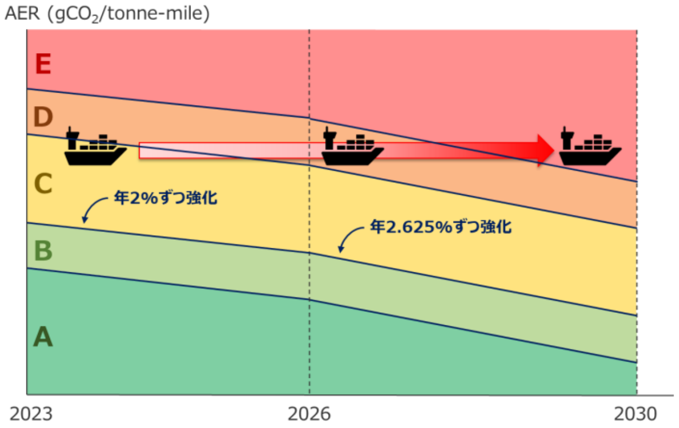
The adoption of alternative fuels is also highly effective in improving CII ratings. Here, we present a comparison of CII ratings for a handymax-sized bulk carrier transitioning from a conventional fuel ship to either a methanol or LNG-fueled ship. (CII: Carbon Intensity Indicators)

Comparison of CII ratings (Conventional fuel oil ship vs. Methanol-fueled ship vs. LNG-fueled ship: e.g. Handymax bulk carrier)

Fuel type	CII ratings 2023 (5%)	2024 (7%)	2025 (9%)	2026 (11%)	2027 (13.625%)	2028 (16.250%)	2029 (18.875%)	2030 (21.500%)
Conventional fuel oil	C	C	C	D	D	D	D	E
Methanol [10% CO_2 reduction]	B	B	C	C	C	C	C	D
LNG [27% CO_2 reduction]	A	A	A	A	A	A	A	B

The percentages in parentheses indicate the reduction rates from the CII reference line used for setting the benchmark values (compared to 2019 levels).

Image of CII rating transition



- Based on the average energy efficiency performance in 2023, the CII rating for a handymax-sized bulk carrier (using conventional fuel oil) would be C as of 2023, and it will follow the trends as indicated in the table (without assuming energy efficiency improvements).
- If it transitions from conventional fuel oil to methanol, the CII rating would improve from C to B as of 2023 (without assuming fuel efficiency improvements).
- If it transitions from conventional fuel oil to LNG, the CII rating would improve from C to A as of 2023 (without assuming fuel efficiency improvements).

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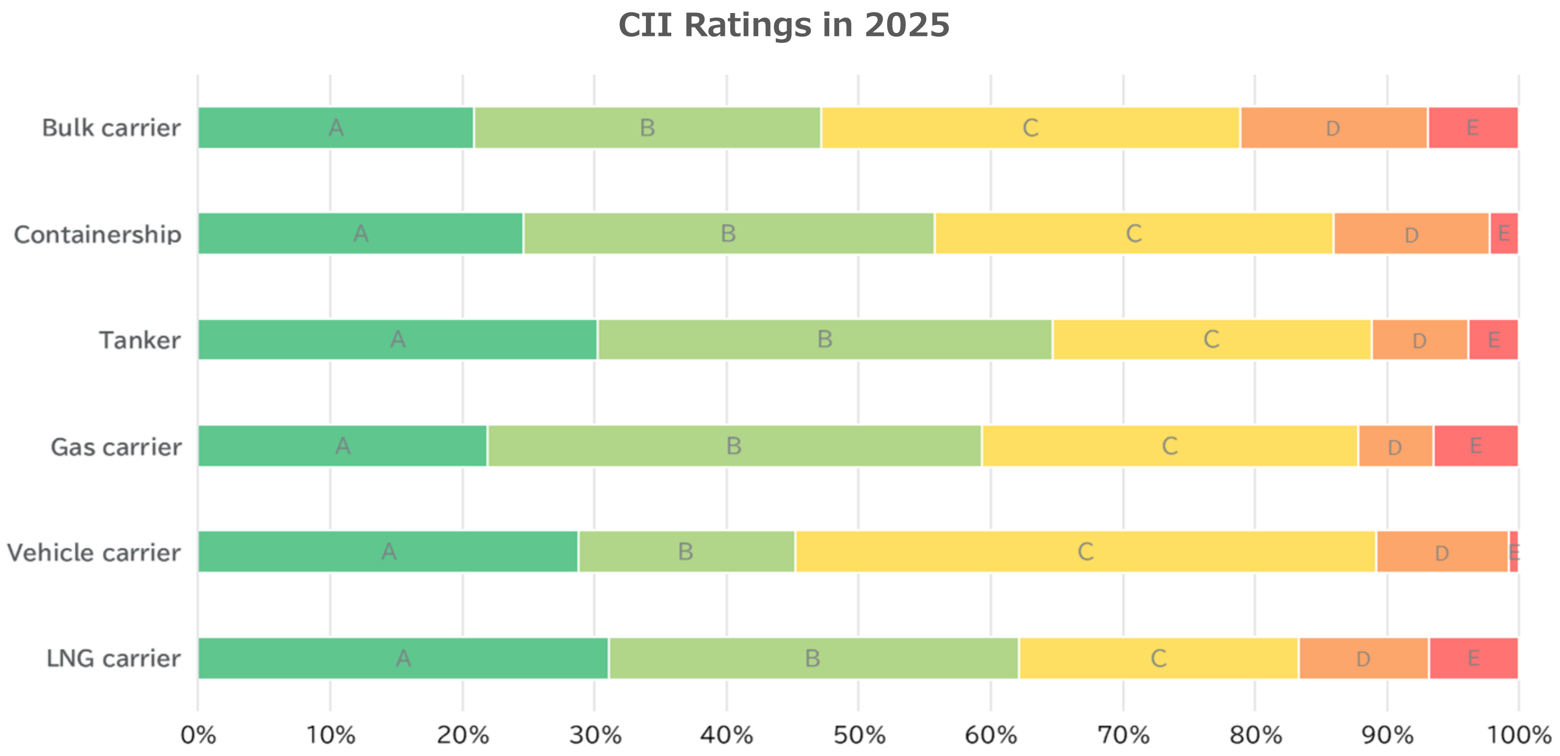
<Reference> Result of CII ratings (2025, verified by ClassNK)



Source: Verified by ClassNK

Rating	Total (NK)	Total (IMO)
A	25 %	To be disclosed
B	29 %	
C	29 %	
D	12 %	
E	5 %	
Source	Verified by ClassNK	-

- Now in its third year since introduction, the CII rating scheme produced favorable results for 2025 among ClassNK-verified vessels, with 54% of the fleet rated A or B. At the same time, vessels rated D or E accounted for a combined 17%, and with the reference lines being tightened each year, improving actual fuel efficiency remains a key challenge.

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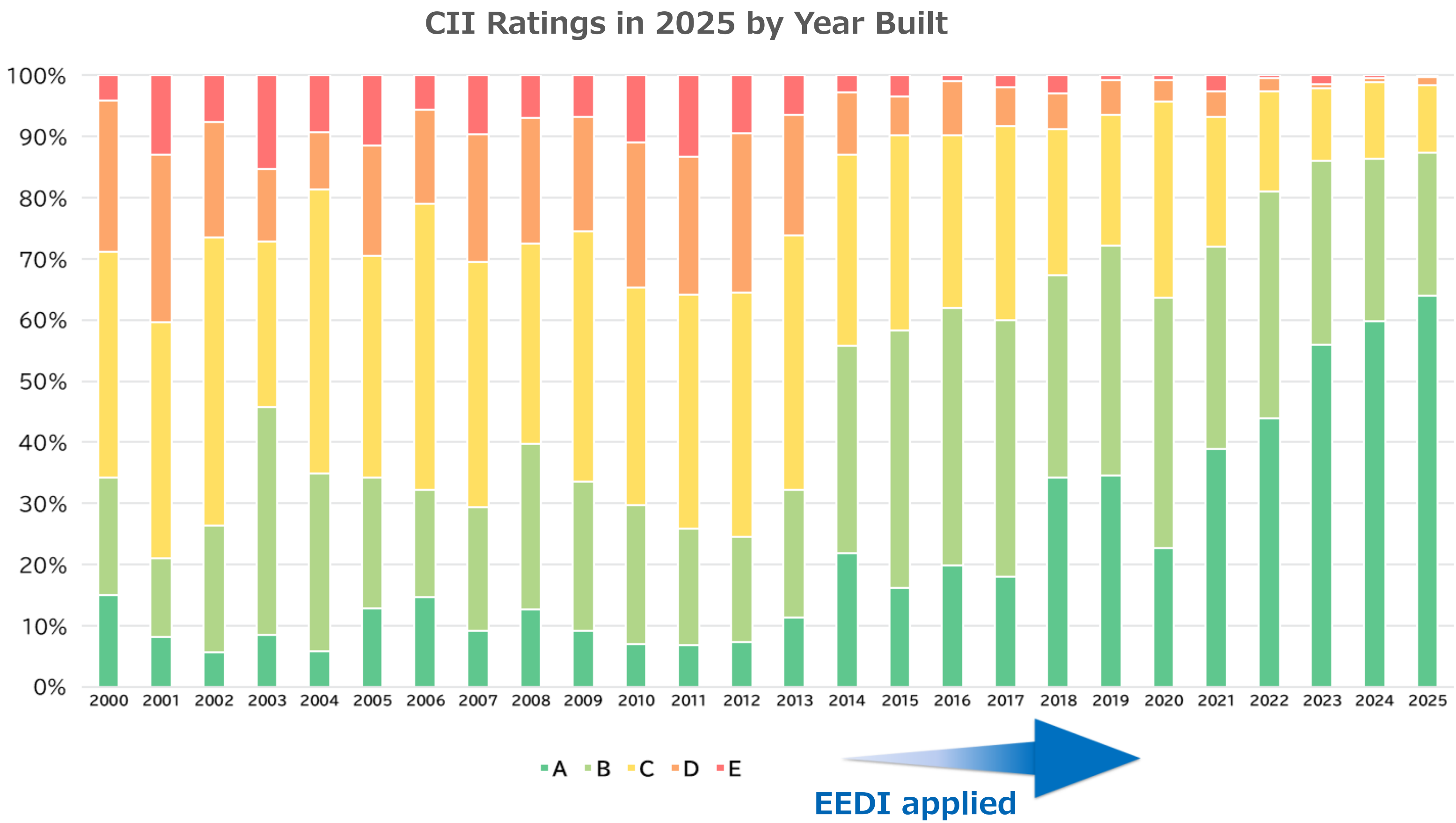
<Reference>Result of CII ratings (2025, verified by ClassNK, by year built)



Source: Verified by ClassNK

- CII ratings tend to be better for vessels that are relatively young and have good design fuel efficiency. This tendency is particularly pronounced for vessels delivered after the EEDI regulations came into force.

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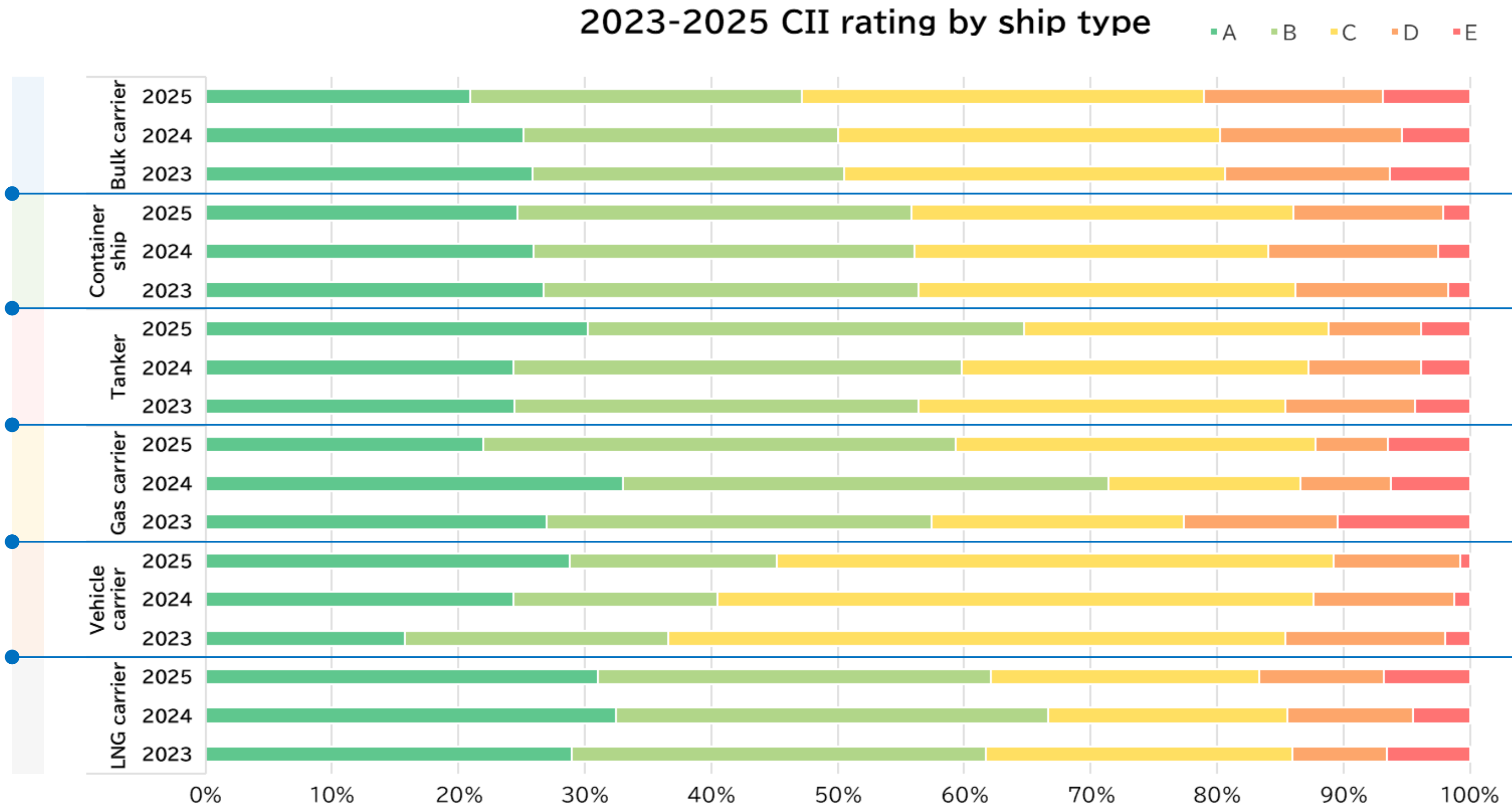
<Reference>Result of CII ratings (2023 vs. 2024 vs. 2025, verified by ClassNK)



Ship type	Year	Average Speed
Bulk carrier	2025	10.6 kn
	2024	10.7 kn
	2023	10.8 kn
Container ship	2025	14.0 kn
	2024	14.0 kn
	2023	14.2 kn
Tanker	2025	11.2 kn
	2024	11.3 kn
	2023	11.9 kn
Gas carrier	2025	13.2 kn
	2024	13.6 kn
	2023	13.6 kn
Vehicle carrier	2025	14.4 kn
	2024	14.6 kn
	2023	14.9 kn
LNG carrier	2025	13.1 kn
	2024	13.9 kn
	2023	14.0 kn

Source: Verified by ClassNK

- Although the required CII values are tightened each year, the proportion of vessels rated A or B was broadly maintained across most ship types. Since average speeds declined consistently from 2023 to 2025 for each ship type, improvements in actual fuel efficiency through slow steaming are considered to have contributed to maintaining these ratings.

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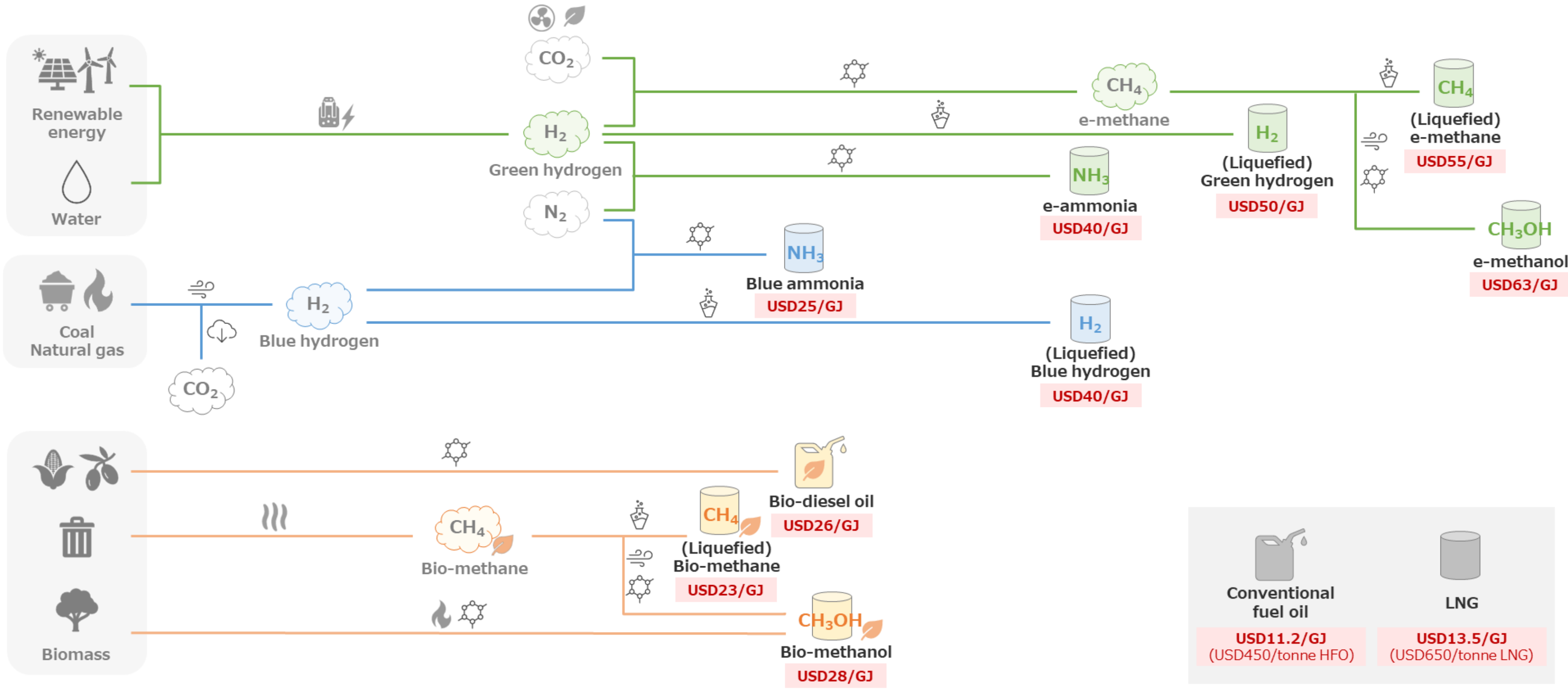
Alternative fuel costs

While a wide variety of alternative fuels are available for ships, they are generally expected to be 1.5 to 4 times more expensive than conventional fuel oil. Although production expansion and new regulations are projected to narrow this cost gap in the future, significant uncertainty remains regarding price trends and the supply-demand balance in the coming years. Therefore, closely monitoring fuel cost trends is the most critical factor when considering the adoption of alternative fuels.

Production pathways and costs of alternative fuels (Image)



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Share of alternative fuels

Of the global fleet's annual fuel consumption of 230 million tonnes (2024), alternative fuels such as LNG, LPG, and methanol accounted for only 9%. However, this share is expected to rise as the number of alternative fueled vessels increases. To meet this growing demand, further expansion of alternative fuel production scale is essential.

Fuel Consumption of ships subject to the IMO DCS (5,000 gross tonnage and above engaged in international voyages) [Unit: ton]

	Heavy Fuel Oil (HFO)	Light Fuel Oil (LFO)	Diesel/Gas Oil (MDO/MGO)	LNG	LPG (Propane)	LPG (Butane)	Methanol	Ethanol	Other (Mainly biofuels)	Total (HFO eq)
2022 (28,834 ships) (1.29 bn GT)	116,576,283	57,077,835	28,285,802	10,950,408	88,774	16,673	35,523	10,890	226,739	218,339,992
2023 (28,620 ships) (1.30 bn GT)	130,441,745	40,416,174	26,600,016	12,890,011	192,405	49,887	93,876	4,137	428,263	215,833,384
2024 (29,690 ships) (1.36 bn GT)	155,863,841	24,446,109	26,368,925	14,954,694	269,507	80,562	137,844	23,474	1,225,531	228,473,260

Source: Report of fuel oil consumption data submitted to the IMO Ship Fuel Oil Consumption Database in GISIS

If we aim to replace all 230 million tons of Heavy Fuel Oil (HFO) with alternative fuels...

- **HFOeq 230 mil. tons** ▶ **For all methanol** **460 mil. tons of methanol needed** (Current global production volume for all sectors: 106 mil. tons/year*)
- **HFOeq 230 mil. tons** ▶ **For all ammonia** **490 mil. tons of ammonia needed** (Current global production volume for all sectors: 183 mil. tons/year*)
- **HFOeq 230 mil. tons** ▶ **For all methane/LNG** **190 mil. tons of methane needed** (Current global production volume for all sectors: 401 mil. tons/year*)
- **HFOeq 230 mil. tons** ▶ **For all hydrogen** **80 mil. tons of hydrogen needed** (Current global production volume for all sectors: 97 mil. tons/year*)

*Approximately 99% of the production volume is derived from fossil resources.

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Amount of renewable energy electricity required for green hydrogen production

Scaling up renewable energy is crucial for expanding green hydrogen production—the feedstock for green ammonia, methanol, and methane. Here, we outline the estimated renewable power required for its production.

Amount of renewable energy electricity required for green hydrogen production

Annual fuel consumption in international shipping[*1]

*1 Subject to ships 5,000 gross tonnage and above engaged in international voyages

HFO eq 230 mil. tonnes

Methanol eq	Ammonia eq	Methane eq	Hydrogen eq
460 mil. tonnes	490 mil. tonnes	190 mil. tonnes	80 mil. tonnes
Required Hydrogen 88 mil. tonnes	Required Hydrogen 88 mil. tonnes	Required Hydrogen 95 mil. tonnes	

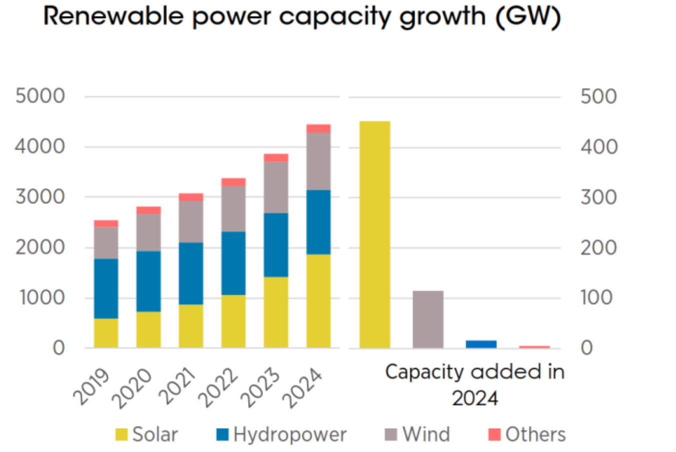
Required renewable energy electricity capacity[*2]

560 GW	560 GW	600 GW	510 GW

x 365 days of operation (8,760h)

*2 The calculated power consumption is based on 5.0 kWh per Nm^3-H_2.

