SHIP FUEL IN THE FUTURE

An analysis by Levent Akson

June 2023

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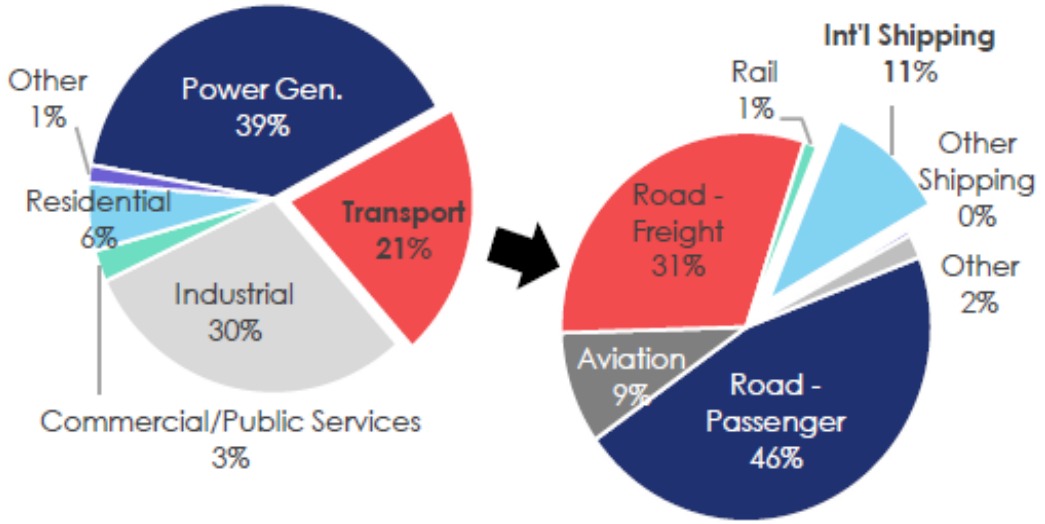
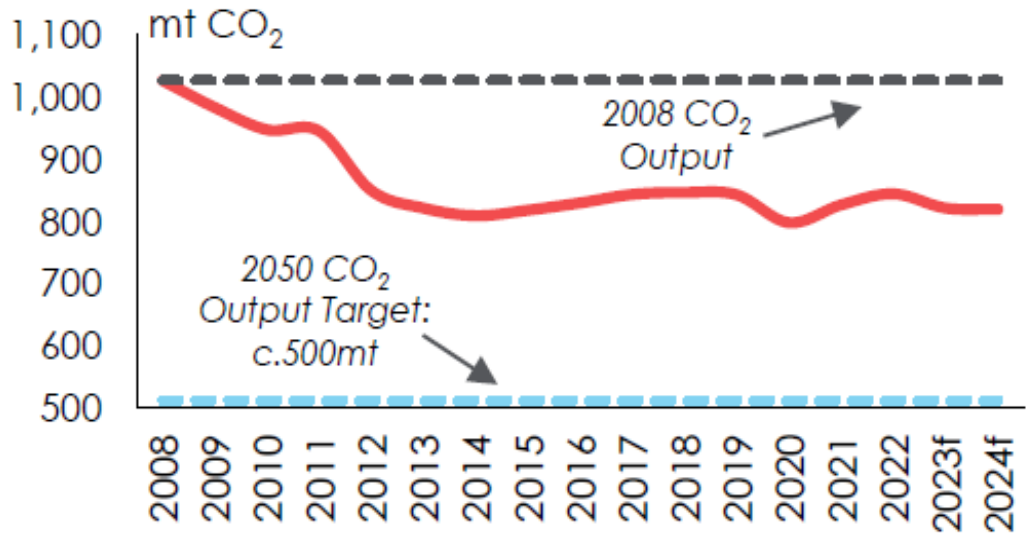
Summary

DECARBONISATION

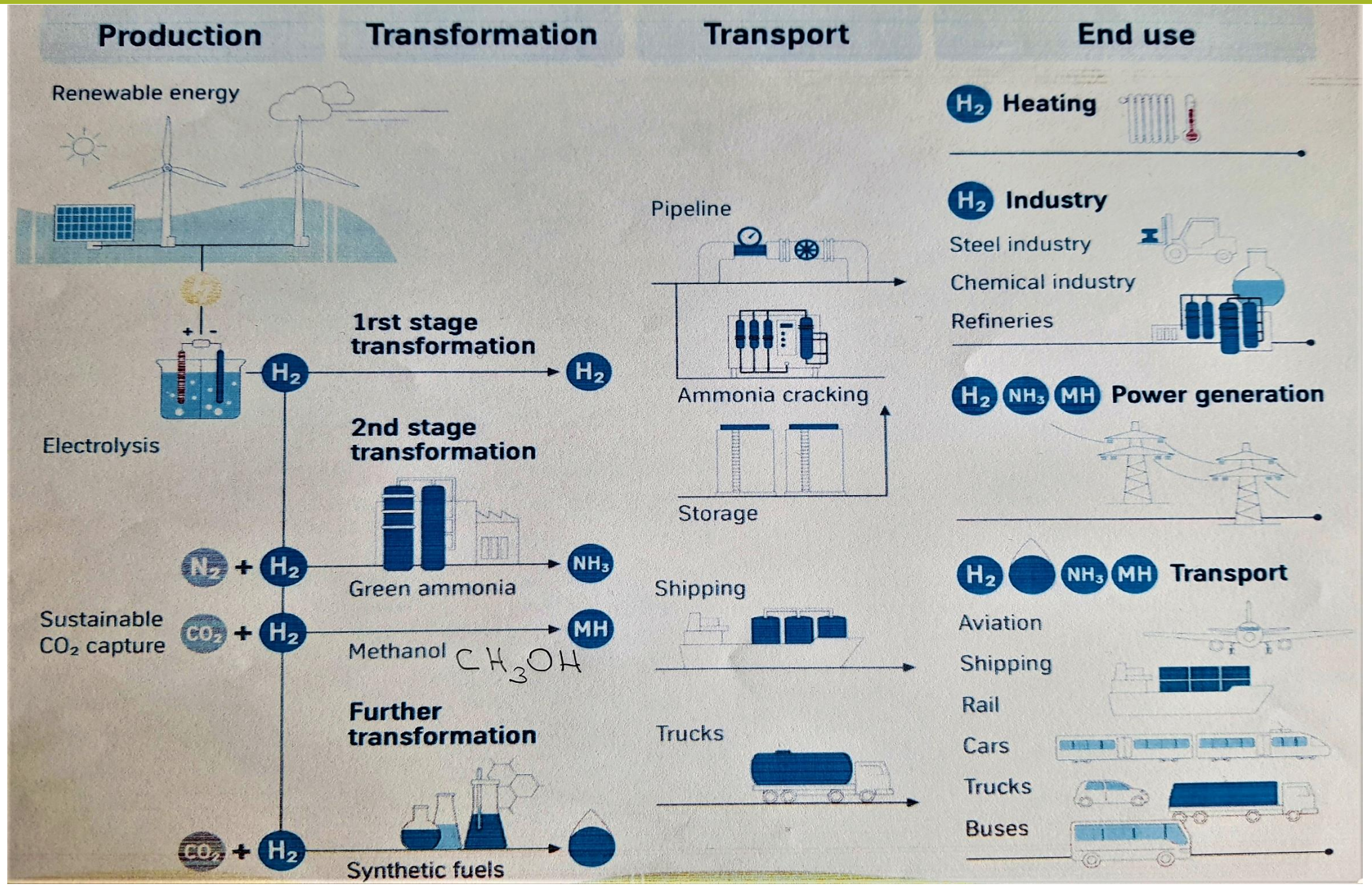
Global CO_2 Emissions By Sector



International Shipping CO_2 Emissions

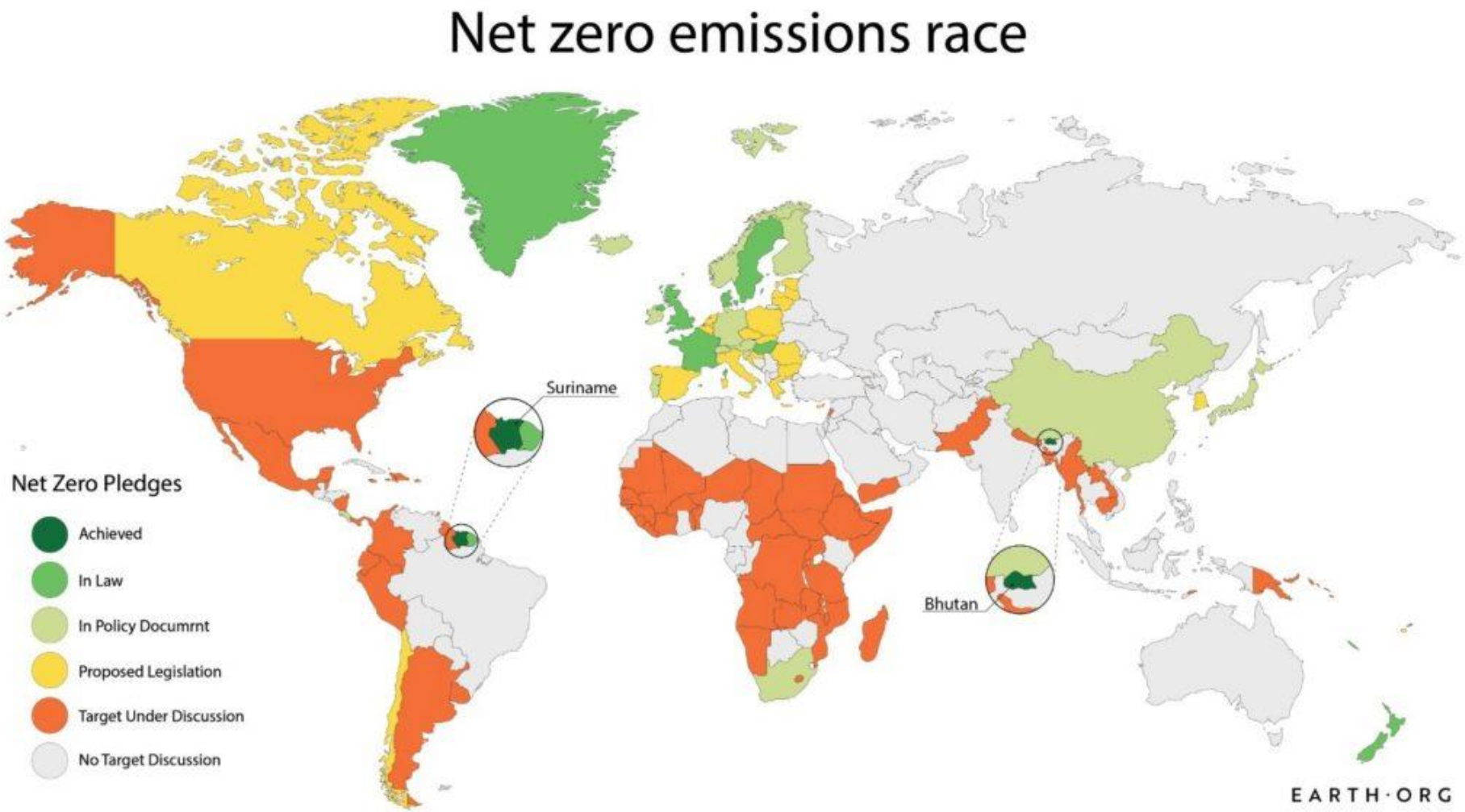


Source : Clarksons Research, IEA


Production
Transformation
Transport
End use
Renewable energy
Electrolysis
1rst stage transformation
2nd stage transformation
Green ammonia
Sustainable CO_2 capture
Methanol CH_3OH
Further transformation
Synthetic fuels
Pipeline
Ammonia cracking
Storage
Shipping
Trucks
H_2 Heating
H_2 Industry
Steel industry
Chemical industry
Refineries
H_2 NH_3 MH Power generation
H_2 NH_3 MH Transport
Aviation
Shipping
Rail
Cars
Trucks
Buses

Carbon neutrality is a global phenomenon

Majority of the countries have made carbon neutrality pledge by 2050. This will significantly affect oil, coal and LNG demand.