Trend of global renewable energy capacity



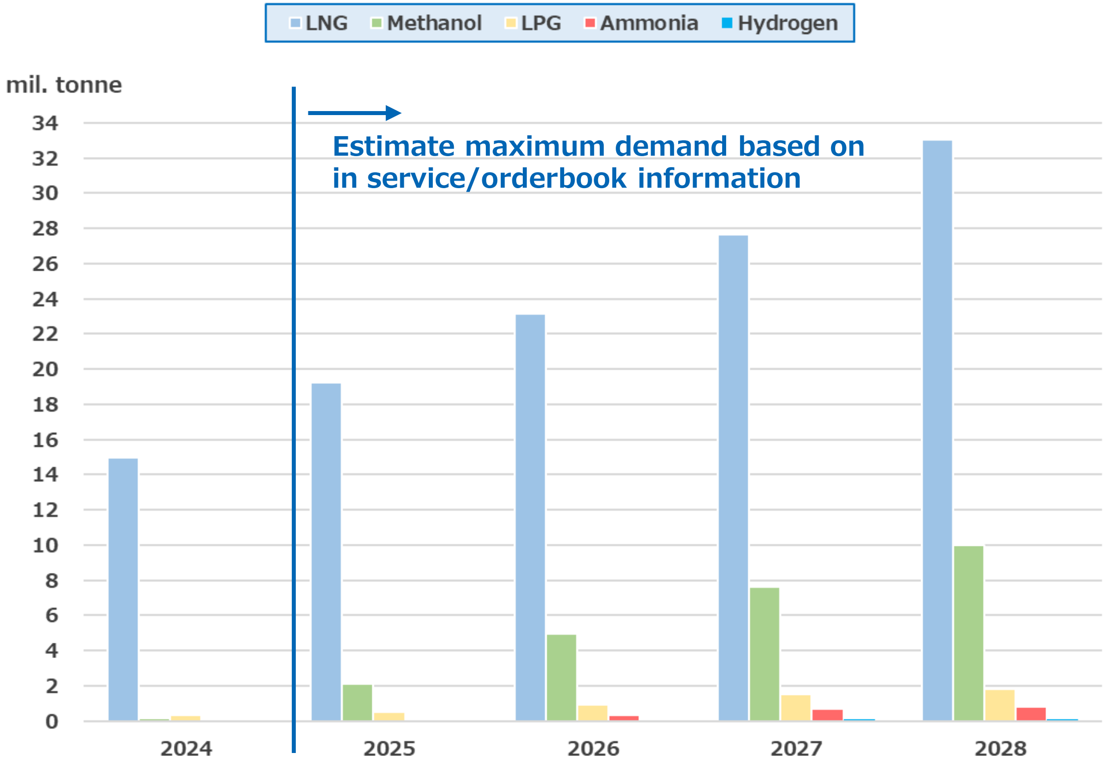
Source: IRENA (2025), Renewable capacity statistics 2025, International Renewable Energy Agency, Abu Dhabi. (Highlights)

- While global renewable energy capacity is steadily increasing, the reality is that most of it is currently consumed directly as electricity. To advance the decarbonization of international shipping, a critical focal point will be how to expand renewable energy deployment specifically for green hydrogen production.

Demand outlook for alternative fuels

Understanding the demand outlook is essential for securing alternative fuels and projecting procurement prices. This section presents demand projections estimated based on data regarding alternative fueled vessels currently in service and in the orderbook.

Maximum demand outlook for alternative fuels



- ✓ 5,000 gross tonnage and above / LNG carriers are included. / Alternative fuel ready ships are not included.
- ✓ For 2024, the figures are IMO DCS aggregated data (actuals).

- ✓ ClassNK has estimated the maximum demand* for each alternative fuel through 2028, using in service and orderbook data for alternative fuel ships as of December 31, 2025.
  *Alternative fueled vessels delivered from 2025 are assumed to run solely on alternative fuels; pilot fuel consumption is excluded from this projection.
- ✓ **LNG**: The mass delivery of LNG-fueled ships, on a scale comparable to the current fleet, could lead to a peak demand of **33 million tonnes** at 2028.
- ✓ **Methanol**: The successive delivery of methanol-fueled ships, especially containerships, could lead to a peak demand of **10 million tonnes** at 2028.
- ✓ **LPG**: Given that the only ship type anticipated to use this fuel is the LPG carrier, the peak demand is forecast to be capped at **1.8 million tonnes** at 2028.
- ✓ **Ammonia** and **Hydrogen**: Despite the current limited demand, future growth is anticipated as these fueled ships are delivered.

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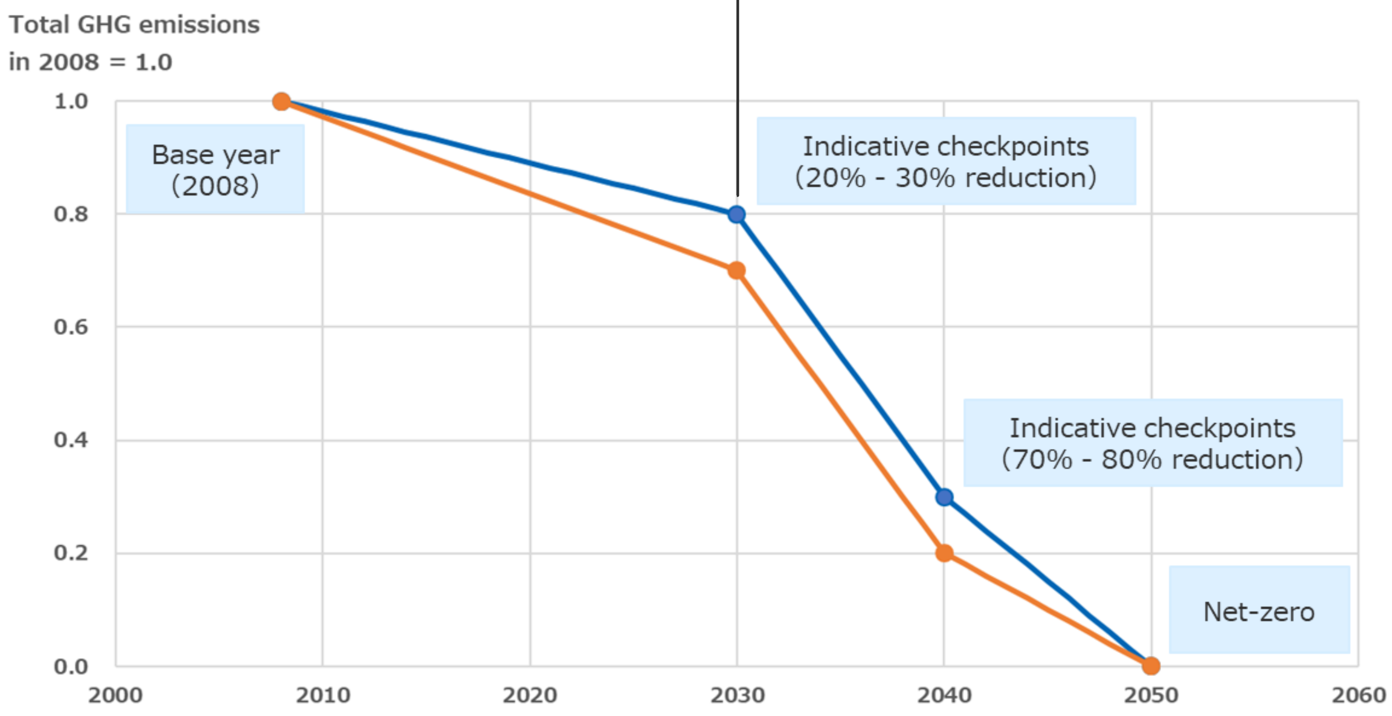
Zero-emission fuels and zero-emission ships required for international shipping

The "2023 IMO GHG Strategy" has set new GHG reduction targets, and international shipping will now chart a course towards achieving net-zero GHG emissions by or around 2050. Here, we introduce the volume of zero-emission fuels and zero-emission ships needed along this pathway.

Introduction volume of zero-emission ships/fuels needed to achieve the 2030 indicative checkpoint in the IMO's GHG reduction goal



Introduction volume of zero-emission ships/fuels needed to achieve the 2030 indicative checkpoint (Well-to-Wake)*:

*Calculations for ships of 5,000 gross tonnage and above engaged in international voyages (ships subject to IMO DCS)

✓ Zero-emission fuels

25% of the fuel used in international shipping to be zero-emission fuel (as of 2030)

- For all green methanol :106 million tons
- For all green ammonia :114 million tons

✓ Zero-emission ships

Zero-emission ships needed to consume the above fuel volume (as of 2030)

- 352 million gross tonnage

Please refer to the ClassNK-issued white paper titled "Pathway to Zero-Emission in International Shipping - Understanding the 2023 IMO GHG Strategy" for more details.

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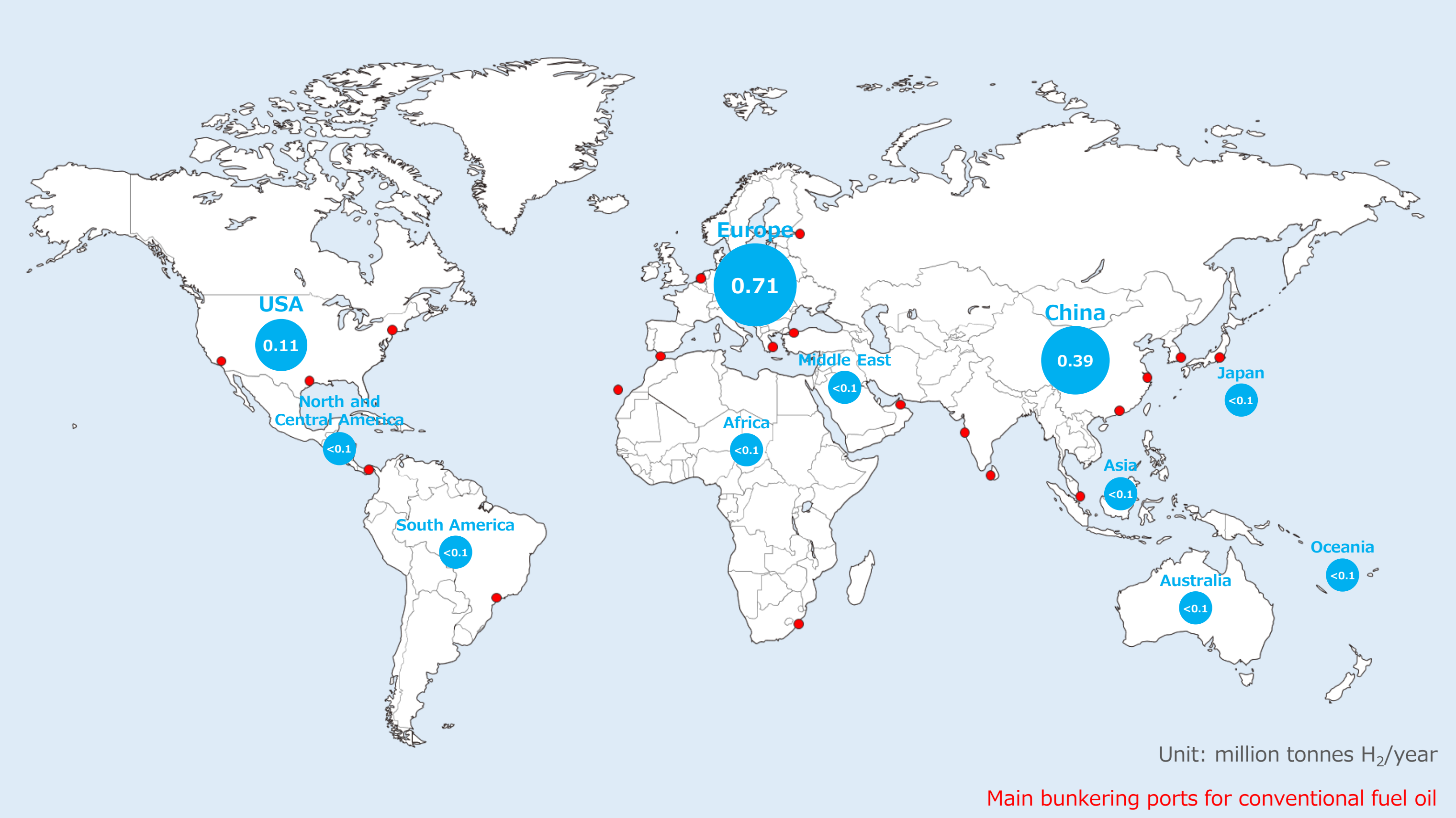
Alternative fuel production projects - 1 (Green hydrogen)

Understanding the supply outlook is essential for the adoption of alternative fuels. This section presents the production scale of green hydrogen, including planned capacity. Hydrogen serves not only as a direct marine fuel but also as a feedstock for ammonia and methanol. Please note that the production projects listed here are not exclusive to the maritime sector.

Distribution of green hydrogen production projects (Operational/Construction/FID, for all sectors, as of Sep. 2025)



Country/ Region	Number of projects	Annual production capacity (total) [Unit: tonne H_2/year]
Europe	286	706,259
China	36	389,871
USA	28	107,733
Asia	39	54,275
North and Central America	11	18,549
Africa	5	14,239
Australia	23	8,230
Japan	18	4,191
South America	16	3,201
Oceania	2	955
Middle East	5	639
Total	**469**	**1,308,142**

Source: Prepared by ClassNK based on IEA (2025), Hydrogen Production Projects Database

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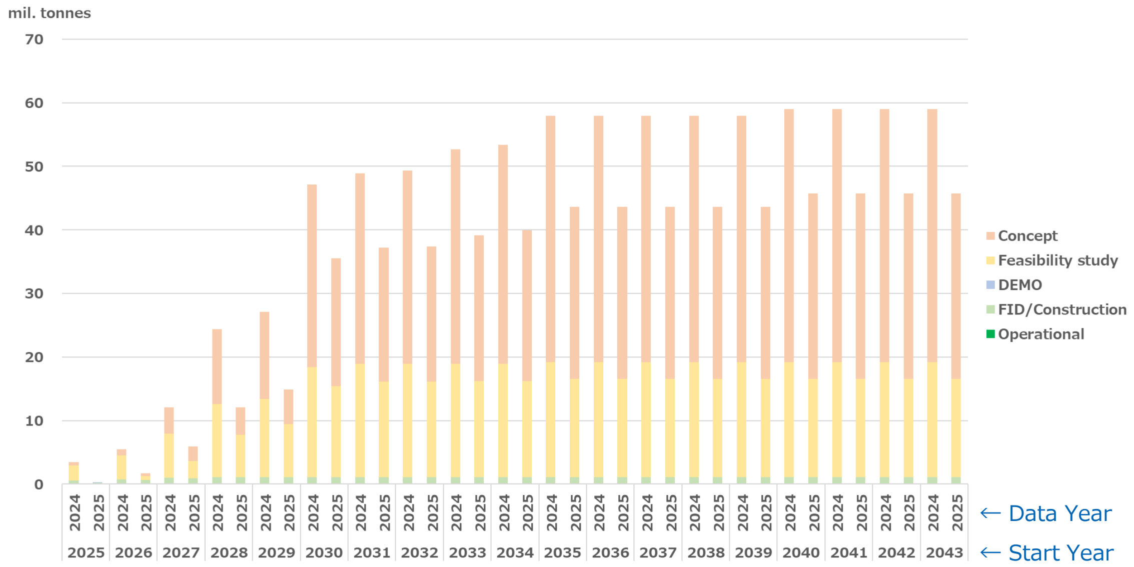
Alternative fuel production projects - 1 (Green hydrogen)

The majority of planned green hydrogen projects remain in the Concept or Feasibility Study phases, with Final Investment Decisions (FID) yet to be reached. Closely monitoring these trends is essential to forecast future production capacity.

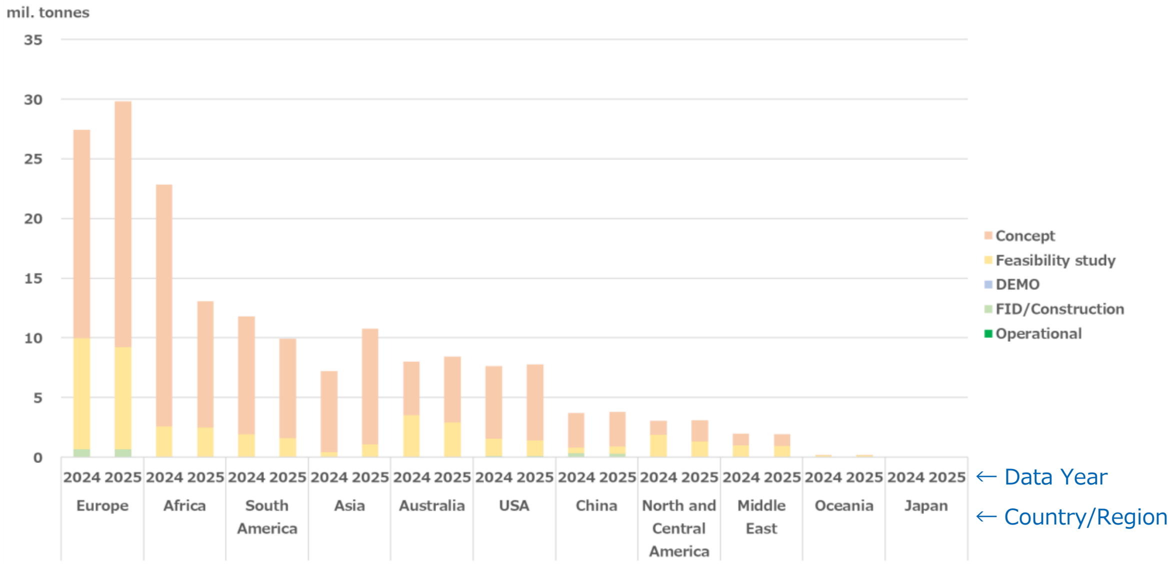
Projected production capacity of green hydrogen (for all sectors, Comparison: 2024 vs. 2025)

Projected production capacity by year



- While production capacity is projected to expand from 2030 onwards, the majority of projects remain in the Concept or Feasibility Study stages. Additionally, some project cancellations have been confirmed over the past year.

Projected production capacity by country/region (as of 2043)



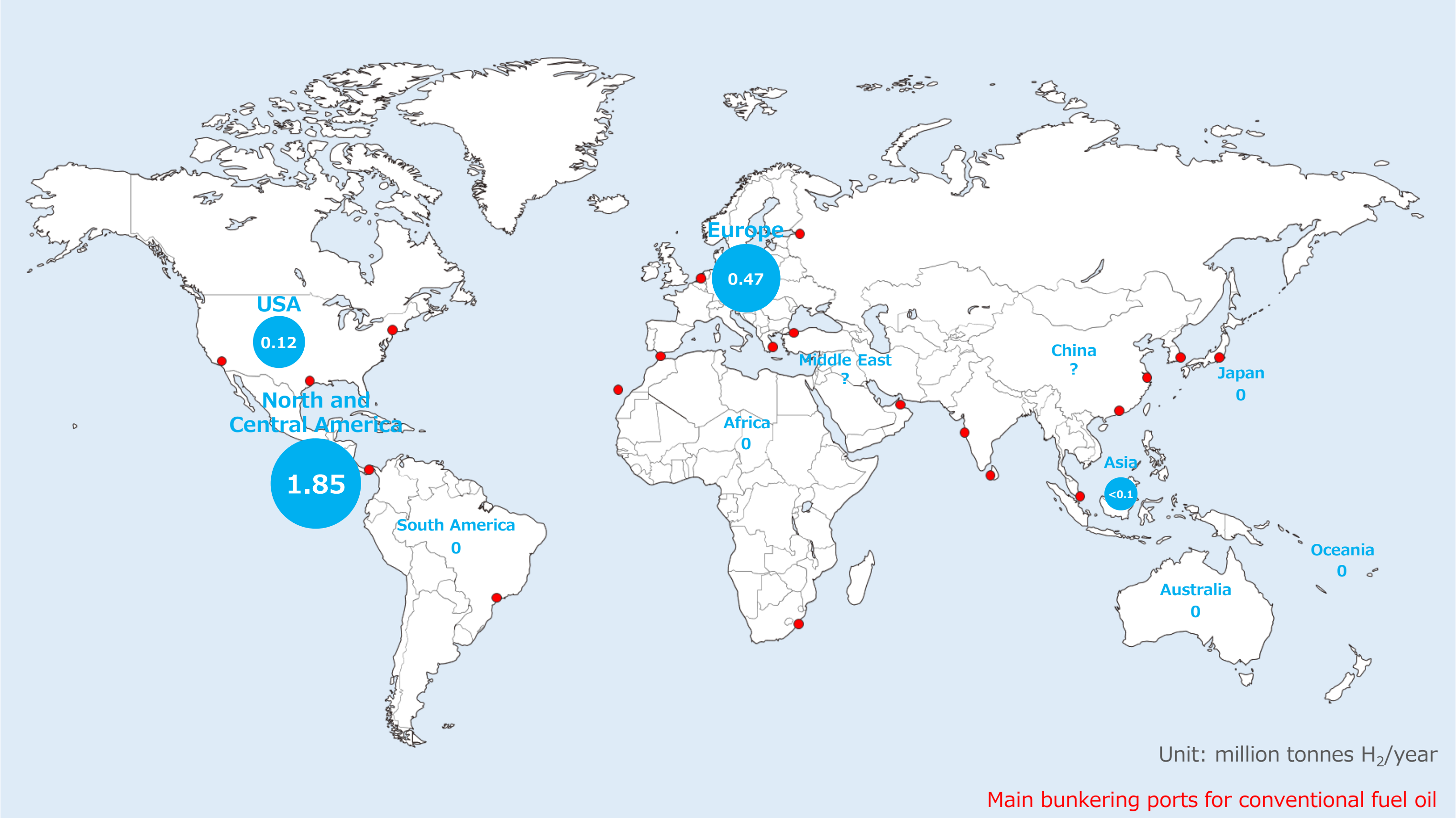
- Production projects are concentrated in Europe. Meanwhile, in Africa and South America—regions considered suitable for production—projected capacity has declined compared to the 2024 data, largely due to project cancellations.

Source: Prepared by ClassNK based on IEA (2025), Hydrogen Production Projects Database

Alternative fuel production projects - 2 (Blue hydrogen)

This section presents the production scale of blue hydrogen, including planned capacity. Hydrogen serves not only as a direct marine fuel but also as a feedstock for ammonia and methanol. Please note that the production projects listed here are not exclusive to the maritime sector.

Distribution of blue hydrogen production projects (Operational/Construction/FID, for all sectors, as of Sep. 2025)



Country/ Region	Number of projects	Annual production capacity (total) [Unit: tonne H_2/year]
North and Central America	6	1,848,000
Europe	8	471,410
USA	2	118,076
Asia	1	1,825
China	1	?
Middle East	1	?
Total	**19**	**2,439,311**

Source: Prepared by ClassNK based on IEA (2025), Hydrogen Production Projects Database

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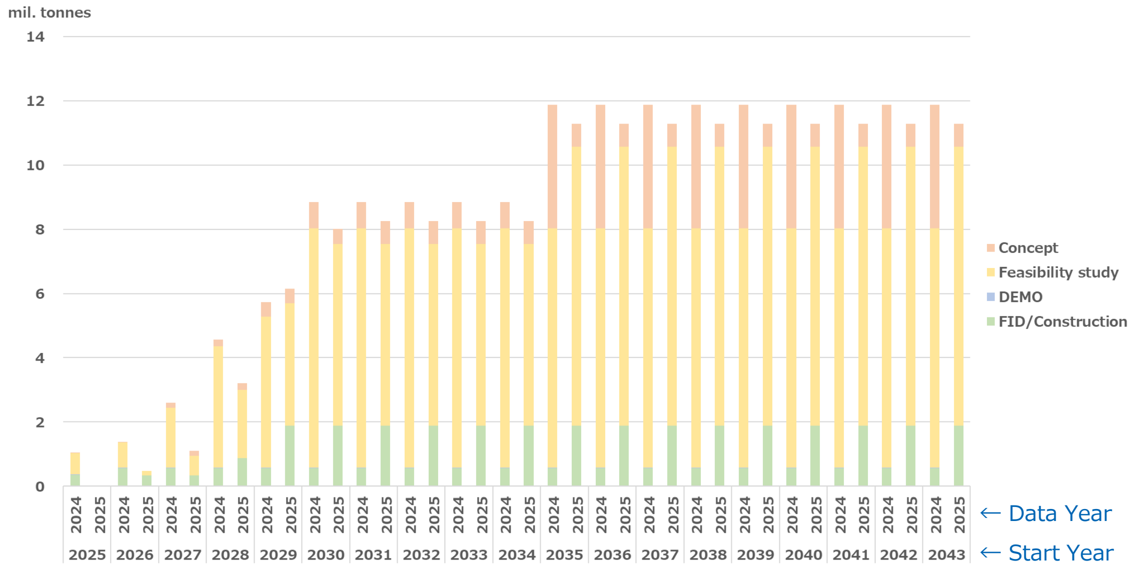
Alternative fuel production projects - 2 (Blue hydrogen)

The majority of planned blue hydrogen projects remain in the Feasibility Study phase, with Final Investment Decisions (FID) yet to be reached. Closely monitoring these trends is essential to forecast future production capacity.

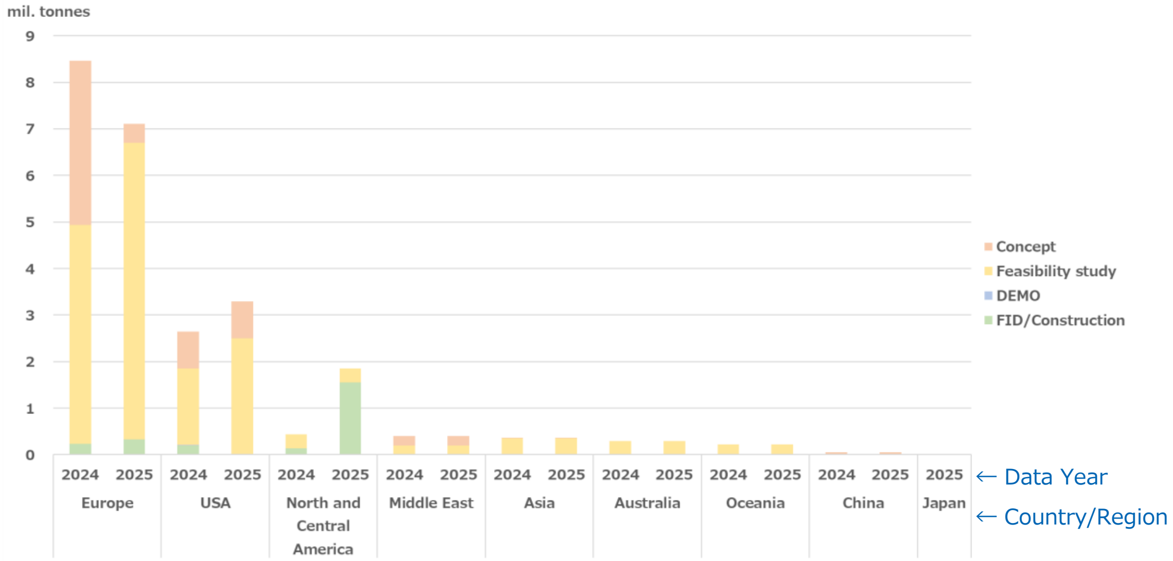
Projected production capacity of blue hydrogen (for all sectors, Comparison: 2024 vs. 2025)

Projected production capacity by year



- While production capacity is projected to expand from 2030 onwards, many projects remain in the Feasibility Study stage. On the other hand, some projects were confirmed to have reached Final Investment Decision (FID) over the past year.

Projected production capacity by country/region (as of 2043)



- Production projects are concentrated in Europe. In North America (Canada), however, new projects reaching Final Investment Decision (FID) were confirmed over the past year, indicating that blue hydrogen is transitioning to the implementation phase.

Source: Prepared by ClassNK based on IEA (2025), Hydrogen Production Projects Database

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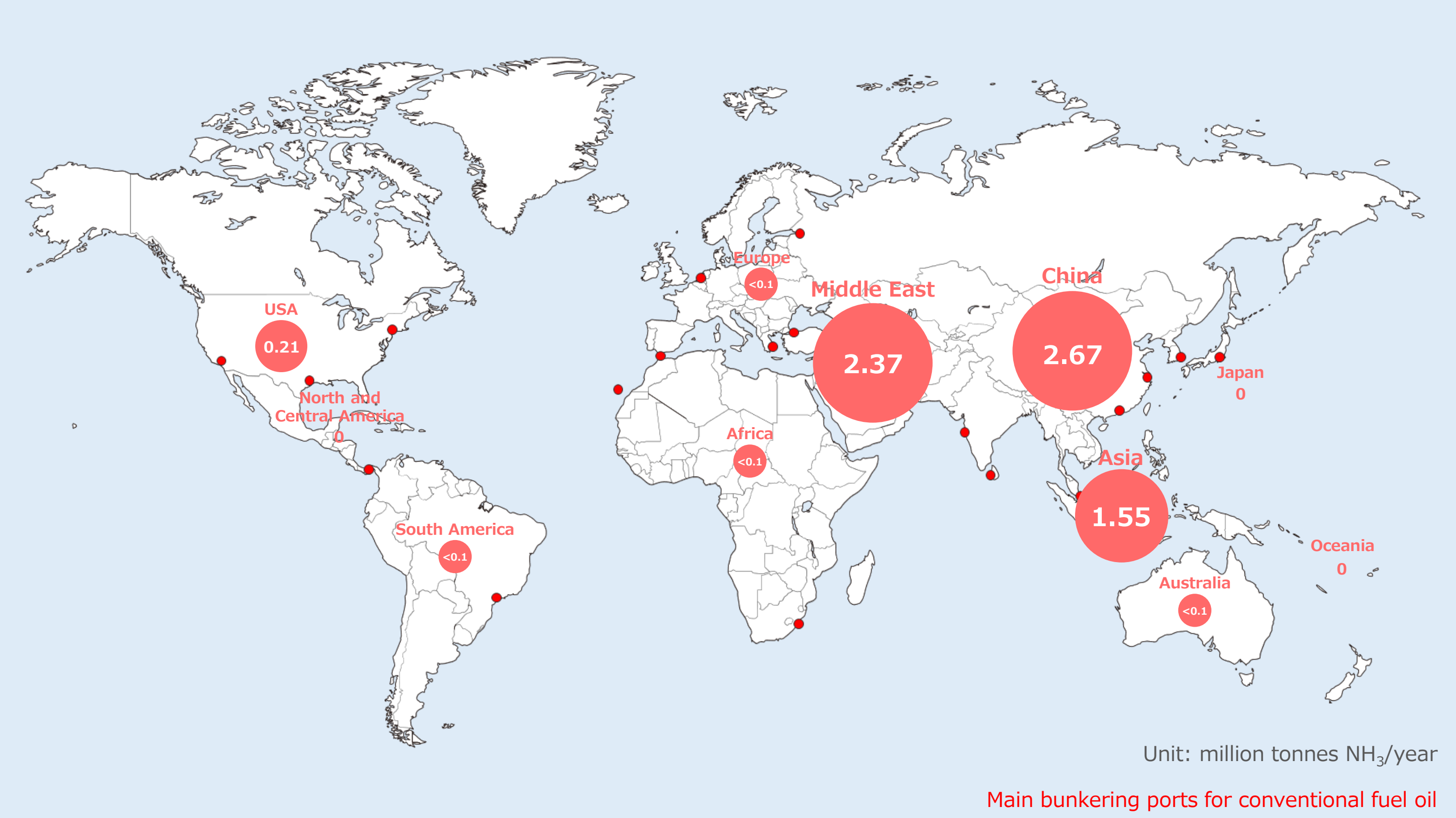
Alternative fuel production projects - 3 (Green ammonia)

This section presents the production scale of green ammonia, including planned capacity. Ammonia is utilized directly as a marine fuel and is also expected to serve as a hydrogen carrier. Please note that the production projects listed here are not exclusive to the maritime sector.

Distribution of green ammonia production projects (Operational/Construction/FID, for all sectors, as of Sep. 2025)



Country/ Region	Number of projects	Annual production capacity (total) [Unit: tonne NH_3/year]
China	9	2,673,038
Middle East	2	2,371,869
Asia	5	1,550,620
USA	3	214,368
South America	4	89,168
Europe	4	75,247
Africa	3	12,730
Australia	1	9,412
Total	**31**	**6,996,452**

Source: Prepared by ClassNK based on IEA (2025), Hydrogen Production Projects Database

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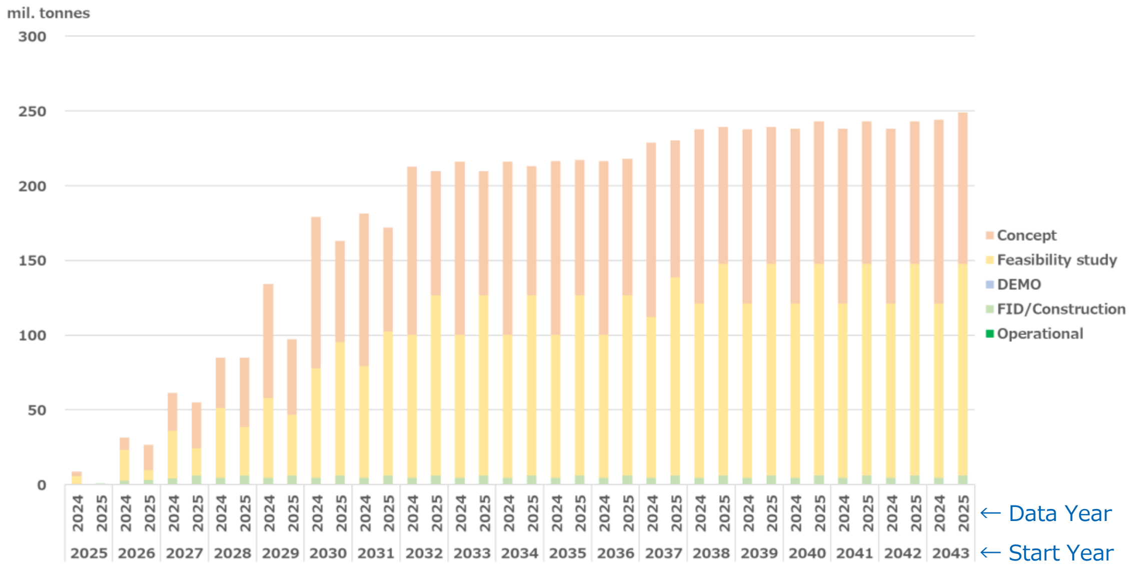
Alternative fuel production projects - 3 (Green ammonia)

The majority of planned green ammonia projects remain in the Concept or Feasibility Study phases, with Final Investment Decisions (FID) yet to be reached. Closely monitoring these trends is essential to forecast future production capacity.

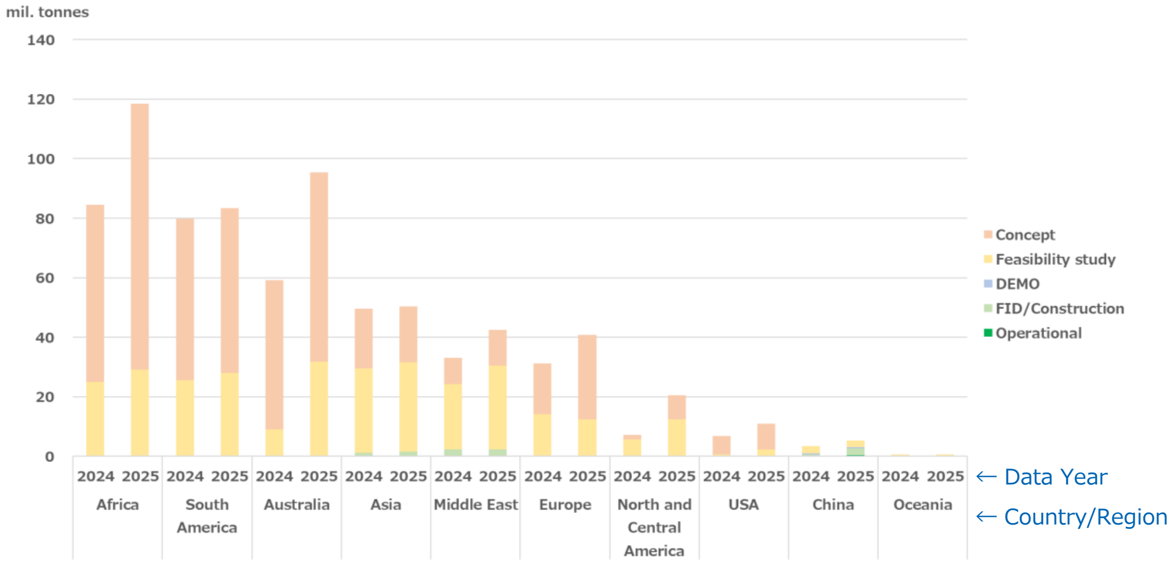
Projected production capacity of green ammonia (for all sectors, Comparison: 2024 vs. 2025)

Projected production capacity by year



- While a gradual expansion of production capacity is projected, the majority of projects remain in the Concept or Feasibility Study stages. Additionally, some project cancellations have been confirmed over the past year.

Projected production capacity by country/region (as of 2043)



- Many production projects are concentrated in Africa, South America, and Australia, which are considered prime locations for green hydrogen. However, project cancellations have been confirmed in these regions over the past year.

Source: Prepared by ClassNK based on IEA (2025), Hydrogen Production Projects Database

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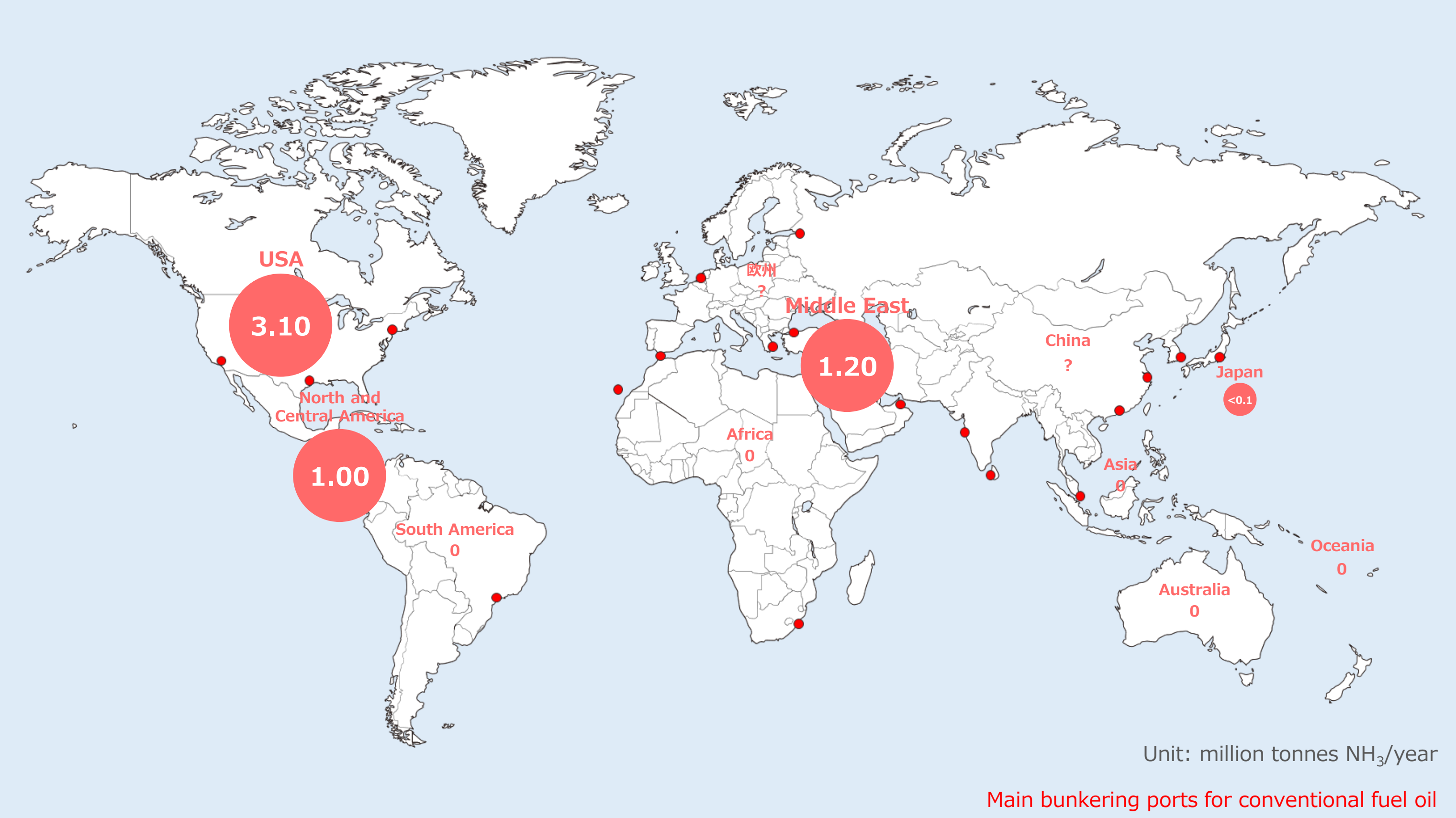
Alternative fuel production projects - 4 (Blue ammonia)

This section presents the production scale of blue ammonia, including planned capacity. Ammonia is utilized directly as a marine fuel and is also expected to serve as a hydrogen carrier. Please note that the production projects listed here are not exclusive to the maritime sector.

Distribution of blue ammonia production projects (Operational/Construction/FID, for all sectors, as of Sep. 2025)



Country/ Region	Number of projects	Annual production capacity (total) [Unit: tonne NH_3/year]
USA	8	3,100,000
Middle East	1	1,200,000
North and Central America	1	1,000,000
Japan	1	3,887
Europe	1	?
China	1	?
Total	**13**	**5,303,888**

Source: Prepared by ClassNK based on IEA (2025), Hydrogen Production Projects Database

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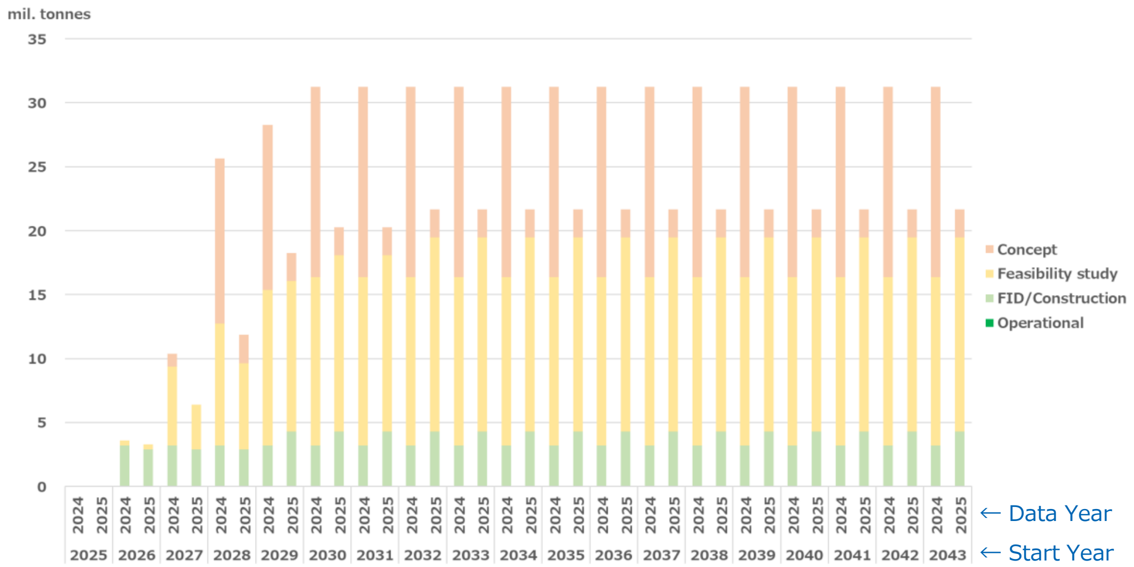
Alternative fuel production projects - 4 (Blue ammonia)

The majority of planned blue ammonia projects remain in the Concept or Feasibility Study phases, with Final Investment Decisions (FID) yet to be reached. Closely monitoring these trends is essential to forecast future production capacity.

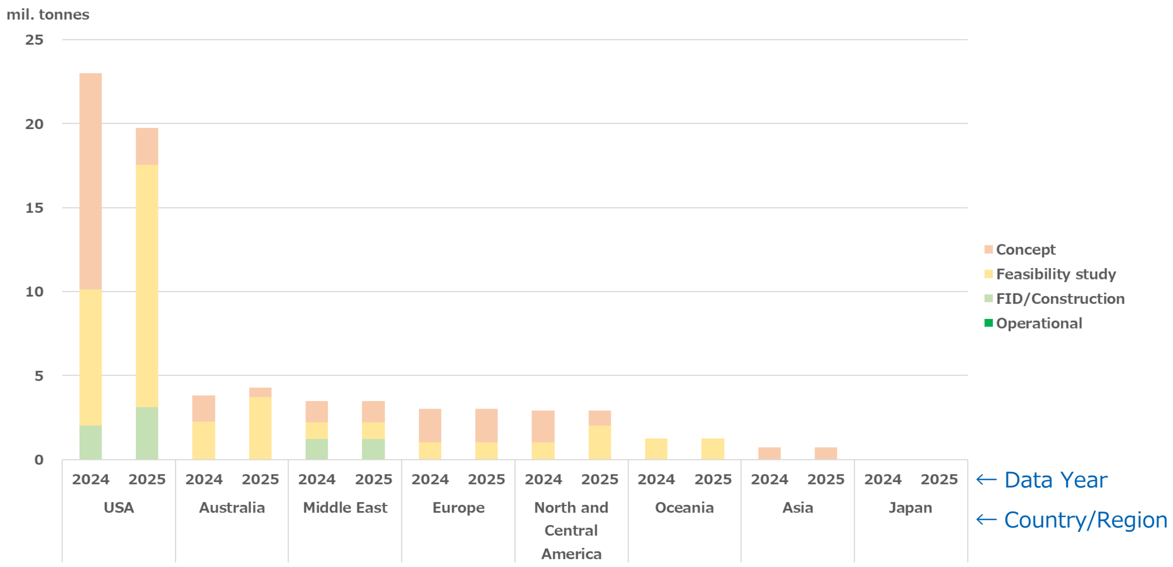
Projected production capacity of blue ammonia (for all sectors, Comparison: 2024 vs. 2025)

Projected production capacity by year



➢ While a gradual expansion of production capacity is projected, many projects remain in the Feasibility Study stage. Additionally, project cancellations have been confirmed over the past year.

Projected production capacity by country/region (as of 2043)



➢ In the United States, which accounts for the majority of projects, steady progress has been observed over the past year. Projects have been confirmed advancing from Concept to Feasibility Study, and further to Final Investment Decision (FID).

Source: Prepared by ClassNK based on IEA (2025), Hydrogen Production Projects Database

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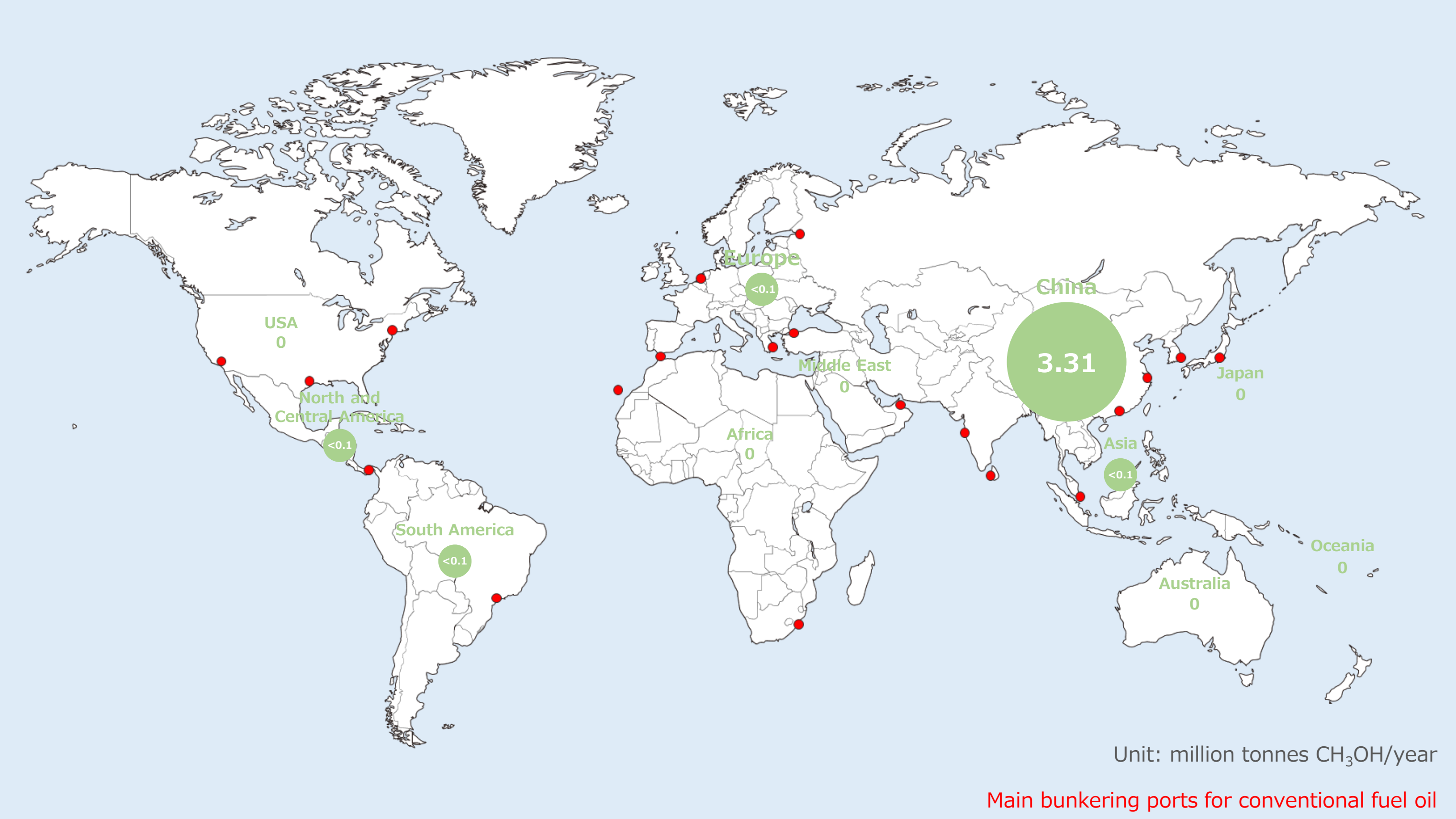
Alternative fuel production projects - 5 (Green methanol)

This section presents the production scale of green methanol, including planned capacity. Methanol is utilized directly as a marine fuel and is also required for the production of FAME (Fatty Acid Methyl Ester) biofuel. Please note that the production projects listed here are not exclusive to the maritime sector.