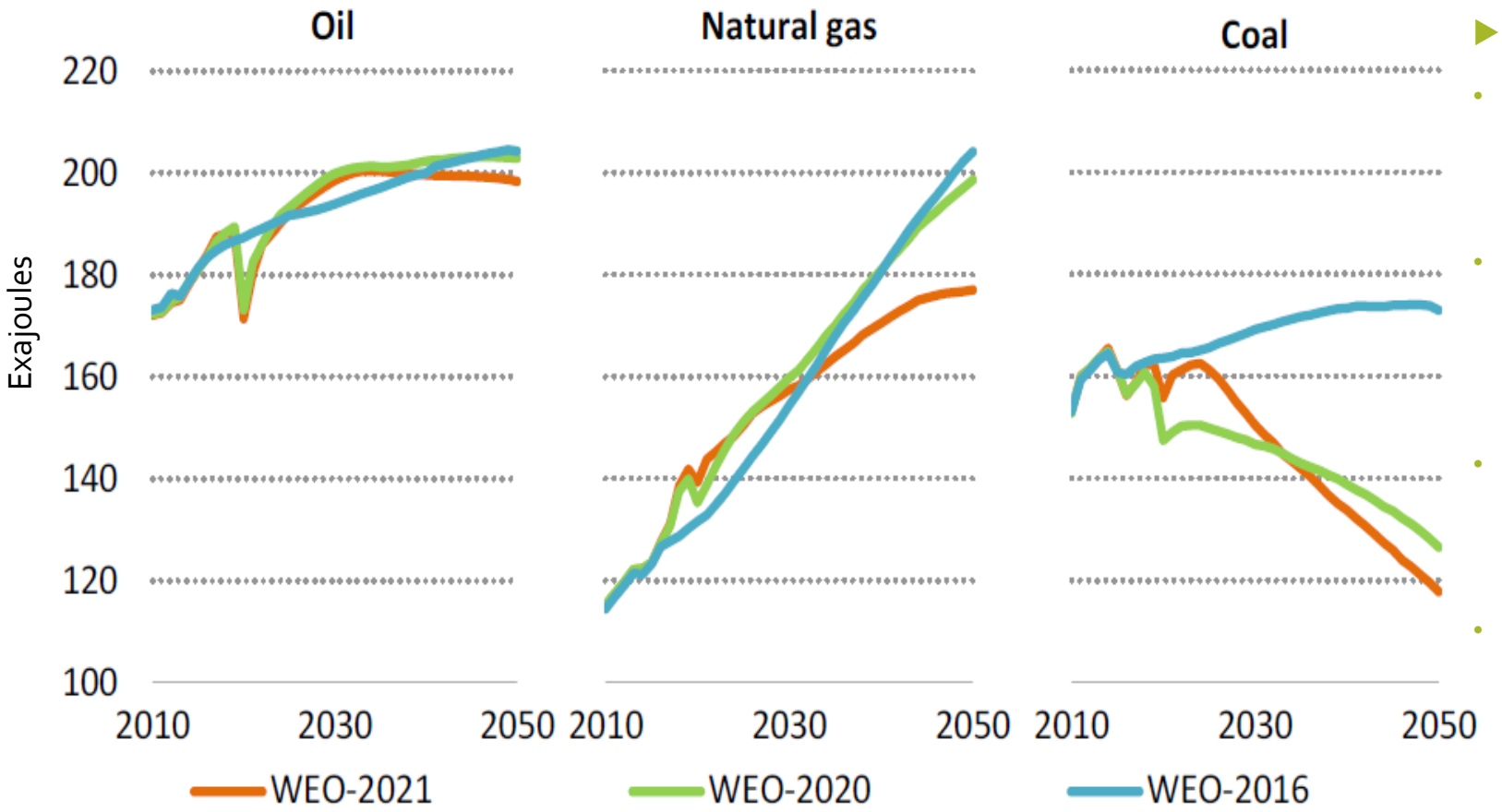


- **Key takeaway**

- All the countries are working towards aligning themselves with Paris 2016 climate pledge.
- Majority of the countries have pledged to be carbon neutral by 2050. Some major countries such as China and India have pledged to be net-zero by 2060 and 2070 respectively.

Energy transition underway

Oil demand in most of the scenarios will flatten or fall significantly by 2050. Natural gas will continue to play a significant role, albeit growth is expected to slow down. During the same time horizon, coal is likely to fall significantly. Renewables will continue to increase in all cases. Hydrogen and Ammonia are likely to emerge as important sources of energy.