Distribution of green methanol production projects (Operational/Construction/FID, for all sectors, as of Sep. 2025)



Country/ Region	Number of projects	Annual production capacity (total) [Unit: tonne CH_3OH/year]
China	19	3,311,262
North and Central America	1	70,527
Europe	7	62,339
Asia	1	3,918
South America	1	940
Total	**29**	**3,448,986**

Source: Prepared by ClassNK based on IEA (2025), Hydrogen Production Projects Database

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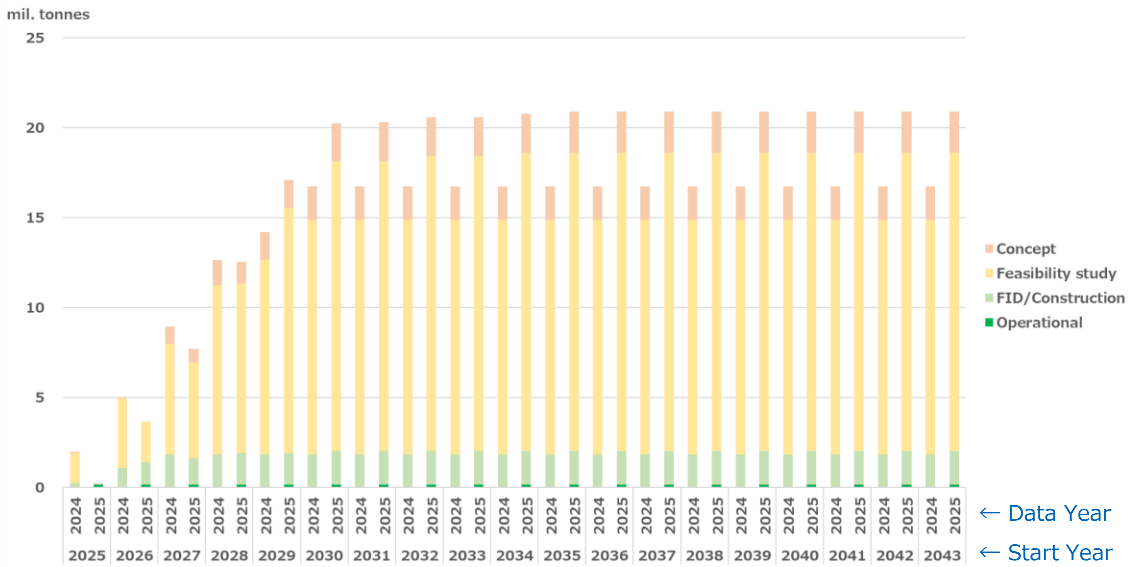
Alternative fuel production projects - 5 (Green methanol)

The majority of planned green methanol projects remain in the Concept or Feasibility Study phases, with Final Investment Decisions (FID) yet to be reached. Closely monitoring these trends is essential to forecast future production capacity.

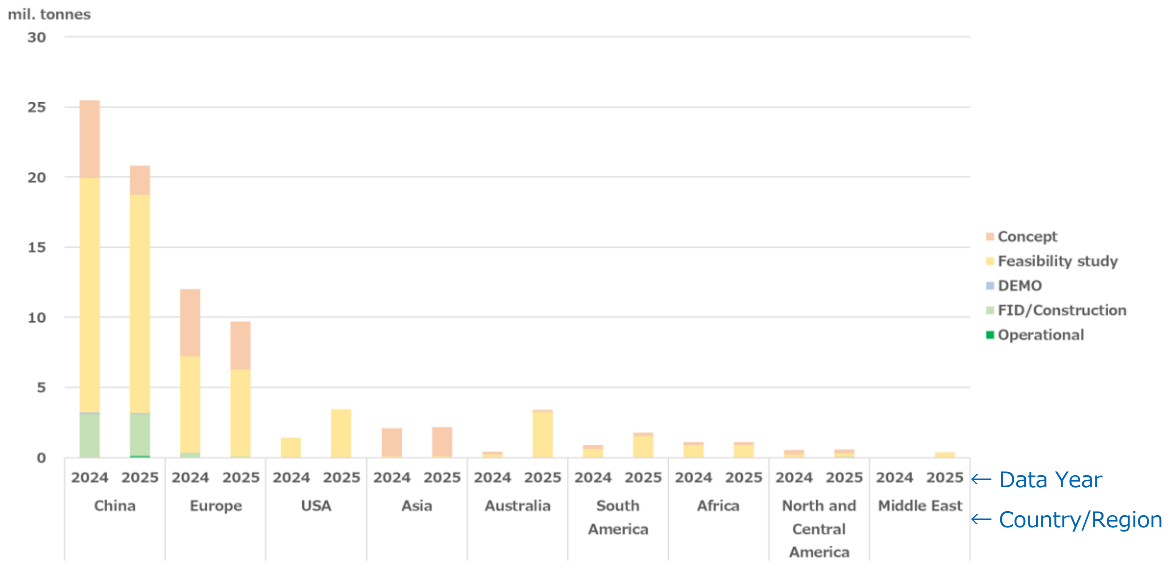
Projected production capacity of green methanol (for all sectors, Comparison: 2024 vs. 2025)

Projected production capacity by year



- While a gradual expansion of production capacity is projected, most projects remain in the Feasibility Study stage. On the other hand, new projects starting production were confirmed over the past year, indicating that commercialization is advancing ahead of other fuels.

Projected production capacity by country/region (as of 2043)



- Most production projects are concentrated in China and Europe. However, due to project cancellations and other factors, projected production capacity in these regions has declined compared to the data from one year ago (2024).

Source: Prepared by ClassNK based on IEA (2025), Hydrogen Production Projects Database

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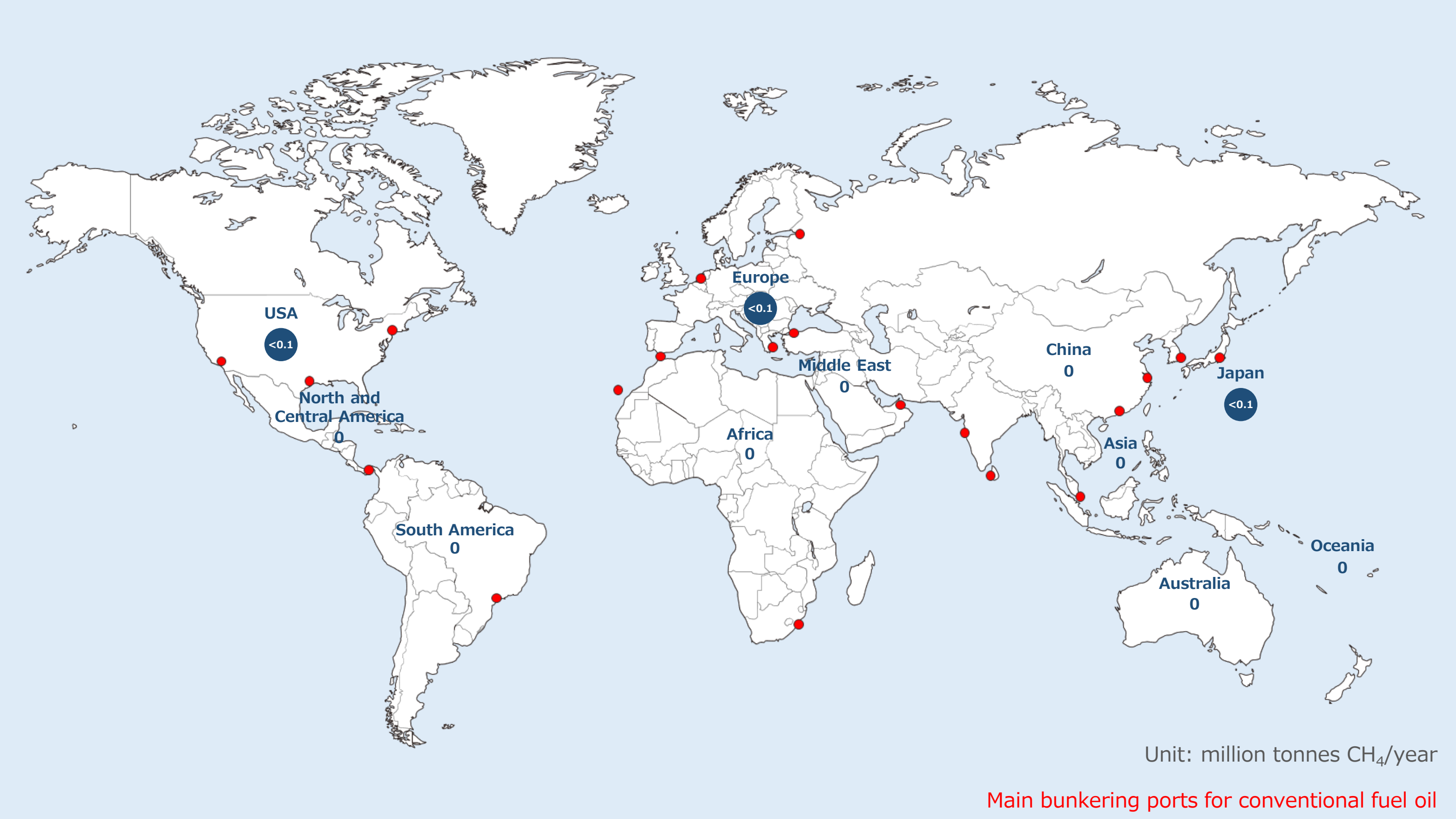
Alternative fuel production projects - 6 (Green methane)

This section presents green methane production capacity, including planned projects. Although methane has a high Global Warming Potential (~30x CO2), advancements in slip reduction are mitigating concerns, leading to renewed interest. Note that listed projects are not exclusive to the maritime sector.

Distribution of green methane production projects (Operational/Construction/FID, for all sectors, as of Sep. 2025)



Country/ Region	Number of projects	Annual production capacity (total) [Unit: tonne CH_4/year]
Europe	18	12,191
USA	1	86
Japan	1	25
Total	**20**	**12,302**

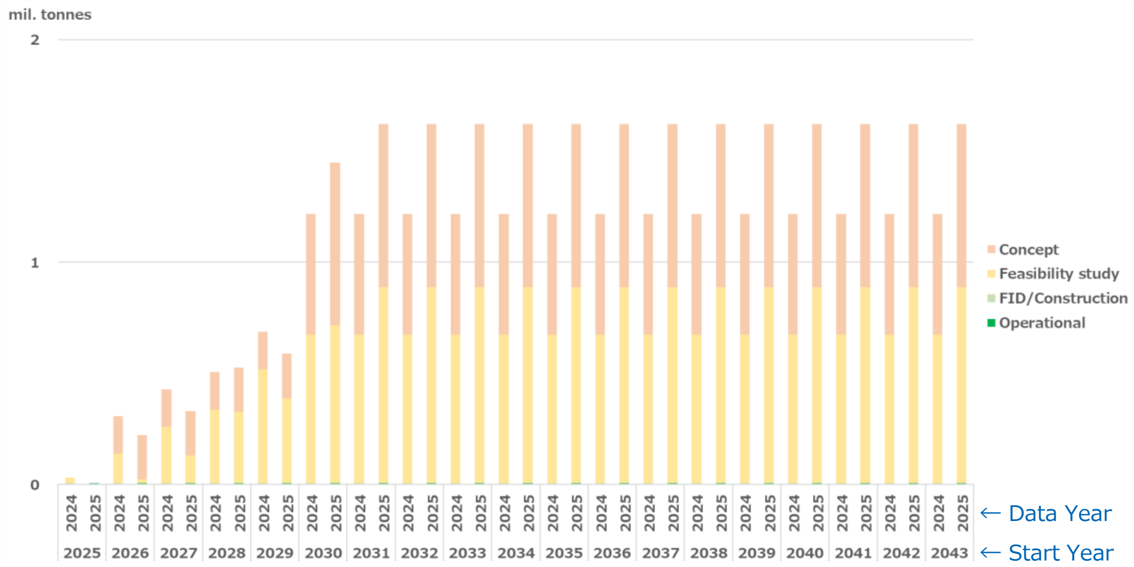
Source: Prepared by ClassNK based on IEA (2025), Hydrogen Production Projects Database

Alternative fuel production projects - 6 (Green methane)

The majority of planned green methane projects remain in the Concept or Feasibility Study phases, with Final Investment Decisions (FID) yet to be reached. Closely monitoring these trends is essential to forecast future production capacity.

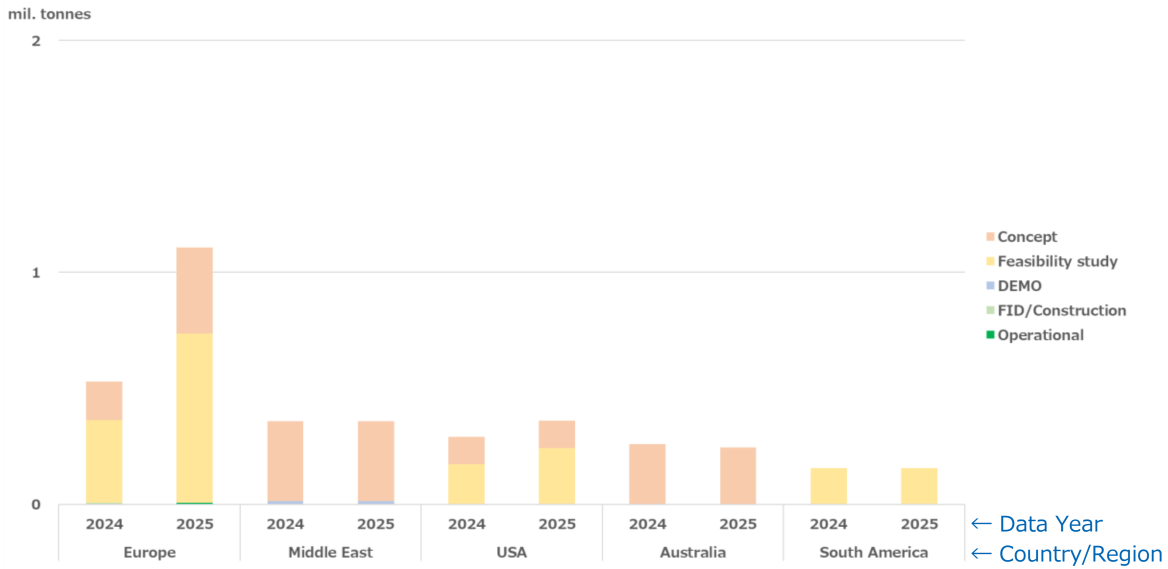
Projected production capacity of green methane (for all sectors, Comparison: 2024 vs. 2025)

Projected production capacity by year



- While production capacity is projected to expand from 2030 onwards, the majority of projects remain in the Concept or Feasibility Study stages. On the other hand, new projects launched over the past year have also been confirmed.

Projected production capacity by country/region (as of 2043)



- While plans in most countries and regions remain in the early stages, new developments were observed in Europe over the past year. Its importance is being re-evaluated as a transition fuel from LNG, given that it can utilize existing infrastructure.

Source: Prepared by ClassNK based on IEA (2025), Hydrogen Production Projects Database

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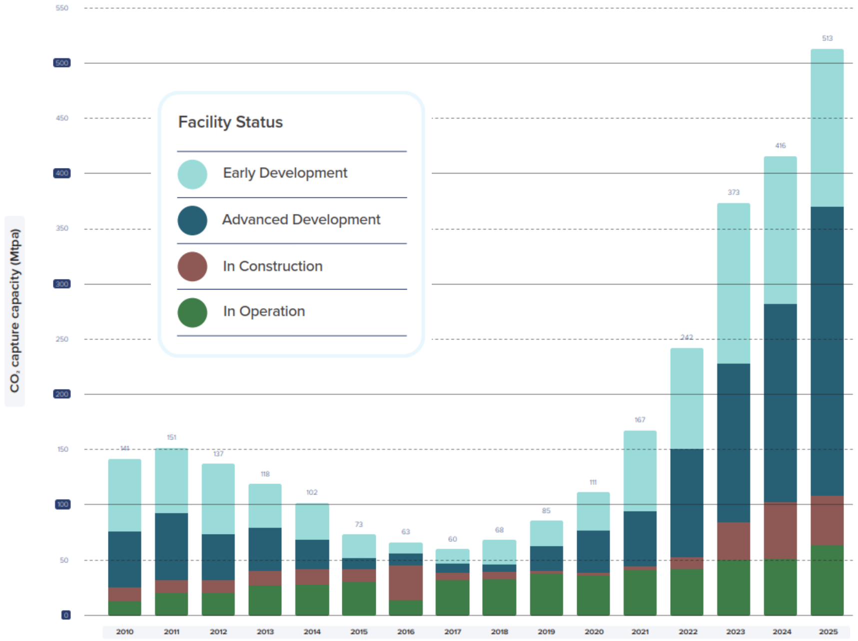
CCS projects

To reduce GHG emissions from ships, not only the use of alternative fuels, but also the utilization of onboard CCS (Carbon Capture and Storage) are effective measures. In the utilization of onboard CCS, it is important to consider where the captured CO_2 will be unloaded and stored. Here, we introduce the trends and distribution of CCS facility development.

Development trends and distribution of CCS facilities

Development trends of CCS facilities

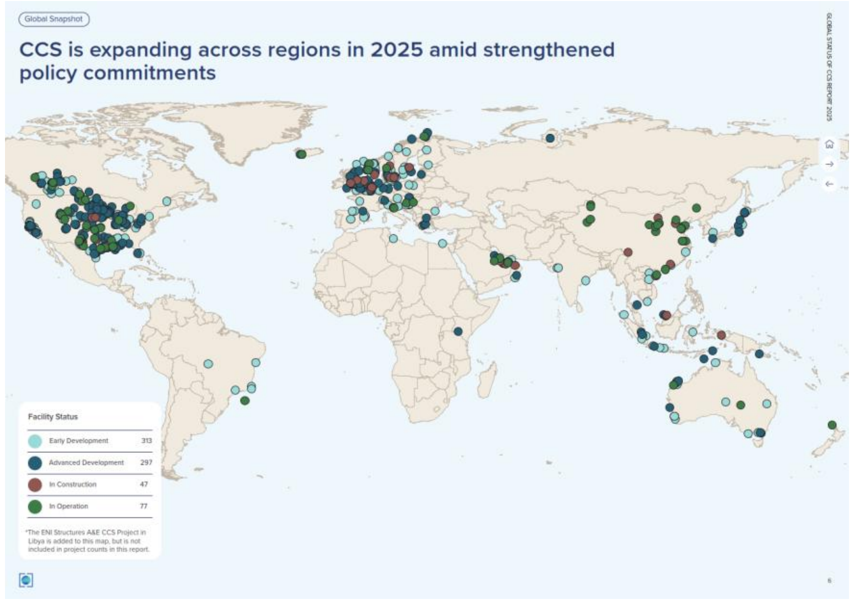


- Operating CO_2 storage capacity reached 64 million tonnes per year[*1] as of 2025.

  *1 Equivalent to emissions from about 21 million tonnes of heavy fuel oil

Source: Global CCS Institute, 2025. The Global Status of CCS: 2025. Australia. (partially edited by ClassNK)

Distribution of CCS facilities



- While operational facilities[*2] are concentrated in the United States, construction and development are underway in various global regions, led by Europe.

  *2 Most of these are CO_2 storage aimed at enhanced oil recovery.

Source: Global CCS Institute, 2025. The Global Status of CCS: 2025. Australia.

Steps from installation of onboard CCS systems to certification of captured CO_2 volume

Utilizing onboard CCS requires a comprehensive approach, including site selection of CO_2 unloading and storage, selection of onboard CCS system, and certification for the captured CO_2 volume. Also, the standards have yet to be established by the IMO for assessing CO_2 reductions from onboard CCS, meaning that flag state approval is required to recognize these reductions in regulations. Here we outline key considerations for onboard CCS and our supports including flag state approval.

Steps from installation of an onboard CCS system to certification of captured CO_2 volume

STEP 01

Planning CO_2 capture

- Planning for capture volume
- Selecting onboard CCS systems and checking safety requirements

ClassNK's support Introduction support

- ✓ Providing information
- ✓ Reviewing plans *Notation "OCCS-Ready"*

STEP 02

Installing onboard CCS systems

- Preparing for surveys
- Maintaining onboard CCS systems

ClassNK's support Introduction support

- ✓ Initial surveys
- ✓ Periodical surveys

Notation "OCCS"

STEP 03

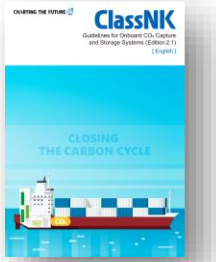
Capturing/unloading CO_2 and certification

- Complying with regulations related to capture and storage
- Confirming captured CO_2 volume

ClassNK's support Certification support

- ✓ Certification of captured CO_2 volume
- ✓ Support for regulatory compliance (including Flag States matters)

Guidelines for Shipboard CO_2 Capture and Storage Systems



- Outlines onboard CCS systems
- Stipulates safety requirements for systems and its onboard installation

These guidelines can be accessed from the "Guidelines" menu on the ClassNK website's My Page after logging in.
https://www.classnk.or.jp/account/en/rules_guidance/ssl/login.aspx

A notation will be granted to a ship that comply with the requirements of the guidelines.

CO_2 Capture and Storage Systems	
OCCS-Full	
CO_2 Capture Systems	**CO_2 Storage Systems**
OCCS-Capture	*OCCS-Storage*

OCCS: Onboard Carbon dioxide Capture and Storage

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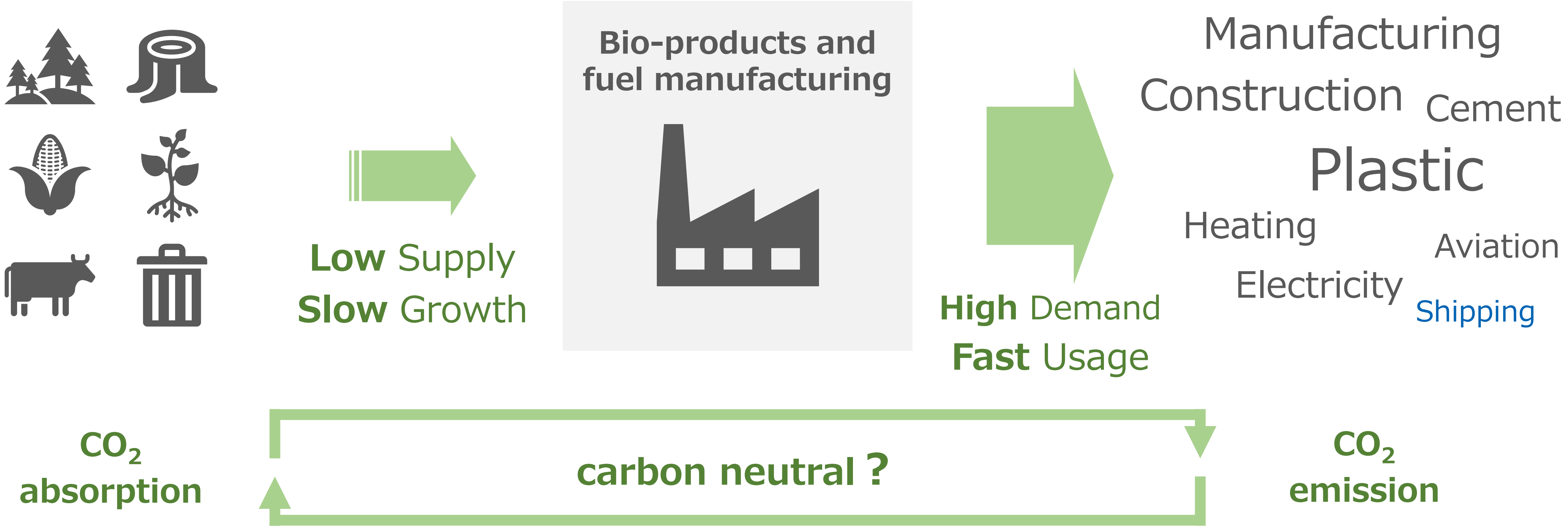
Feasibility of biofuel supply

Biofuels are considered carbon-neutral fuels over their entire lifecycle because the plants used as their raw materials absorb CO_2 from the atmosphere during their growth. Additionally, they attract attention as drop-in fuels that can be used without extensive modification of existing engines. However, biofuels face constraints due to the limited availability of biomass resources, and competition for these resources with other sectors highlights the importance of ensuring stable procurement.

The gap between "supply and demand" and "growth time and usage time"



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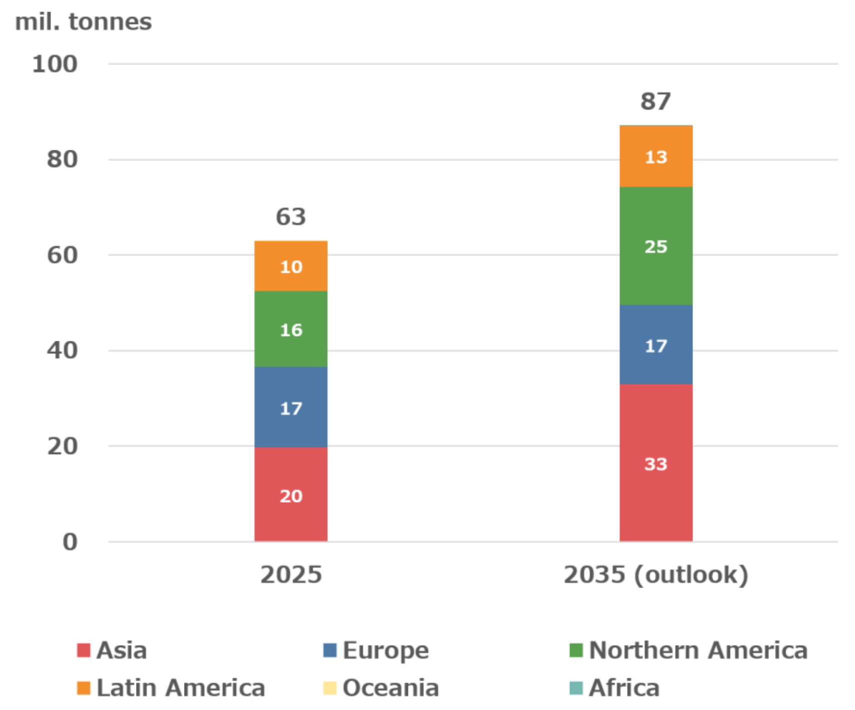
Biofuel production

Biofuels, serving as drop-in fuels that require no major modifications to existing engines, offer an effective means of reducing GHG emissions for existing vessels. This section presents biodiesel production volumes. Please note that with demand projected to rise across non-maritime sectors as well, the risk of price increases due to tight supply-demand conditions warrants close attention.

Biodiesel production by region



Source: Prepared by ClassNK based on OECD/FAO (2026), OECD-FAO Agricultural Outlook 2026-2035, Paris and Rome, https://doi.org/10.1787/47874669-en.

- ✓ Global biodiesel production in 2025 stood at 63 million tonnes, with Asia the largest producing region at 20 million tonnes.
- ✓ Of this total, **biodiesel derived from used cooking oil** — regarded as having a low GHG intensity on a life cycle basis — **accounted for 23%**.
- ✓ Relative to this global production scale, consumption in international shipping remained limited to **approximately 1.2 million tonnes** as of 2024 (including blended fuels)*, equivalent to just 1.9% of global production.

  *Source: Report of fuel oil consumption data submitted to the IMO Ship Fuel Oil Consumption Database in GISIS (Reporting year: 2024)
- ✓ Production is expected to expand further, led by Asia and North America, with global output forecast to reach **87 million tonnes** by 2035.
- ✓ If the current feedstock mix is maintained, production of used cooking oil-derived biodiesel is projected to reach 20 million tonnes by 2035.

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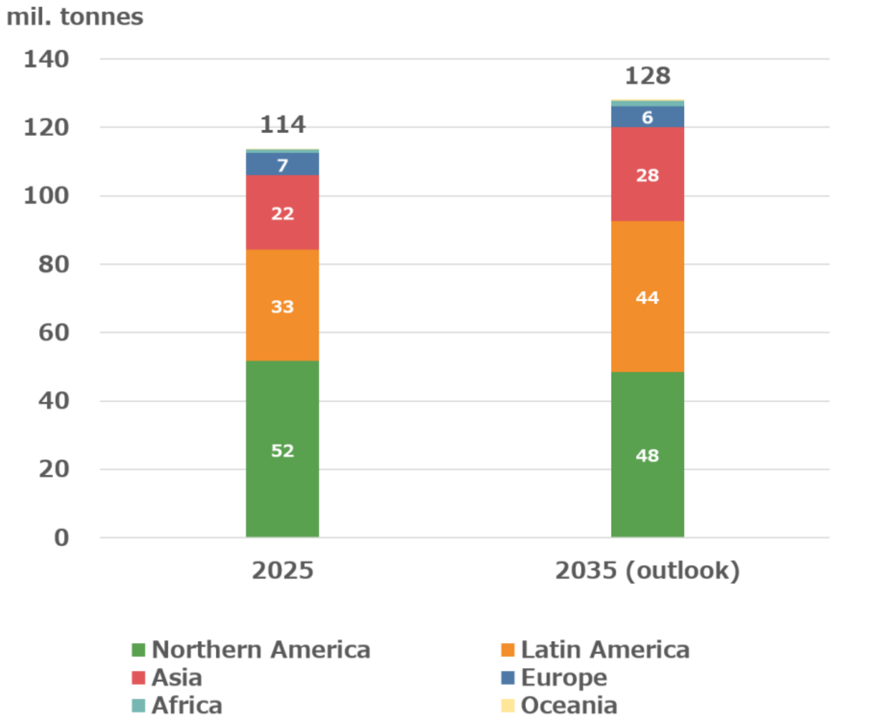
Bioethanol production

Bioethanol, usable in methanol-fuelled engines with modifications, has recently drawn attention as an option easing low-carbon methanol supply constraints. This section outlines bioethanol production. Note that bioethanol already sees strong demand from blending mandates in land transport. As this demand grows, availability for the shipping sector may be limited, and the risk of price increases from supply tightness warrants attention.

Bioethanol production by region



Source: Prepared by ClassNK based on OECD/FAO (2026), OECD-FAO Agricultural Outlook 2026-2035, Paris and Rome, https://doi.org/10.1787/47874669-en.

- ✓ Global bioethanol production in 2025 stood at **114 million tonnes**, with North America — principally the United States — the largest producing region at 52 million tonnes.
- ✓ By feedstock, maize accounted for 61% and sugarcane for 22% (2023–25 average), with first-generation feedstocks that compete with food use continuing to make up the majority.
- ✓ Production is expected to expand further, led by Latin America (mainly Brazil) and Asia (mainly India), with global output forecast to reach **128 million tonnes** by 2035.
- ✓ In North America, meanwhile, ethanol consumption is expected to decline as gasoline demand falls with the uptake of electric vehicles and improvements in fuel economy, and the United States' share of global production is projected to fall from 44% (2023–25 average) to 37% in 2035.

Use of biofuels

Reducing GHG emissions from ships is important, and the use of biofuels stands out as a significant option. However, it's crucial to fully understand the considerations associated with their use and to identify in advance the types of biofuels acknowledged for their GHG reduction effects under regulations.

Two steps to using biofuels

1. **Understand safety precautions**

   Biofuels vary widely in their characteristics depending on the feedstock and production methods. When using them, it's essential to understand the features of each fuel, any precautions for use, and potential issues that may arise. ClassNK provides support for the use of biofuels through information in the "Technical Guide for Using Biofuels."

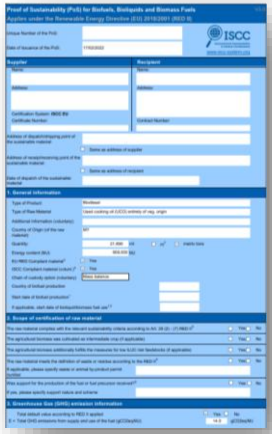
2. **Make arrangements to use recognized biofuels for GHG reduction**

   Biofuels that are recognized for their GHG reduction effects may vary depending on regulations. When arranging to use biofuels, please ensure beforehand whether the biofuels meet the requirements of the regulations.
   → Compliance with the requirements can be confirmed by a Proof of Sustainability or equivalent, arranged by the fuel supplier.

Technical Guide for
Using Biofuels (Edition 1.1)
April 2024

This technical guide can be accessed from the "Guidelines" menu on the ClassNK website's My Page after logging in.
https://www.classnk.or.jp/account/en/Rules_Guidance/ssl/guidelines.aspx

Image of
Proof of Sustainability



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<Reference> GHG emissions assessment of biofuels

The GHG emissions assessment of biofuels in the CII, EU-ETS for Shipping, and FuelEU Maritime are as follows.

Regulation	Requirements for biofuels to contribute to GHG emissions reductions	GHG emissions assessment (in case of B-100[*3]) *3 In the case of blended oils like B-24 and B-29, the GHG emissions reduction is attributed solely to the biofuel component.
CII (Scope: TtW)	• **Certified by an international certification scheme (ISCC, RSB, etc.), meeting its sustainability criteria** • **Not exceeding WtW GHG intensity 33gCO_2eq/MJ**[*1] *1 Reduction of at least 65% compared to the 94gCO_2eq/MJ (MGOeq) Note: Temporary measures in place until the IMO finalizes its LCA guidelines	e.g.) In case of biofuels derived from used cooking oil[*4] *4 WtW GHG intensity 14.9gCO_2eq/MJ **Approx. 80% reduction compared to conventional fuel oil** <Explanation> ✓ Calculate the TtW emission factor, using the WtW GHG intensity *WtW GHG intensity 14.9gCO_2eq/MJ × LCV 0.037MJ/g fuel* *= 0.551gCO_2eq/g fuel* (Ref.: HFO 3.114gCO_2eq/g fuel) Note: Temporary measures in place until the IMO finalizes its LCA guidelines
EU-ETS for Shipping (Scope: TtW)	• **Compliance with the sustainability and GHG emissions reduction criteria[*2] as defined in the EU Renewable Energy Directive (RED)** *2 Different criteria are required for biofuels depending on the operation date of the installations producing the fuels. ✓ Starting operation on or before 5 October 2015 At least 50% reduction from 94gCO_2eq/MJ ✓ Starting operation from 6 October 2015 At least 60% reduction from 94gCO_2eq/MJ ✓ Starting operation from 1 January 2021 At least 65% reduction from 94gCO_2eq/MJ	Regardless of the origin of the biofuel **Approx. 99% reduction compared to conventional fuel oil** <Explanation> ✓ CO_2 emissions=0, but account CH_4 and N_2O emissions
FuelEU Maritime (Scope: WtW)		e.g.) In case of biofuels derived from used cooking oil[*5] *5 WtW GHG intensity 14.9gCO_2eq/MJ **Approx. 80% reduction compared to conventional fuel oil** <Explanation> ✓ Account for the TtW CH_4 & N_2O in addition to the WtW GHG intensity *WtW 14.9 (=WtT 14.9 + TtW 0) + TtW CH_4 0.03 + TtW N_2O 1.5 = 16.4*

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Regulatory trends

The IMO has been actively developing rules and guidelines for various alternative fuels, including zero- and low-emission fuels. Here, we introduce the rules and guidelines of the IMO regarding each alternative fuel, as well as the corresponding rules and guidelines provided by ClassNK.

Rules and guidelines concerning alternative fuels

Alternative fuels/ Related technologies	IMO Rules/Guidelines	ClassNK Rules/Guidelines
LNG	IGF Code	Rules for the Survey and Construction of Steel Ships / Guidance Part GF SHIPS USING LOW-FLASHPOINT FUELS
Methanol	Interim Guidelines for the Safety of Ships Using Methyl / Ethyl alcohol as Fuel (MSC.1/Circ.1621)	Guidelines for Ships Using Alternative Fuels (Edition 3.1) Part A Guidelines for Ships Using Methyl/Ethyl Alcohol as Fuels Part B Guidelines for Ships Using LPG as Fuel Part C Guidelines for Ships Using Ammonia as Fuel Part D Guidelines for Ships Using Hydrogen as Fuel Annex 1 Alternative Fuel Ready
LPG	Interim Guidelines for the Safety of Ships Using LPG Fuels (MSC.1/Circ. 1666)	
Ammonia	Interim Guidelines for the Safety of Ships Using Ammonia as Fuel (MSC.1/Circ. 1687)	
Hydrogen	Interim Guidelines for the Safety of Ships Using Hydrogen as Fuel (MSC.1/Circ. 1701)	
Fuel Cell	Interim Guidelines for the Safety of Ships Using Fuel Cell Power Installations (MSC.1/Circ.1647)	Guidelines for Fuel Cell Power Systems On Board Ships [Second Edition]

Existing rule

Existing guidelines

UPDATED

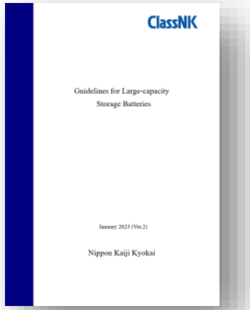
ClassNK's guidelines

ClassNK provides technical support for various aspects, such as issuing Approval in Principle and retrofitting alternative fuel ships, through the issuance of various guidelines. When considering the adoption of alternative fuel ships, we encourage you to make use of these guidelines.

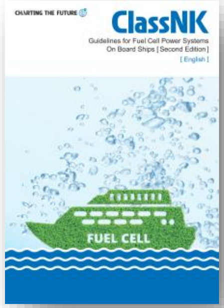
ClassNK List of alternative fuel-related guidelines

Guidelines for Technology Qualification
March 2022

Guidelines for Approval in Principle and General Design Approval
March 2022

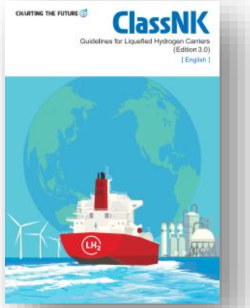


Guidelines for Large-capacity Storage Batteries
January 2023

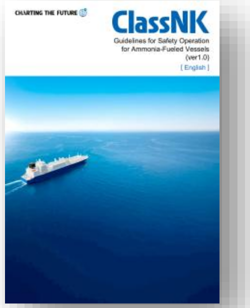


Guidelines for Fuel Cell Power Systems On Board Ships
September 2023

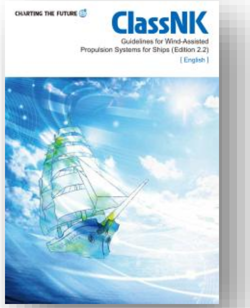
Technical Guide for Using Biofuels
April 2024



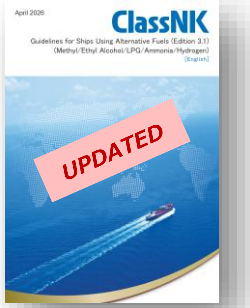
Guidelines for Liquefied Hydrogen Carriers
September 2024



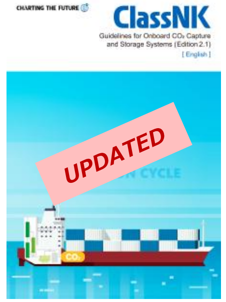
Guidelines for Safety Operation for Ammonia-Fueled Vessels
May 2025



Guidelines for Wind-Assisted Propulsion Systems for Ships
June 2025



Guidelines for Ships Using Alternative Fuels
April 2026



Guidelines for Shipboard CO_2 Capture and Storage Systems
May 2026

These guidelines can be accessed from the "Guidelines" menu on the ClassNK website's My Page after logging in.
https://www.classnk.or.jp/account/en/rules_guidance/ssl/login.aspx

— Step 4

Understanding costs

When considering the adoption of alternative fuels, understanding the total cost for each fuel is paramount. In this section, we will introduce the cost factors to consider during fuel transition and discuss the cost simulation conducted by ClassNK.

Key Takeaways

- ✓ The primary costs associated with adopting alternative fuel ships are shipbuilding, fuel, and regulatory costs.
- ✓ Regulatory compliance costs for IMO and EU frameworks depend on GHG emissions from fuel usage. Therefore, to accurately assess these costs, it is essential to understand each vessel's GHG emissions, including potential reductions achieved through fuel transition.
- ✓ It should be noted that while EU regulations (EU-ETS and FuelEU Maritime) apply to GHG emissions from EU-related voyages, IMO regulations (Mid-Term Measures) target emissions from all voyages globally. Consequently, the regulatory cost burden under the IMO framework is relatively higher, a factor that requires careful consideration.
- ✓ ClassNK conducts cost simulations that incorporate fuel transition scenarios. These simulations are updated regularly to reflect the latest details of IMO Mid-Term Measures.
- ✓ The latest simulation presents a fuel transition model designed to minimize total annual costs for each fuel type. ClassNK has established a proprietary calculation methodology that enables these estimations.

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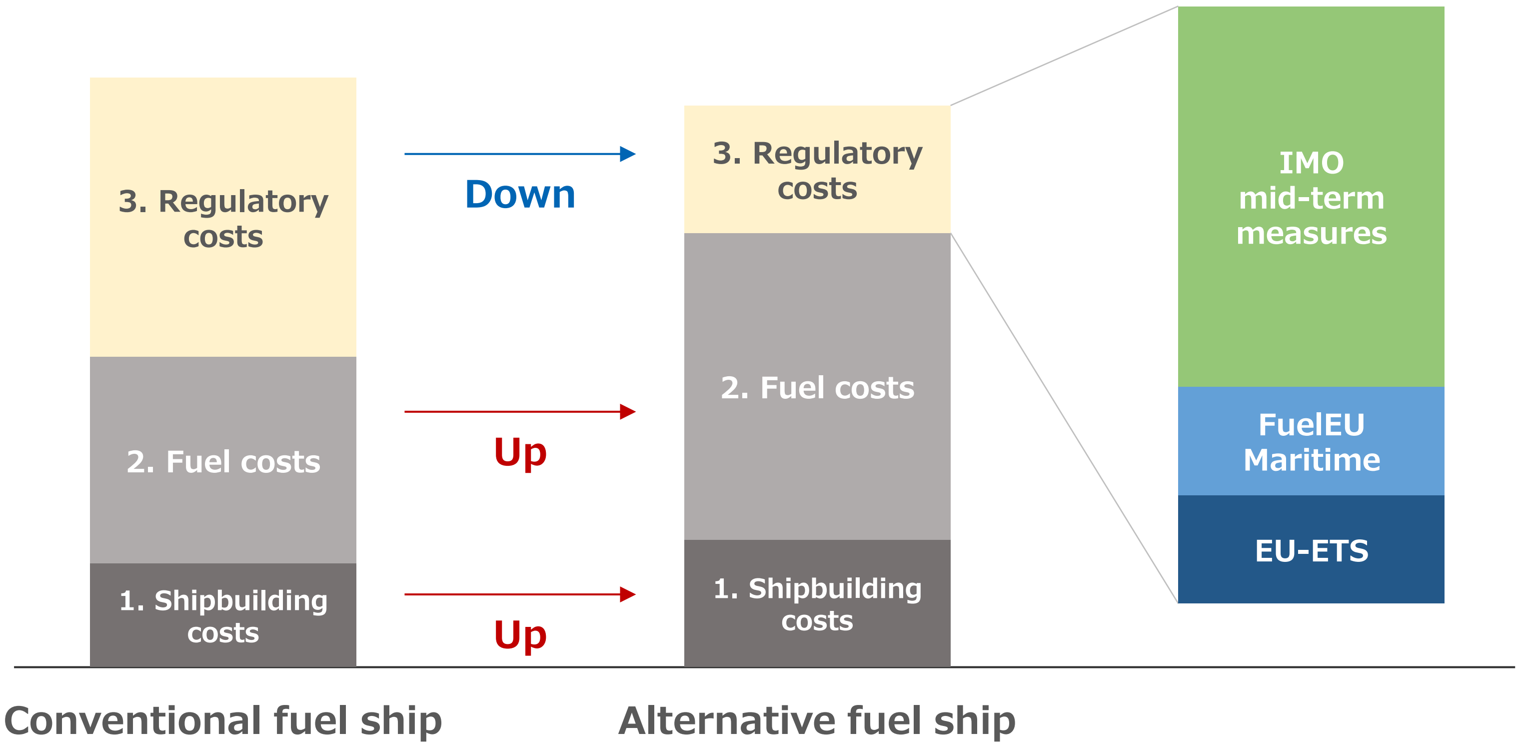
Uncertain factors in costs (1. Shipbuilding costs, 2. Fuel costs, 3. Regulatory costs)

When considering the adoption of alternative fuels, it's crucial to understand the total costs associated with each fuel option for comparison. Among the various cost factors, shipbuilding costs, fuel costs, and regulatory costs stand out as significant components. It's essential to forecast how these costs will change in the future and make the right fuel selections at the appropriate time, as this will determine the competitive advantage in the maritime business going forward.

Image of primary costs

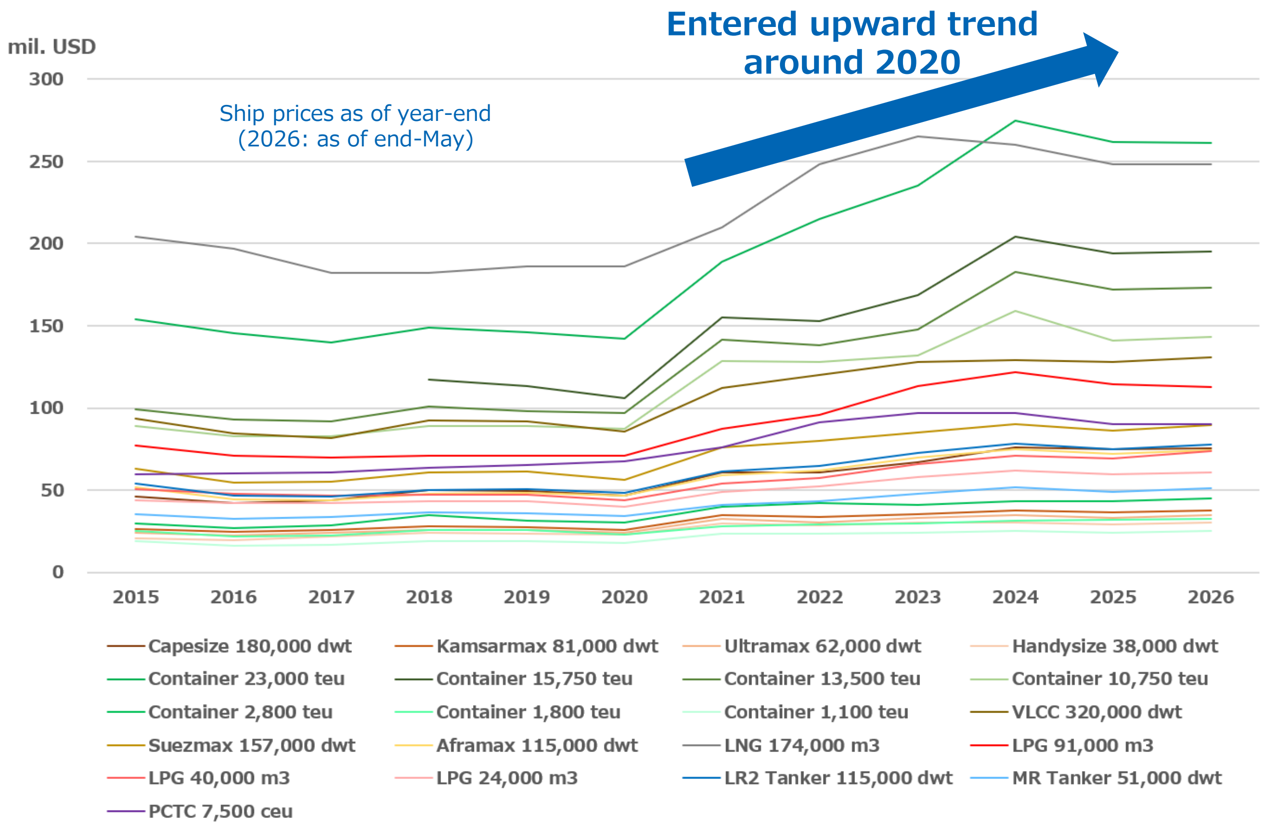


- ✓ The adoption of alternative fuel ships is expected to result in increased shipbuilding costs and fuel costs compared to conventional fuel ships, while regulatory costs are anticipated to decrease.
- ✓ The primary factors contributing to regulatory costs are the EU's EU-ETS and FuelEU Maritime, as well as IMO's mid-term measures.
- ✓ While EU regulations target GHG emissions in EU-related voyages, IMO regulations cover GHG emissions in all voyages, potentially leading to relatively higher regulatory cost burdens.

Uncertain factors in costs (1. Shipbuilding costs)

The shipbuilding cost of alternative fuel ships, which require different fuel tanks and fuel supply systems, is expected to be higher than that of conventional fuel ships. The outlook for shipbuilding costs until 2050 is uncertain due to significant fluctuations in steel prices, but it's important to invest based on a long-term assessment of ship pricing levels.

The historical trend of shipbuilding costs (ship prices) and the shipbuilding costs of alternative fuel ships



Source: Prepared by ClassNK based on data from Clarkson Research Services Limited

Shipbuilding costs of alternative fuel ships (relative to conventional fuel ships)

LNG	+30% - +40%
LPG	+20% - +30%
Methanol	+10% - +20%
Ammonia	+30% - +40%

Source: ClassNK

✓ The shipbuilding cost of alternative fuel ships is typically 10% to 40% higher compared to conventional fuel ships, depending on the ship types and sizes.

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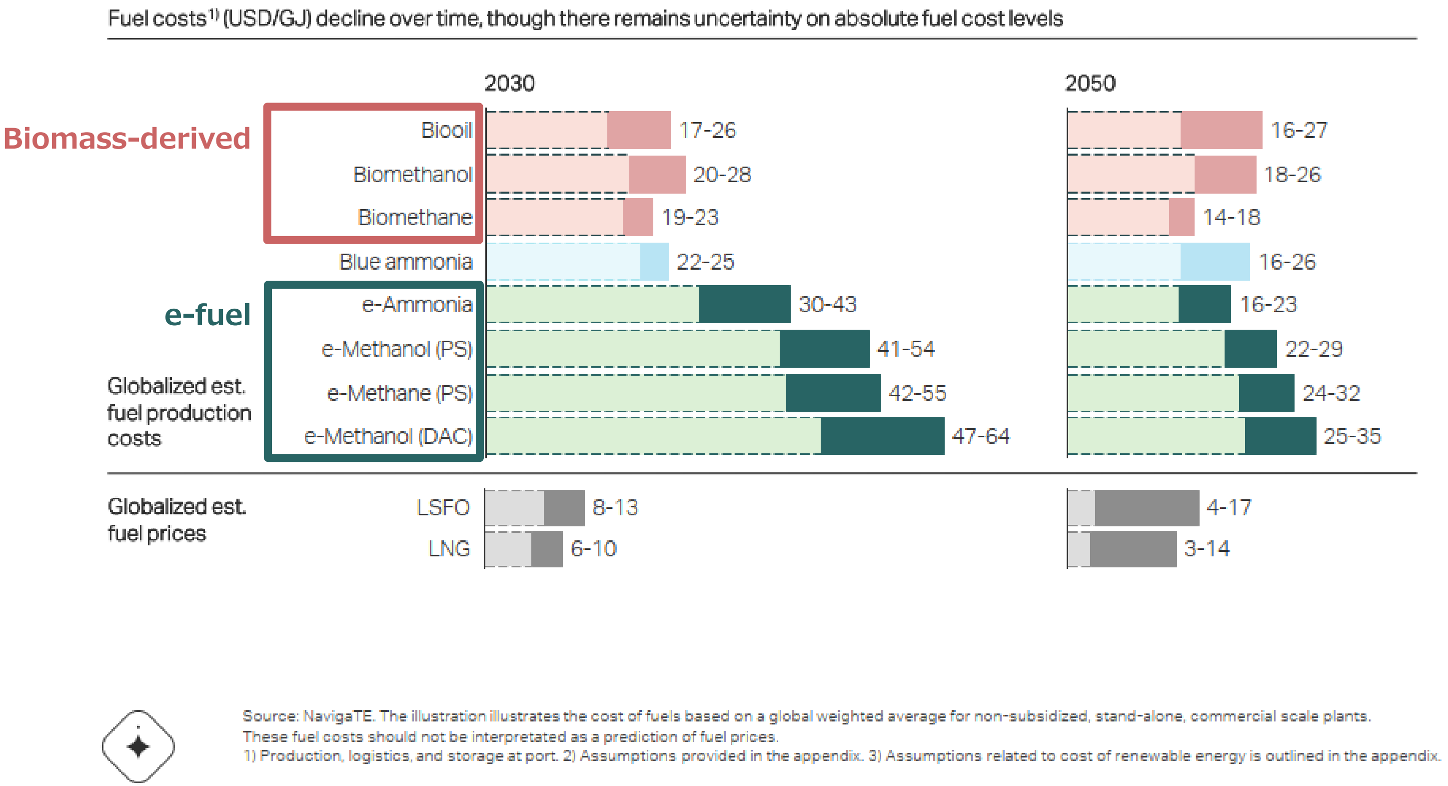
Uncertain factors in costs (2. Fuel costs)

There is a wide range of alternative fuels available for use in ships, but it is anticipated that the cost of each alternative fuel will be higher than conventional fuel oil. However, with the expected expansion of production and the introduction of regulations in the future, the cost gap between alternative fuels and conventional fuel oil is expected to narrow. When considering the adoption of alternative fuels, it is crucial to closely monitor the trends in fuel costs.

Image of fuel costs



Source: Maersk Mc-Kinney Moller Center for Zero Carbon Shipping (2021), Position Paper Fuel Option Scenarios (partially edited by ClassNK)

- ✓ Alternative fuels can be broadly categorized into "biomass-derived fuels" and "e-fuels produced from green hydrogen and captured CO_2."
- ✓ The main cost factor for "biomass-derived fuels" is the price of biomass itself. The price of biomass is influenced by factors such as the availability of biomass resources and the demand trends in other sectors.
- ✓ For "e-fuels produced from green hydrogen and captured CO_2," the main cost factor is the price of green hydrogen. The price of green hydrogen is influenced by the costs of renewable energy and electrolysis equipment.
- ✓ It is possible that the cost of alternative fuels will remain higher than that of conventional fuel oil even by the year 2050.
- ✓ It is important to note that the actual procurement price can vary depending on supply and demand conditions.

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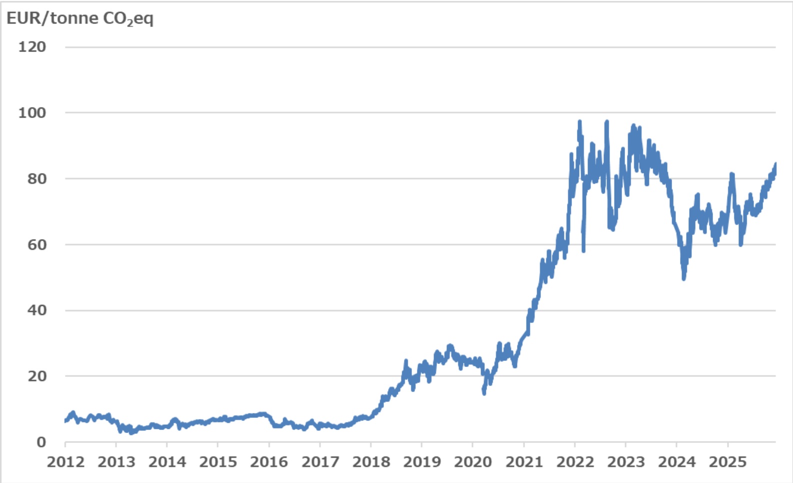
Uncertain factors in costs (3. Regulatory costs)

International shipping is seeing the successive introduction of regulations designed to promote the use of zero- and low-emission fuels. In Europe, the EU Emissions Trading System (EU-ETS) was expanded to the shipping sector in 2024, followed by the introduction of FuelEU Maritime in 2025. Meanwhile, the framework for new regulations (Mid-Term Measures) remains under discussion at the IMO. Since costs associated with each regulation involve uncertain factors, careful consideration is required when estimating total costs.

The three major GHG regulations in international shipping going forward

1. **EU-ETS (2024 -)**
   - ✓ It requires the surrender of emission allowances corresponding to the targeted GHG emissions.
   - ✓ Emission allowances must be procured through the market, and their prices fluctuate based on supply-demand balances, etc. which makes the price an uncertain factor in EU-ETS costs.
2. **FuelEU Maritime (2025 -)**
   - ✓ It sets limits for the GHG intensity of fuels (GHG emissions per unit of energy) and requires ships exceeding these limits to pay penalties based on their energy consumption.
   - ✓ Flexibility mechanisms (banking, borrowing, pooling) are available to avoid penalties, and the adept use of these flexibility mechanisms affects the costs of FuelEU Maritime.
3. **IMO mid-term measures (Under discussion)**
   - ✓ It sets two limits for the GHG intensity of fuels and requires ships exceeding these limits to making contributions based on their energy consumption.
   - ✓ Flexibility mechanisms (banking and transfer of surplus units) are available to reduce contributions, and the adept use of these flexibility mechanisms affects the costs of IMO mid-term measures.

Transition of the price of allowances at the European Energy Exchange (EEX)



Source: Prepared by ClassNK, based on the emission allowance price data publicly available from the EEX

Step 4 - Understanding costs

Conducting cost simulation

ClassNK conducts cost simulations for the transition from conventional to alternative fuels, aimed at supporting future fuel selection. This section presents an overview of the cost simulation service provided by ClassNK.

Overview of cost simulation service (Service launched in July 2025)

1. **Estimates costs through 2050, including regulatory costs.**
   - ✓ Projects future total costs based on actual fuel consumption data.
   - ✓ Conducts cost optimization simulations factoring in fuel transition.
2. **Provides an Excel-based calculation tool.**
   - ✓ Supports diverse inputs, allowing for flexible configuration of assumptions.

Point 1 **Compatible with various inputs**

Fuel price, Pilot fuel usage rate, Energy efficiency rate, EUA price, Exchange rate, Other costs, etc.

Point 2 **Updates according to regulatory trends**

IMO mid-term measures, LCA guidelines, etc.

Click [here](#) for details on the Cost Simulation Service

Cost simulation case study

ClassNK conducts multifaceted economic simulations to visualize future cost structures associated with the continued use of conventional fuel oil, as well as the effects of transitioning to alternative fuels such as biodiesel, LNG, methanol, and ammonia. This section presents specific case studies based on this analysis. Please note that current EU regulations (EU-ETS and FuelEU Maritime) are stipulated to be reviewed by the European Commission upon the adoption of IMO Mid-Term Measures. While these simulations incorporate existing EU regulations, uncertainties regarding potential future regulatory restructuring or discontinuation should be noted as underlying assumptions.

Cost simulation case study (Summary)

1. **Understanding the current situation**
   - ✓ We have estimated the total cost for a conventional fuel ship, assuming it continues to use conventional fuel oil.
2. **Simulation**
   - ✓ For conventional fuel vessels, the simulation models a scenario where biodiesel (B30) is incorporated to minimize annual total costs.
   - ✓ For LNG, methanol, and ammonia-fueled vessels, the simulation models scenarios where low-carbon fuels are incorporated to minimize annual total costs.
3. **Assumptions**
   - ✓ Ship price
     The assumptions are based on ship price data provided by Clarkson Research Services Limited and other information.
   - ✓ Fuel price
     Assumptions are based on the latest fuel prices and renewable energy price forecasts, as well as fuel production cost outlooks provided by the Mærsk Mc-Kinney Møller Center for Zero Carbon Shipping, which ClassNK has joined as a Mission Ambassador.

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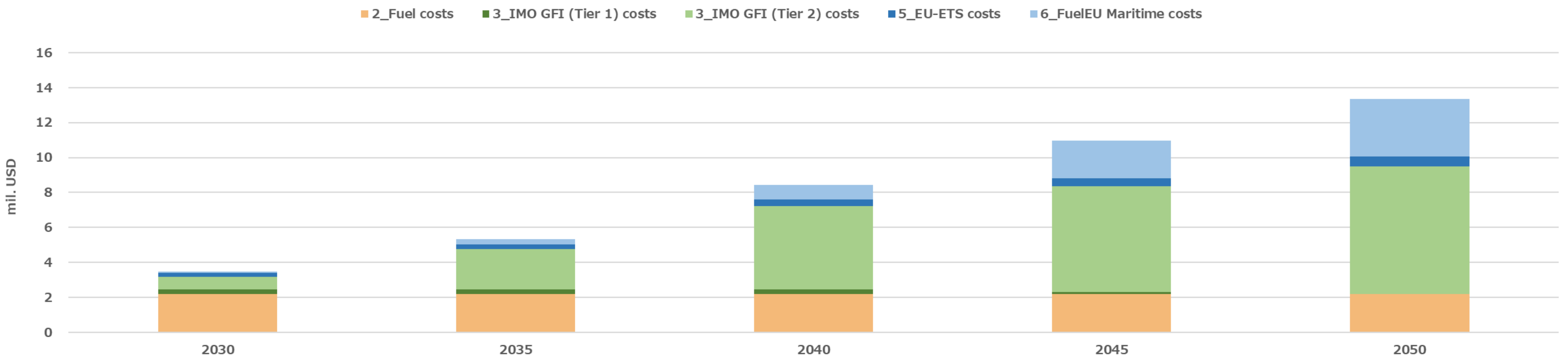
Cost simulation case study – 1: Continued Use of Conventional Fuel Oil (Current Status Assessment)

To minimize total costs under future regulations, it is essential to compare all options while accounting for shipbuilding, fuel, and regulatory costs. Here, using a 64,000 DWT bulk carrier as a case study, we present estimation results for the continued use of conventional fuel oil to serve as a comparative baseline.

Cost simulation case study (64,000DWT Bulk carrier: In the case of continued use of conventional fuel oil)



- ✓ Total costs are projected to quadruple from 2030 to 2050 due to stricter regulations.
- ✓ Regulatory costs will rival fuel costs by ~2035, subsequently becoming the primary cost driver.
- ✓ The surge is driven mainly by IMO GFI Tier 2 costs, which present a significantly higher financial burden than Tier 1.
- ✓ FuelEU Maritime targets tighten every five years and include multipliers for consecutive non-compliance. Extreme caution is warranted for the continued use of conventional fuels on EU-related voyages.

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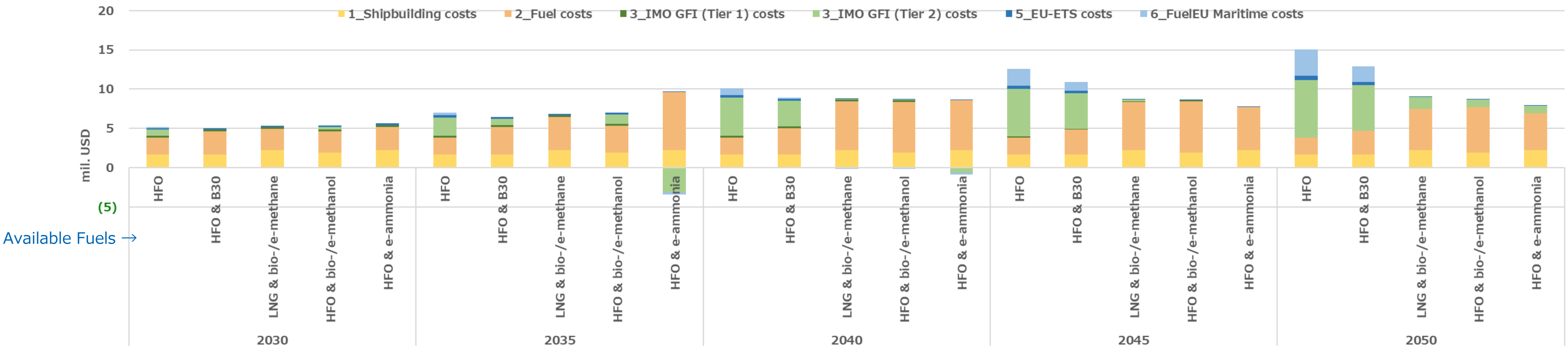
Cost simulation case study – 2: Low-Carbon Fuel Mix (Simulation Case)

To effectively minimize total costs under the increasingly stringent future regulations, it is essential to thoroughly compare all strategic options while fully accounting for shipbuilding, fuel, and regulatory costs. Here, we present detailed estimation results in the case of incorporating low-carbon fuels specifically **to minimize annual total costs**.

Cost simulation case study (64,000DWT Bulk carrier: In the case of incorporating low-carbon fuels)



- ✓ Risks of Conventional Fuel :With increasing regulatory costs, continued use is expected to become the most expensive option annually.
- ✓ Transitional Measures :Blending with biodiesel can achieve certain cost reductions (depending on price).
- ✓ Economic Viability :Although initial fuel costs are high for alternative fuel vessels, avoiding regulatory costs offsets the difference in the mid-to-long term, optimizing total costs.
- ✓ Acceleration Potential :Depending on IMO GFI reward settings, the break-even point for fuel transition is likely to be brought forward significantly.

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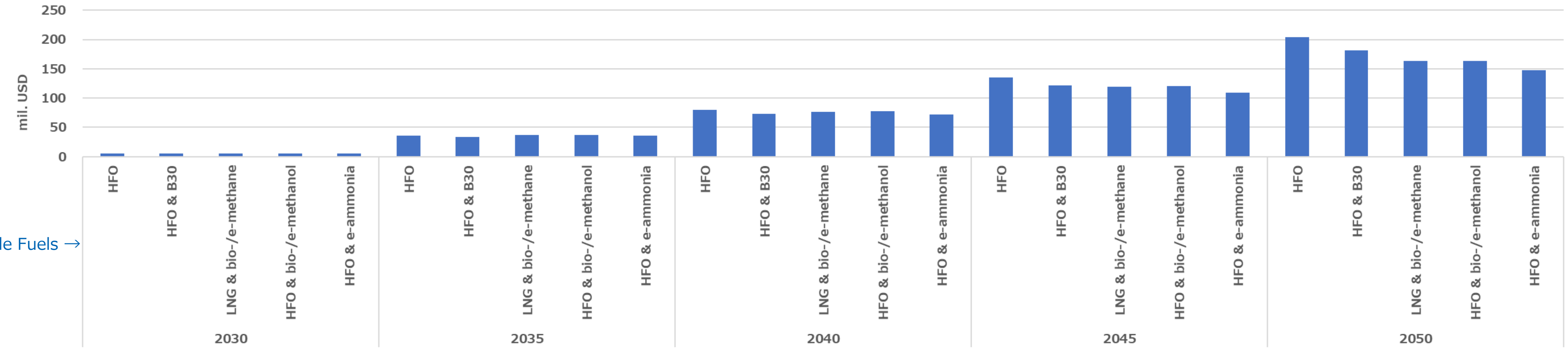
Cost simulation case study – 2: Low-Carbon Fuel Mix (Simulation Case)

To effectively minimize total costs under the increasingly stringent future regulations, it is essential to thoroughly compare all strategic options while fully accounting for shipbuilding, fuel, and regulatory costs. Here, we present detailed estimation results in the case of incorporating low-carbon fuels specifically **to minimize annual total costs**.

Cost simulation case study (64,000DWT Bulk carrier: In the case of incorporating low-carbon fuels) Cumulative costs through 2050

Available Fuels →



- ✓ Shift in Economic Viability :Conventional vessels are projected to be the costliest option in terms of cumulative costs through 2050.
- ✓ Certainty of Investment Recovery :Despite the initial CAPEX premium, alternative fuel vessels are expected to recoup the investment by the late 2030s, as cumulative costs fall below conventional vessels due to regulatory cost savings.

→ **To improve the accuracy of cumulative cost forecasts and ensure optimal decision-making, continuous cost simulations that capture changes in assumptions are essential.**

Cost simulation case study – 2: Low-Carbon Fuel Mix (Simulation Case)

To effectively minimize total costs under the increasingly stringent future regulations, it is essential to thoroughly compare all strategic options while fully accounting for shipbuilding, fuel, and regulatory costs. Here, we present detailed estimation results in the case of incorporating low-carbon fuels specifically **to minimize annual total costs**.

Cost simulation case study (64,000DWT Bulk carrier: In the case of incorporating low-carbon fuels) Fuel Mix Ratio

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<Reference> Assumptions for Cost Simulation Case Study: General

Ship subject to simulation	1 ship (64,000DWT Bulk carrier)
Simulation period	2030 – 2050 (21 years)
Fuel consumption	5,000 tonnes/year (HFO base)
Annual energy efficiency	None (=5,000 tonnes consumed annually)
Pilot fuel	Not considered
Ship price (Pro-rated over the simulation period)	Conventional fuel ship :35,000,000 USD LNG-fueled ship :47,250,000 USD (Conventional fuel ship +35%) Methanol-fueled ship :40,250,000 USD (Conventional fuel ship +15%) Ammonia-fueled ship :47,250,000 USD (Conventional fuel ship +35%)
IMO GFI regulations (Based on the draft approved at MEPC 83)	✓ Unit price for transferring surplus units to other vessels: 380 USD/tonne CO_2eq ✓ Reward: not considered
Subject to EU regulations	10% of total voyages (=500 tonnes/year)
EUA price (EU-ETS)	Increasing by 5.0% year-on-year from 90.0 EUR/tonne CO_2eq
FuelEU Maritime	Unit price for transferring compliance balance surplus to other vessels: 200 EUR/tonne CO_2eq
Exchange rate	Fixed at 0.86 EUR/USD

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<Reference> Assumptions for Cost Simulation Case Study: Fuel Price

Fuel Type	Unit	2026 (Ref.)	2030	2035	2040	2045	2050	Note
Heavy Fuel Oil（HFO）	USD/tonne	450.0	450.0	450.0	450.0	450.0	450.0	±0% YoY
	(USD/GJ)	(11.2)	(11.2)	(11.2)	(11.2)	(11.2)	(11.2)	
Biodiesel（B30）	USD/tonne	750.0	720.4	685.1	651.6	619.6	589.3	−1% YoY
	(USD/GJ)	(19.1)	(18.3)	(17.4)	(16.6)	(15.8)	(15.0)	
LNG	USD/tonne	650.0	650.0	650.0	650.0	650.0	650.0	±0% YoY
	(USD/GJ)	(13.5)	(13.5)	(13.5)	(13.5)	(13.5)	(13.5)	
bio-methane	USD/tonne	1,800.0	1,729.1	1,644.3	1,563.7	1,487.1	1,414.2	−1% YoY
	(USD/GJ)	(37.5)	(36.0)	(34.3)	(32.6)	(31.0)	(29.5)	
e-methane	USD/tonne	2,600.0	2,301.8	1,976.6	1,697.4	1,457.6	1,251.7	−3% YoY
	(USD/GJ)	(54.2)	(48.0)	(41.2)	(35.4)	(30.4)	(26.1)	
bio-methanol	USD/tonne	1,000.0	960.6	913.5	868.7	826.2	785.7	−1% YoY
	(USD/GJ)	(50.3)	(48.3)	(45.9)	(43.7)	(41.5)	(39.5)	
e-methanol	USD/tonne	1,200.0	1,062.4	912.3	783.4	672.7	577.7	−3% YoY
	(USD/GJ)	(60.3)	(53.4)	(45.8)	(39.4)	(33.8)	(29.0)	
e-ammonia	USD/tonne	900.0	796.8	684.2	587.6	504.6	433.3	−3% YoY
	(USD/GJ)	(48.4)	(42.8)	(36.8)	(31.6)	(27.1)	(23.3)	

ClassNK

<Reference> Assumptions for Cost Simulation Case Study: GHG intensity limit

Year	IMO GFI regulations		FuelEU Maritime
	Base target	Direct compliance target	
2028	89.6 gCO_2eq/MJ	77.4 gCO_2eq/MJ	89.3 gCO_2eq/MJ
2029	87.7	75.6	89.3
2030	85.8	73.7	85.7
2031	81.7	69.6	85.7
2032	77.6	65.5	85.7
2033	73.5	61.4	85.7
2034	69.4	57.3	85.7
2035	65.3	53.2	77.9
…	…	…	…
2040	32.7	20.6	62.9
…	…	…	…
2045	16.3	10.0	34.6
…	…	…	…
2050	0.0	0.0	18.2

Note: The values in red are assumptions provided by ClassNK (not yet decided by IMO). For the Base target and Direct compliance target values under the IMO GFI regulations after 2035, they are linearly interpolated based on the assumptions from ClassNK.

<Reference> Assumptions for Cost Simulation Case Study: Well-to-Wake GHG Intensity (by Fuel)

	IMO GFI	FuelEU Maritime
Heavy Fuel Oil (HFO) Low Sulphur	95.48408 gCO_2eq/MJ	91.74420 gCO_2eq/MJ
Biodiesel (B30)	75.92110	70.67229
LNG (Otto dual fuel slow speed)	85.33134	82.86808
bio-methane (Otto dual fuel slow speed)	28.70968	27.37945
e-methane (Otto dual fuel slow speed)	19.53968	18.16808
Gray methanol	102.86281	103.15377
bio-methanol	12.86734	13.14450
e-methanol	12.46734	12.95377
Gray ammonia	123.63978	123.95108
e-ammonia	12.63978	12.95108

Note: Includes assumptions made by ClassNK. Differences in WtW GHG intensity between IMO and EU frameworks stem from variations in the emission factors, calorific values, and Global Warming Potential (GWP) applied in calculations. Regarding GWP, the IMO uses IPCC AR5 values in accordance with its LCA Guidelines, whereas the EU uses IPCC AR4 values based on the FuelEU Maritime Regulation.

ClassNK's support

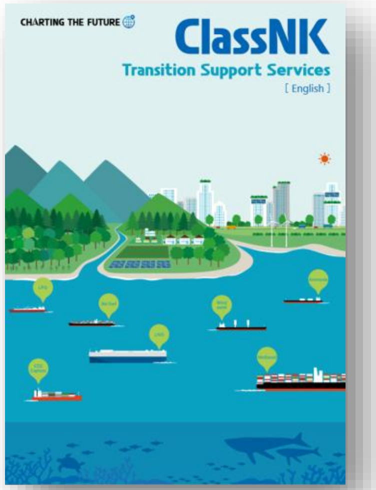
ClassNK provides services to support your efforts in achieving a smooth transition to zero emissions.

ClassNK

Towards net-zero GHG emissions by 2050

The international shipping industry is expected to undergo a significant fuel transition period toward achieving net-zero GHG emissions by or around 2050. However, the infrastructure for supplying zero-emission fuels is currently underdeveloped. Therefore, in the meantime, it is necessary to transition to zero emissions while utilizing various GHG emission reduction measures. ClassNK has launched the "ClassNK Transition Support Services" to provide comprehensive support for seamless transitions to zero emissions for our clients by leveraging insights gained from activities such as issuing Approval in Principle (AiP) for alternative fuel ships, participating in demonstration projects for energy efficiency improvement technologies and onboard CCS, and verifying GHG emissions. We encourage you to take advantage of our "ClassNK Transition Support Services" for your efforts to reduce GHG emissions from ships.

ClassNK Transition Support Services



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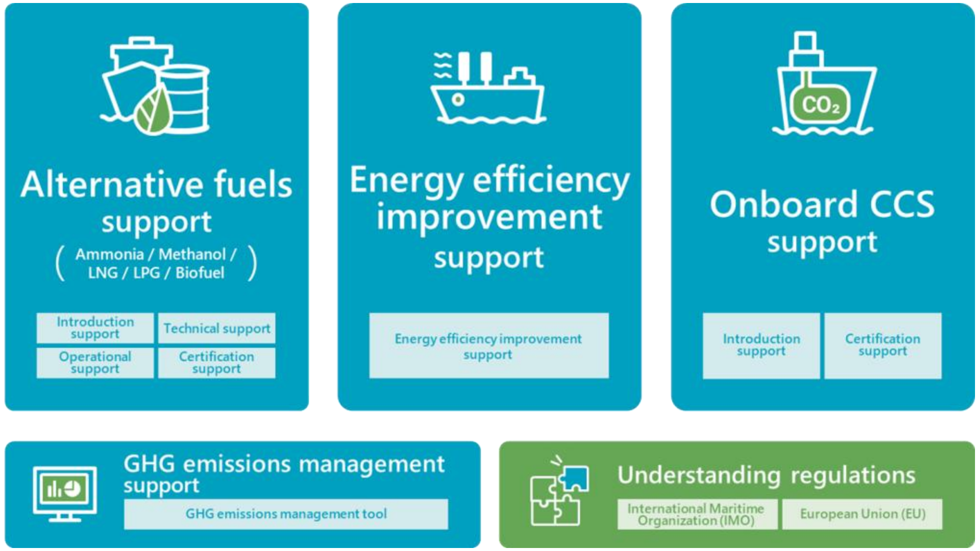

For inquiries regarding ClassNK Transition Support Services in general, please contact us at the following:

NIPPON KAIJI KYOKAI (ClassNK)
Green Transformation Center
TEL: +81-3-5226-2031
E-mail: gxc@classnk.or.jp

ClassNK Alternative Fuels Insight will continue to be updated according to the alternative fuel trends. For more detailed information about the contents of this document or for any feedback or requests, please contact us.

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Inquiries can also be made using this feedback form.

THANK YOU

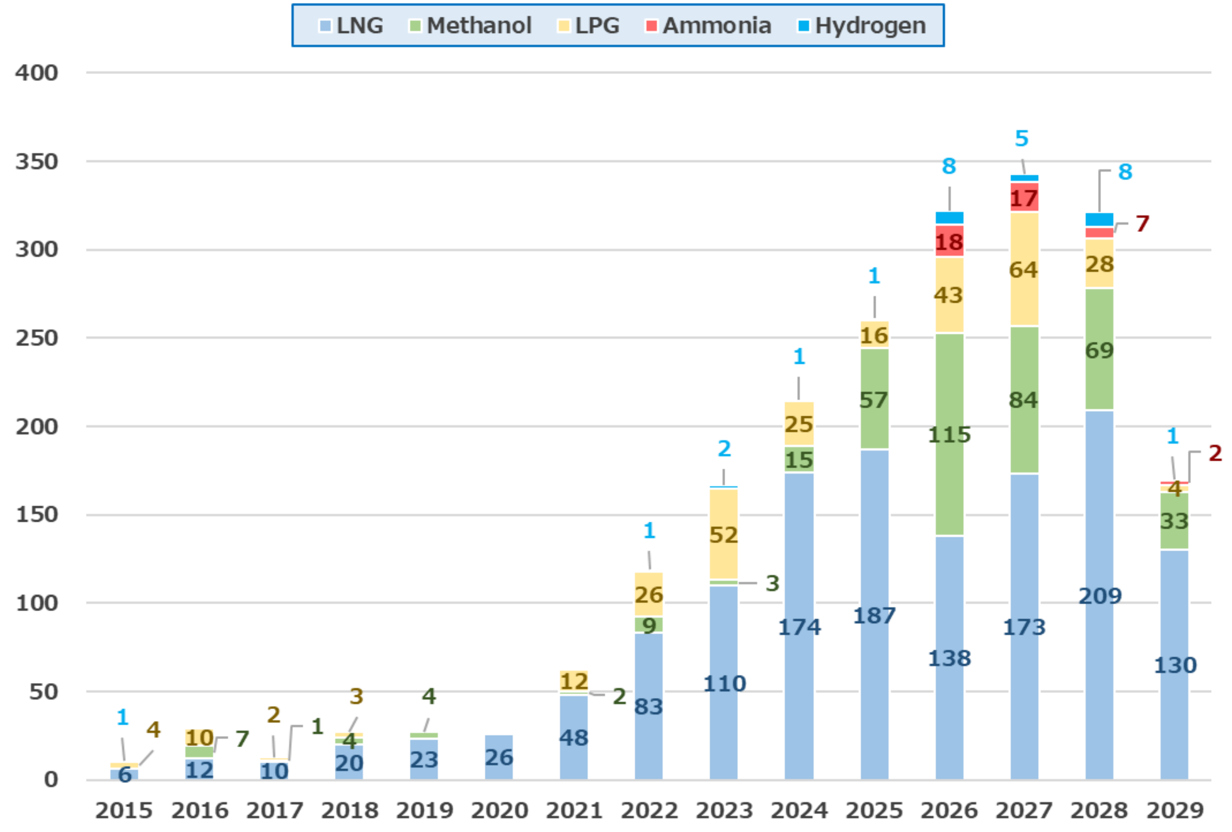
Appendix

To provide a more comprehensive view of the changing adoption of alternative fuels, we present data on the number of alternative fuel ships in service and on order as of December 31, 2025, based on ClassNK Alternative Fuels Insight (Version 3.2).

Trends in alternative fuel ships

As of the end of December 2025

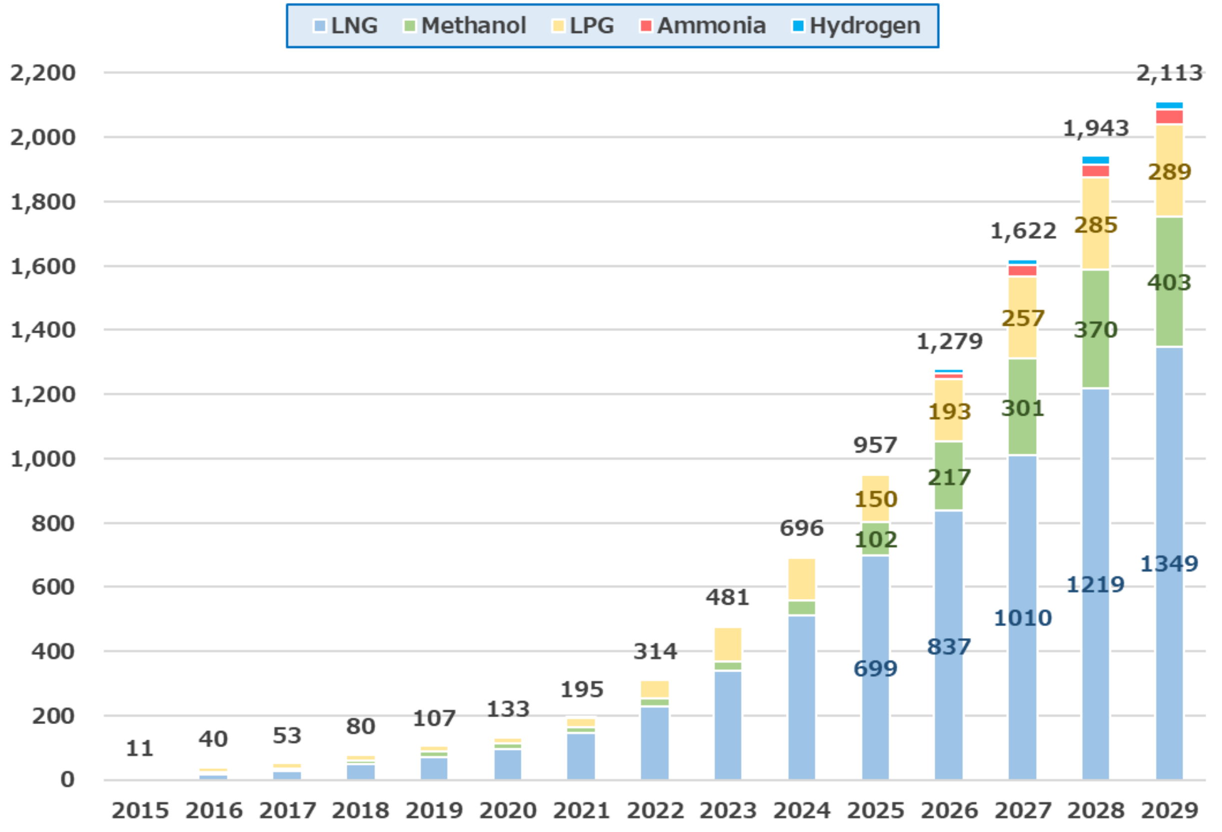
"Newbuilding" alternative fuel ship trend



- ✓ As of the end of December 2025 (Orderbook is included after 2026.)
- ✓ 5,000 gross tonnage and above
- ✓ LNG carriers are excluded from LNG-fueled ships.
- ✓ Alternative fuel ready ships are not included.

"In service" alternative fuel ship trend*

∗Cumulative number of ships delivered since 2015, without considering scrapping



- ✓ As of the end of December 2025 (Orderbook is included after 2026.)
- ✓ 5,000 gross tonnage and above
- ✓ LNG carriers are excluded from LNG-fueled ships.
- ✓ Alternative fuel ready ships are not included.

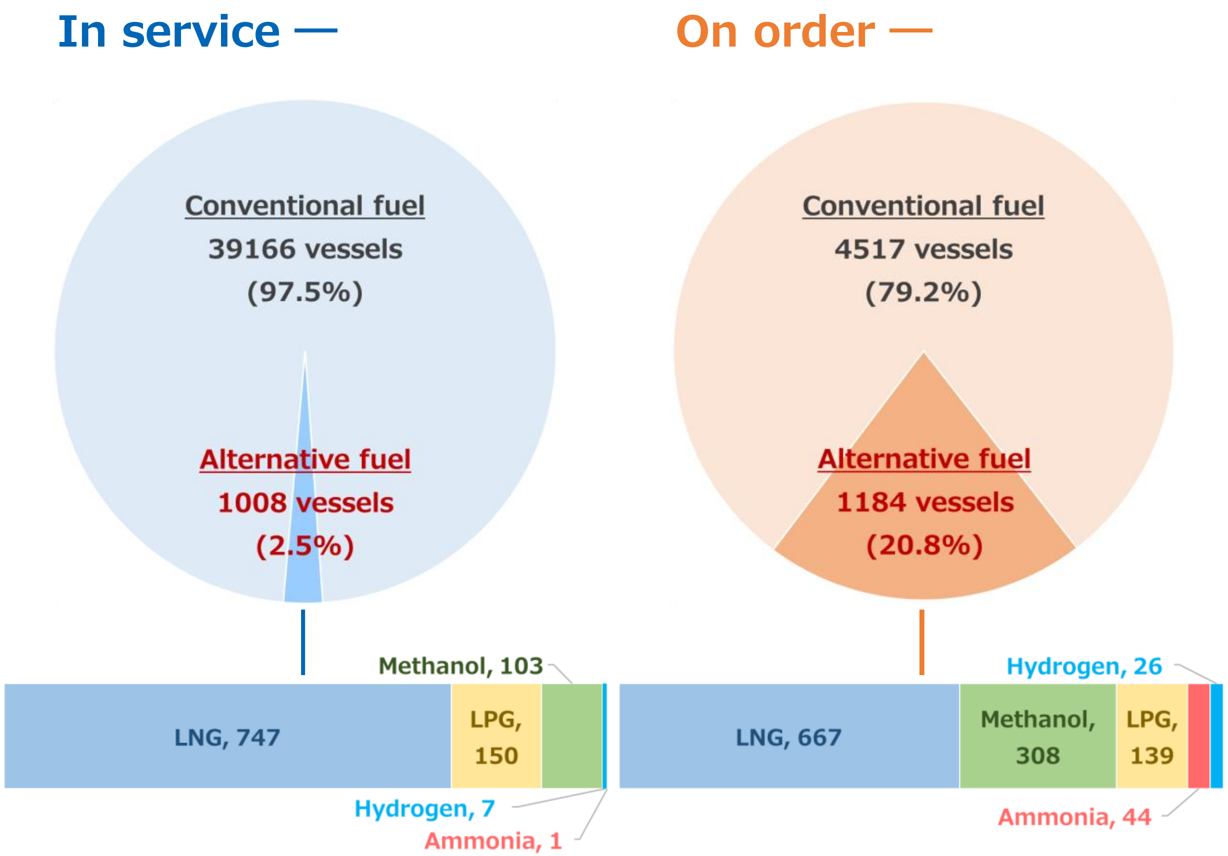
Source: The figures and tables presented in this section are created by ClassNK based on data from Clarkson Research Services Limited.

ClassNK

As of the end of December 2025

Trends in alternative fuel ships

Share of alternative fuel ships



- ✓ As of the end of December 2025
- ✓ 5,000 gross tonnage and above
- ✓ LNG carriers are excluded from LNG-fueled ships.
- ✓ Alternative fuel ready ships are not included.

Details of alternative fuel ships (Jun. 2025 → Dec. 2025)

In service

	As of Jun. 30, 2025	As of Dec. 31, 2025
Number of vessels	869 vessels (2.2%)	1,008 vessels (2.5%)
Total GT	62,147,411 GT (3.8%)	74,697,151 GT (4.5%)

There was an increase of 139 vessels, totaling 12.5 million GT, over the six-month period. By fuel type, LNG fueled vessels accounted for the majority with 91 units. Meanwhile, **deliveries of methanol fueled vessels doubled from 19 in the first half of 2025 to 38.**

On order

	As of Jun. 30, 2025	As of Dec. 31, 2025
Number of vessels	1,187 vessels (23.3%)	1,184 vessels (20.8%)
Total GT	112,588,899 GT (38.5%)	117,141,829 GT (35.5%)

The share of alternative fueled vessels in the orderbook has declined in both vessel numbers and GT, **reflecting a growing "wait-and-see" attitude**. Meanwhile, a breakdown reveals **a marked resurgence of LNG fueled vessels**, with their share jumping from 49% to 79% over the past six months.

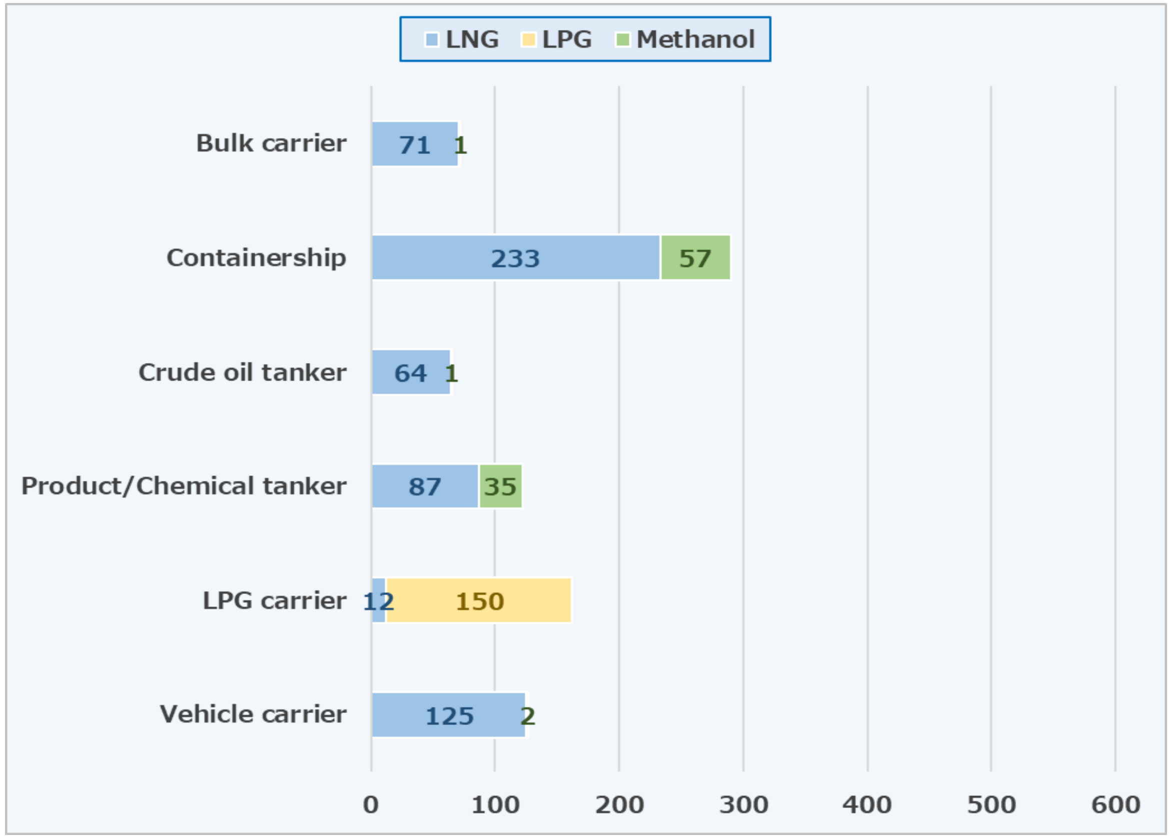
Appendix

ClassNK

Trends in alternative fuel ships (by ship type)

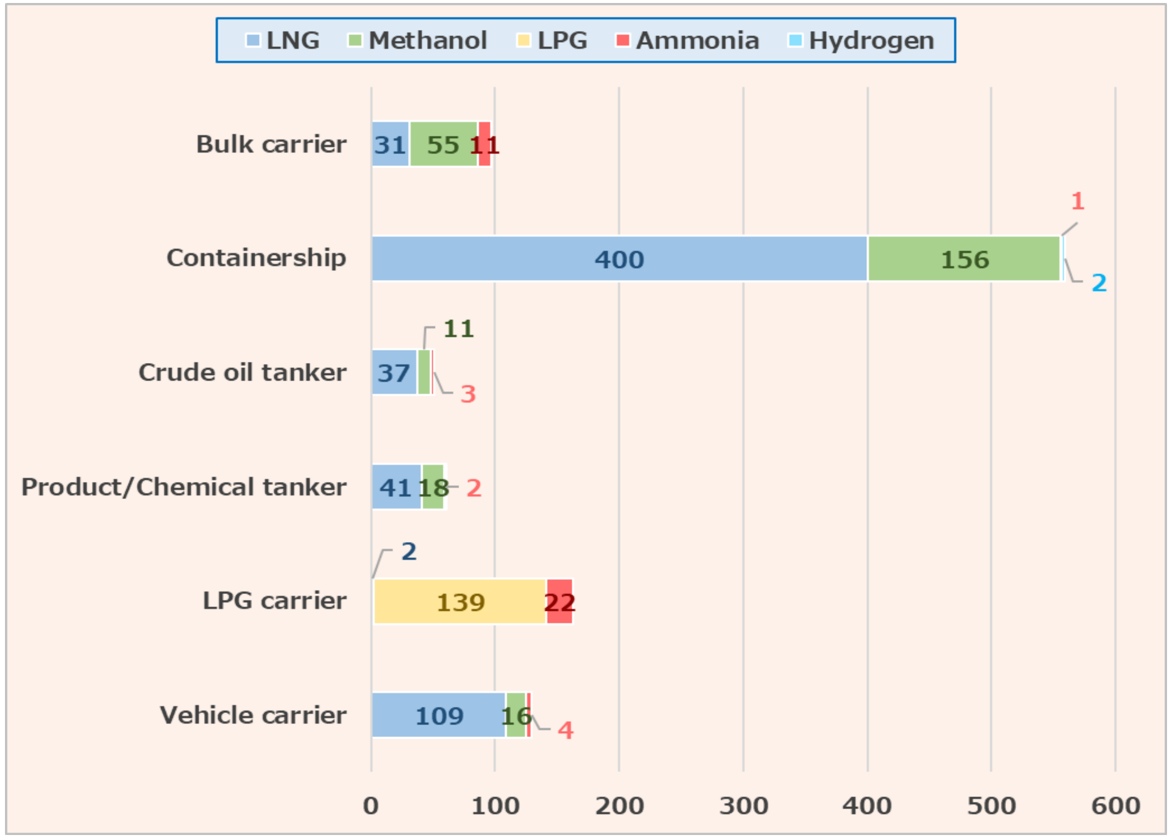
As of the end of December 2025

In service —



- ✓ As of the end of December 2025 / 5,000 gross tonnage and above / Alternative fuel ready ships are not included.
- ➢ Excluding LPG carriers, LNG fueled vessels account for the majority across all sectors, while methanol vessels are also operating, notably in containerships.

On order —



- ✓ As of the end of December 2025 / 5,000 gross tonnage and above / Alternative fuel ready ships are not included.
- ➢ Unlike the operating fleet, methanol fueled vessels hold a larger orderbook share, though this declined in the past six months (see appendix).

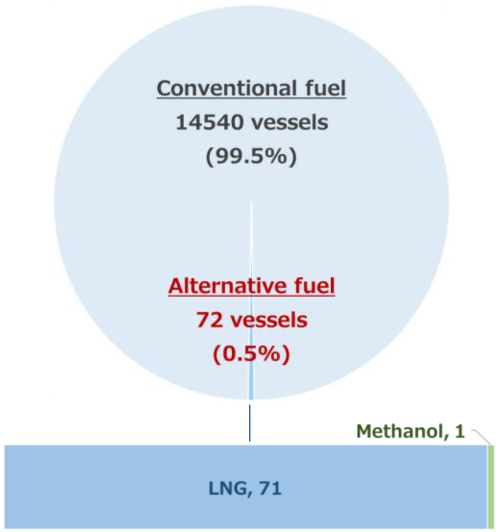
ClassNK

Trends in alternative fuel ships (by ship type)

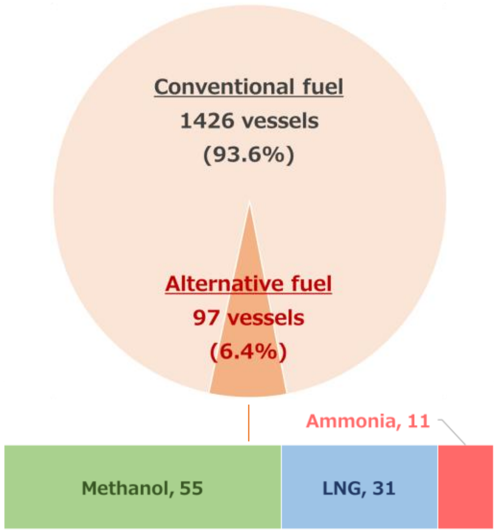
As of the end of December 2025

Bulk carriers

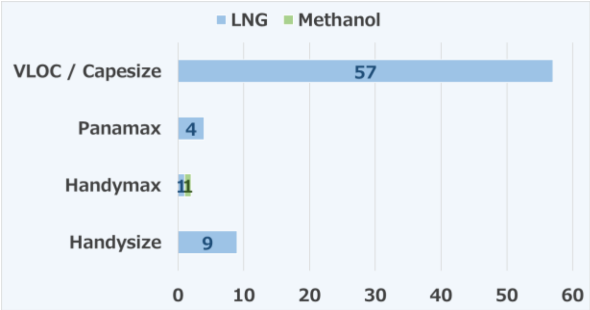
In service —



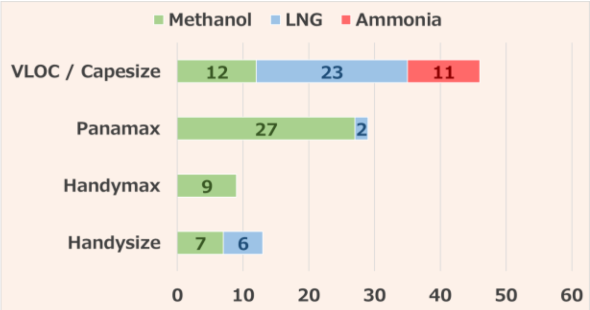
On order —



In service —



On order —



Details of alternative fuel ships (Jun. 2025 → Dec. 2025)

In service —

	As of Jun. 30, 2025	As of Dec. 31, 2025
Number of vessels	64 vessels (0.4%)	72 vessels (0.5%)
Total GT	5,955,213 GT (1.0%)	6,591,108 GT (1.1%)

There was an increase of 8 vessels, totaling 0.6 million GT, over the six-month period. Deliveries of alternative fueled vessels were observed across a wide range of sizes, from VLOC / Capesize to Handysize. **All of these were LNG fueled vessels.**

On order —

	As of Jun. 30, 2025	As of Dec. 31, 2025
Number of vessels	110 vessels (8.0%)	97 vessels (6.4%)
Total GT	9,099,251 GT (14.6%)	7,582,545 GT (10.3%)

There was a decrease of 13 vessels, totaling 1.5 million GT, over the six-month period. **The number of new orders was zero, reflecting an intensifying "wait-and-see" attitude toward the adoption of alternative fueled vessels.**

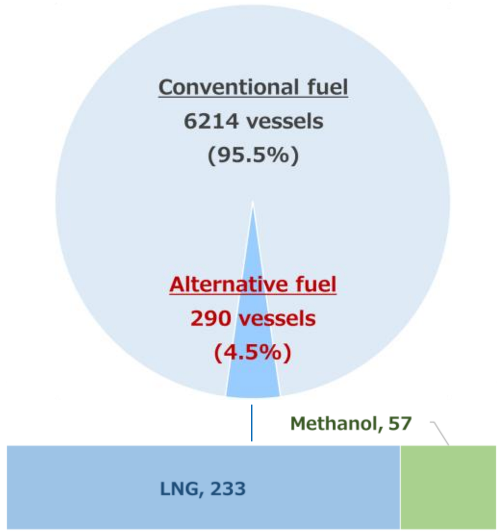
ClassNK

As of the end of December 2025

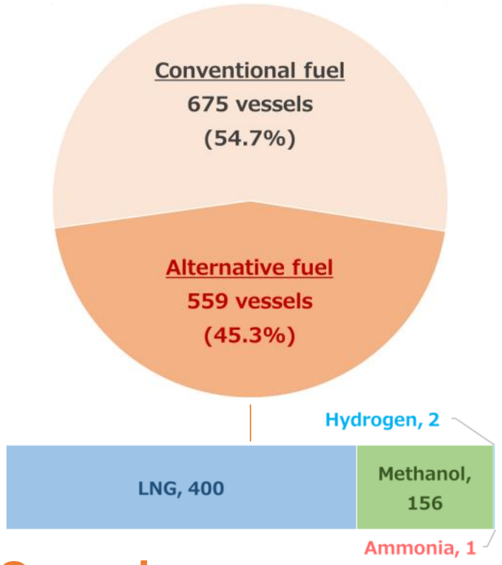
Trends in alternative fuel ships (by ship type)

Containerships

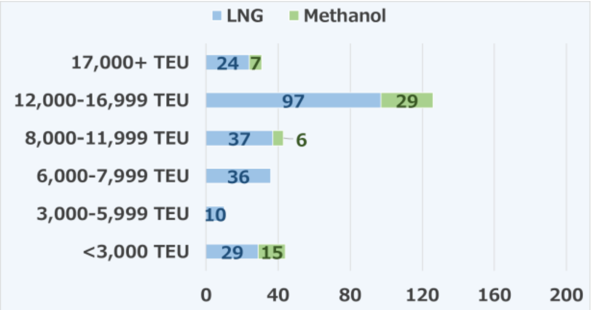
In service —



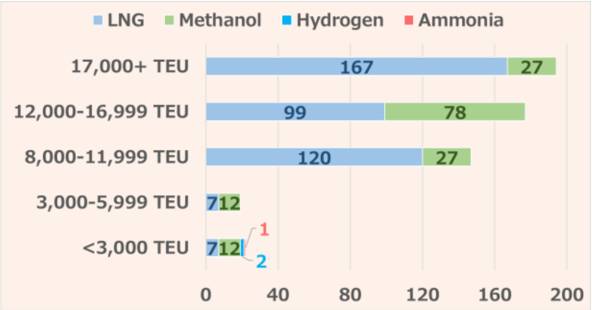
On order —



In service —



On order —



Details of alternative fuel ships (Jun. 2025 → Dec. 2025)

In service —

	As of Jun. 30, 2025	As of Dec. 31, 2025
Number of vessels	224 vessels (3.5%)	290 vessels (4.5%)
Total GT	26,085,470 GT (7.8%)	33,706,066 GT (9.8%)

There was an increase of 66 vessels, totaling 7.6 million GT, over the six-month period. By fuel type, LNG fueled vessels accounted for 40 units, and methanol fueled vessels accounted for 22.

On order —

	As of Jun. 30, 2025	As of Dec. 31, 2025
Number of vessels	521 vessels (58.3%)	559 vessels (45.3%)
Total GT	71,722,774 GT (77.6%)	79,302,773 GT (71.7%)

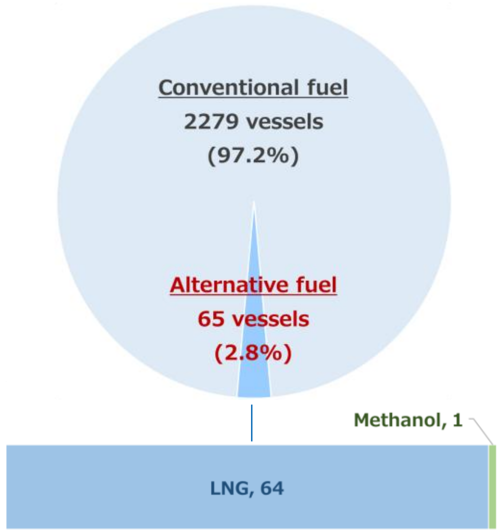
There was an increase of 38 vessels, totaling 7.6 million GT, over the six-month period. New orders totaled 105, with LNG fueled vessels accounting for 97 (92%). Meanwhile, the methanol share decreased from 26% in the first half of 2025 to 8%, indicating a shift back to LNG even in the containership sector, which had actively adopted methanol.

As of the end of December 2025

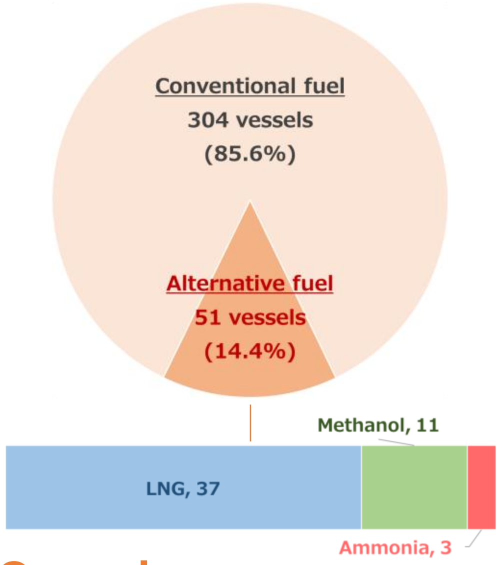
Trends in alternative fuel ships (by ship type)

Crude oil tankers

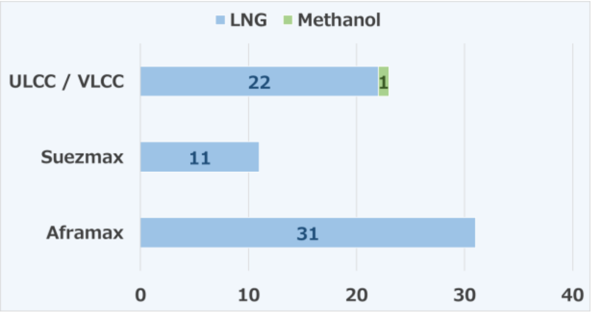
In service —



On order —



In service —



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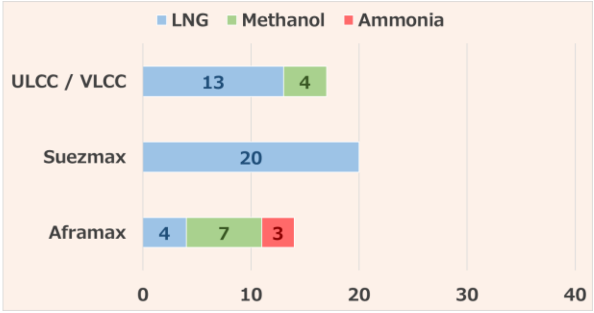


Details of alternative fuel ships (Jun. 2025 → Dec. 2025)

In service —

	As of Jun. 30, 2025	As of Dec. 31, 2025
Number of vessels	60 vessels (2.5%)	65 vessels (2.8%)
Total GT	6,060,939 GT (2.5%)	6,648,521 GT (2.7%)

There was an increase of 5 vessels, totaling 0.6 million GT, over the six-month period. **By fuel type, LNG fueled vessels accounted for 4 units, and methanol fueled vessels accounted for 1.**

On order —

	As of Jun. 30, 2025	As of Dec. 31, 2025
Number of vessels	50 vessels (17.7%)	51 vessels (14.4%)
Total GT	5,388,981 GT (18.1%)	5,209,093 GT (13.1%)

There was an increase of 1 vessel, but a decrease of 0.2 million GT over the six-month period. New orders totaled 8, with LNG fueled vessels accounting for 6 units (75%). Meanwhile, **the share of methanol fueled vessels decreased significantly from 83% in the first half of 2025 to 25%.**

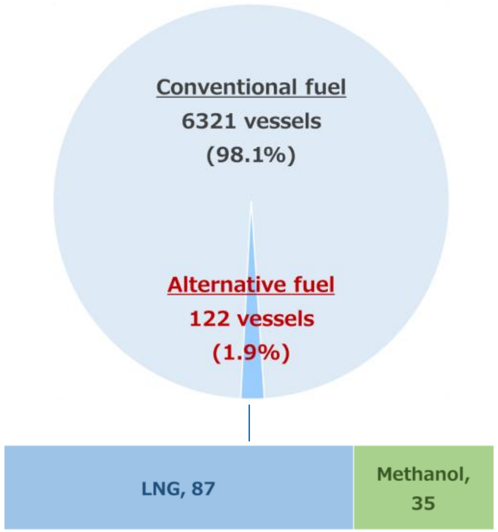
ClassNK

As of the end of December 2025

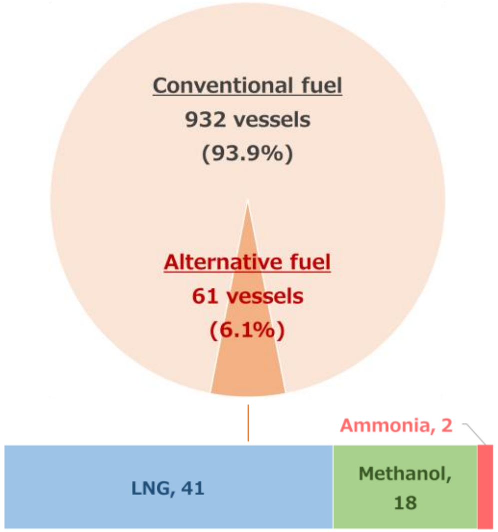
Trends in alternative fuel ships (by ship type)

Product/Chemical tankers

In service —



On order —



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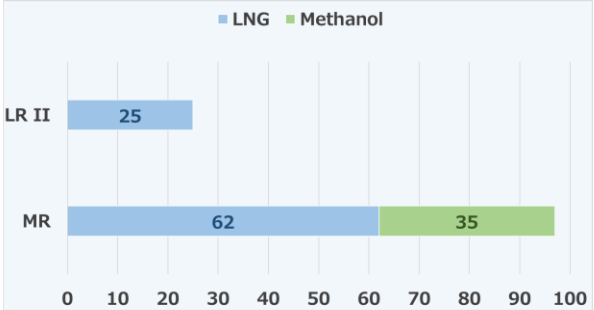

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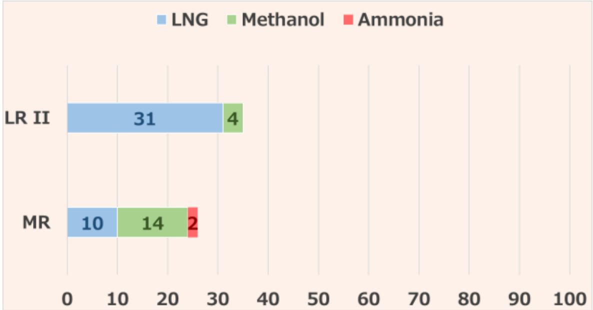


Details of alternative fuel ships (Jun. 2025 → Dec. 2025)

In service —

	As of Jun. 30, 2025	As of Dec. 31, 2025
Number of vessels	111 vessels (1.8%)	122 vessels (1.9%)
Total GT	3,239,989 GT (2.2%)	3,519,837 GT (2.3%)

There was an increase of 11 vessels, totaling 0.3 million GT, over the six-month period. By fuel type, LNG fueled vessels accounted for 4 units, and methanol fueled vessels accounted for 7. Notably, all 7 methanol vessels were MR type deliveries.

On order —

	As of Jun. 30, 2025	As of Dec. 31, 2025
Number of vessels	64 vessels (6.5%)	61 vessels (6.1%)
Total GT	2,718,123 GT (9.7%)	2,656,557 GT (9.4%)

There was a decrease of 3 vessels, totaling 0.06 million GT, over the six-month period. New orders totaled 5, all of which were methanol fueled vessels. Continuing from the first half of 2025, no orders for LNG fueled vessels were observed.

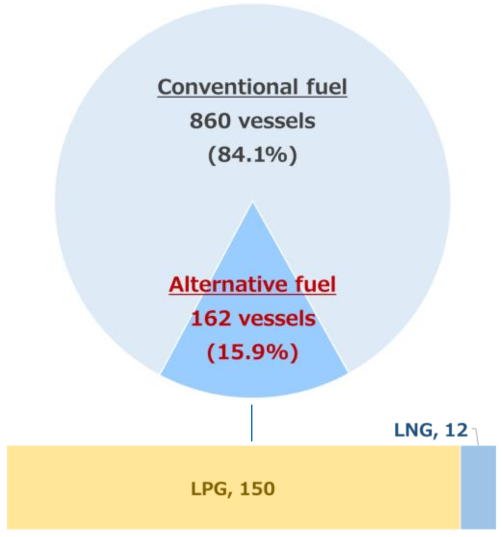
ClassNK

Trends in alternative fuel ships (by ship type)

As of the end of December 2025

LPG carriers

In service —



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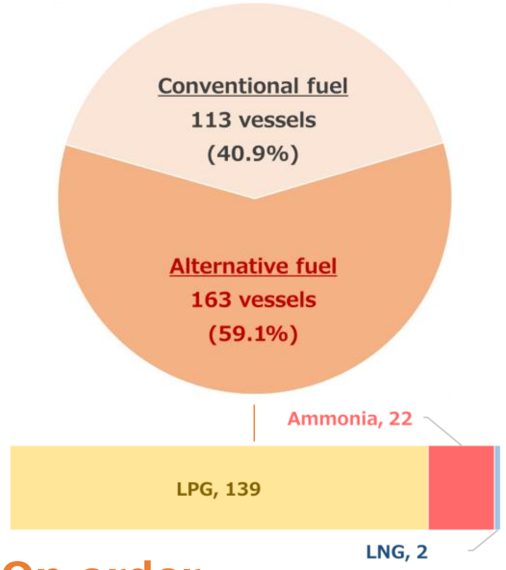

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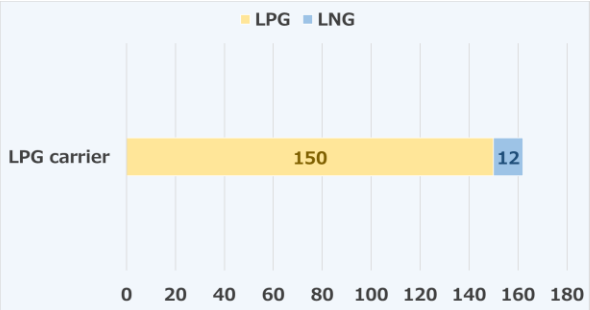

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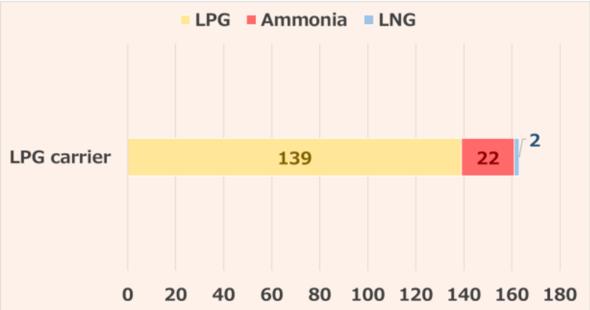


Details of alternative fuel ships (Jun. 2025 → Dec. 2025)

In service —

	As of Jun. 30, 2025	As of Dec. 31, 2025
Number of vessels	151 vessels (15.2%)	162 vessels (15.9%)
Total GT	6,454,834 GT (21.7%)	6,898,438 GT (22.3%)

There was an increase of 11 vessels, totaling 0.4 million GT, over the six-month period. By fuel type, LPG fueled vessels accounted for 9 units, and LNG fueled vessels accounted for 2.

On order —

	As of Jun. 30, 2025	As of Dec. 31, 2025
Number of vessels	164 vessels (56.7%)	163 vessels (59.1%)
Total GT	6,597,202 GT (57.8%)	6,544,929 GT (61.8%)

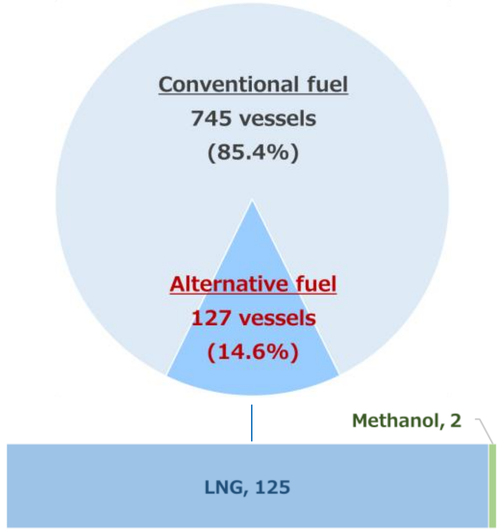
There was a decrease of 1 vessel, totaling 0.05 million GT, over the six-month period. New orders totaled 10, with LPG fueled vessels accounting for 7, ammonia fueled vessels for 2, and LNG fueled vessels for 1. Continuing from the first half of 2025, no significant changes were observed in the adoption trends of alternative fueled vessels.

As of the end of December 2025

Trends in alternative fuel ships (by ship type)

Vehicle carriers

In service —



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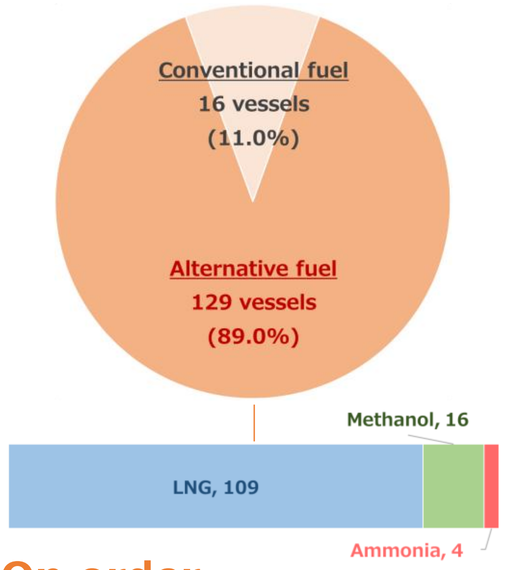

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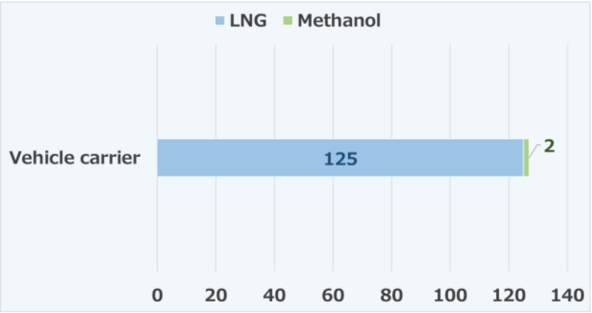
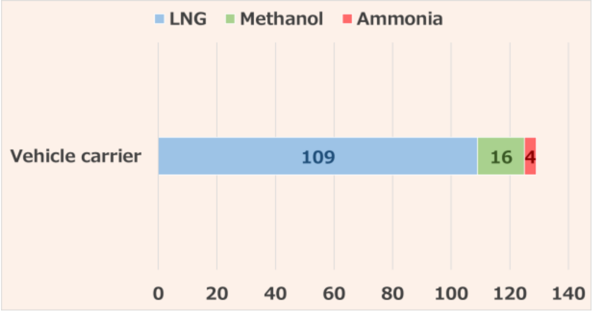


On order —



Details of alternative fuel ships (Jun. 2025 → Dec. 2025)

In service —

	As of Jun. 30, 2025	As of Dec. 31, 2025
Number of vessels	98 vessels (11.8%)	127 vessels (14.6%)
Total GT	6,900,406 GT (15.5%)	9,083,330 GT (19.1%)

There was an increase of 29 vessels, totaling 2.2 million GT, over the six-month period. By fuel type, LNG fueled vessels accounted for 27 units, and methanol fueled vessels accounted for 2.

On order —

	As of Jun. 30, 2025	As of Dec. 31, 2025
Number of vessels	153 vessels (84.5%)	129 vessels (89.0%)
Total GT	9,354,962 GT (82.4%)	7,833,754 GT (86.9%)

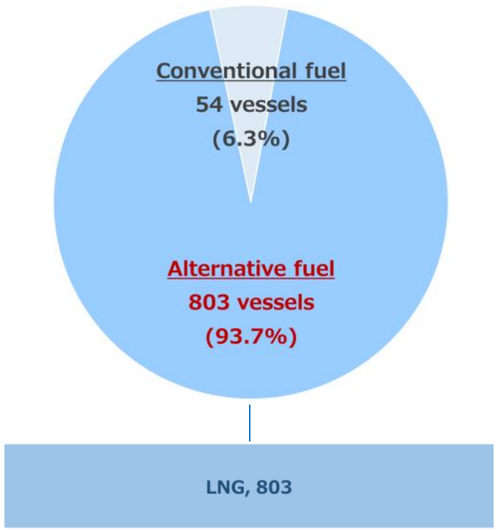
Due to a large volume of newbuilding deliveries, the orderbook decreased by 24 vessels, totaling 1.5 million GT, over the six-month period. New orders totaled only 3 vessels, all of which were LNG fueled.

As of the end of December 2025

Trends in alternative fuel ships (by ship type)

LNG carriers (for reference)

In service —



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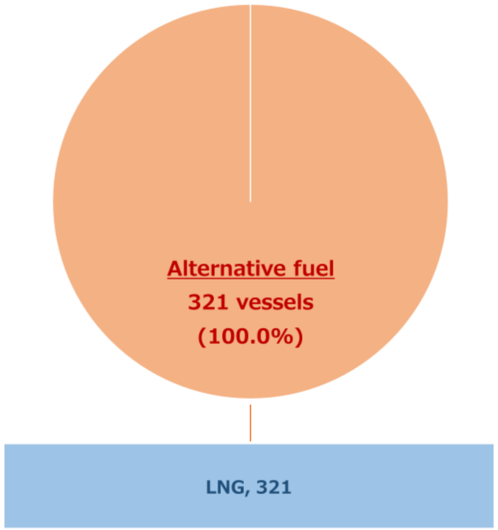

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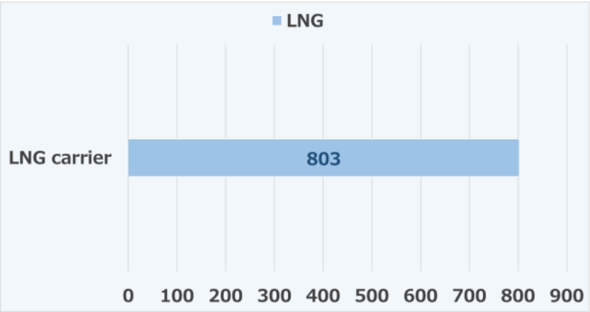

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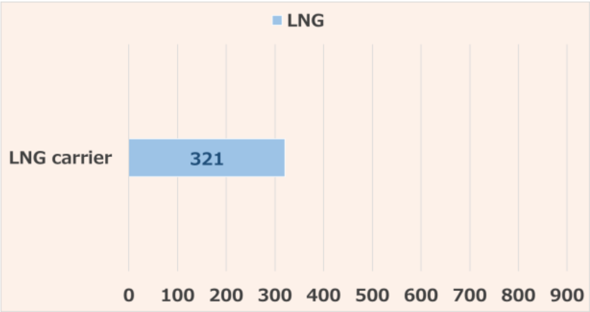

Details of alternative fuel ships (Jun. 2025 → Dec. 2025)

In service —

	As of Jun. 30, 2025	As of Dec. 31, 2025
Number of vessels	764 vessels (93.4%)	803 vessels (93.7%)
Total GT	79,180,322 GT (92.0%)	83,807,489 GT (92.4%)

There was an increase of 39 vessels, totaling 4.6 million GT, over the six-month period. All of these were LNG fueled vessels, and no deliveries of other alternative fueled vessels were observed.

On order —

	As of Jun. 30, 2025	As of Dec. 31, 2025
Number of vessels	335 vessels (100.0%)	321 vessels (100.0%)
Total GT	35,564,165 GT (100.0%)	33,306,593 GT (100.0%)

Due to a large volume of newbuilding deliveries, the orderbook decreased by 14 vessels, totaling 2.3 million GT, over the six-month period. New orders totaled 37 vessels, all of which were LNG fueled.