Source: IEA

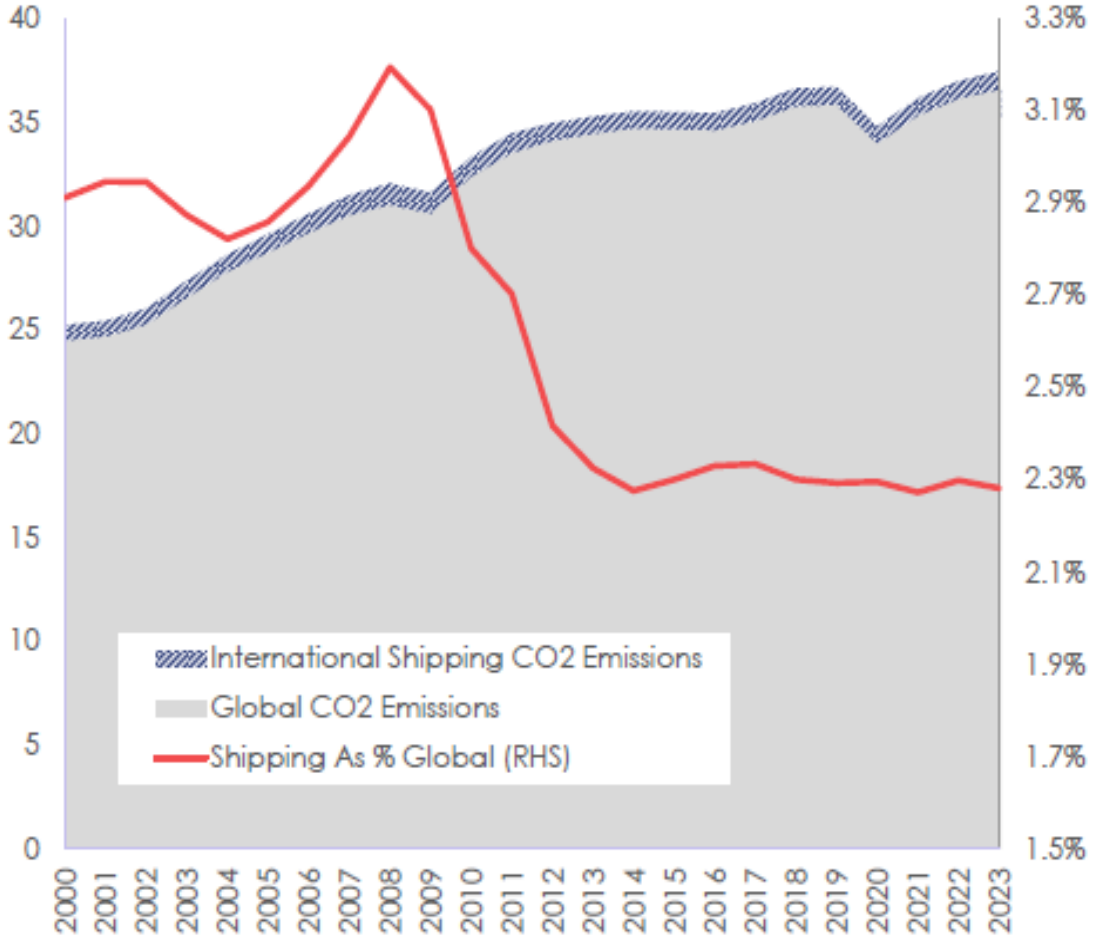
Key takeaway

- In the last five years International Energy Agency (IEA) has gradually become pessimistic about the outlook of fossil fuels. It has been due to increasing investment in renewable sources of energy.
- Climate Bonds forecasts half a trillion US dollars of investment in annual green bond investment in 2021, reflecting the strength of the green market. Green bonds have been soaring at a 49% growth rate in the five preceding years before 2021.
- There has been a formation of an industry-led, UN-convened Net-Zero Banking Alliance with 53 members in 27 countries with US$37 trillion in assets- representing almost a quarter of banking assets worldwide
- Glasgow Financial Alliance for Net Zero (GFANZ) has over 250 financial institutions from 32 countries, representing over US$88 trillion in assets.

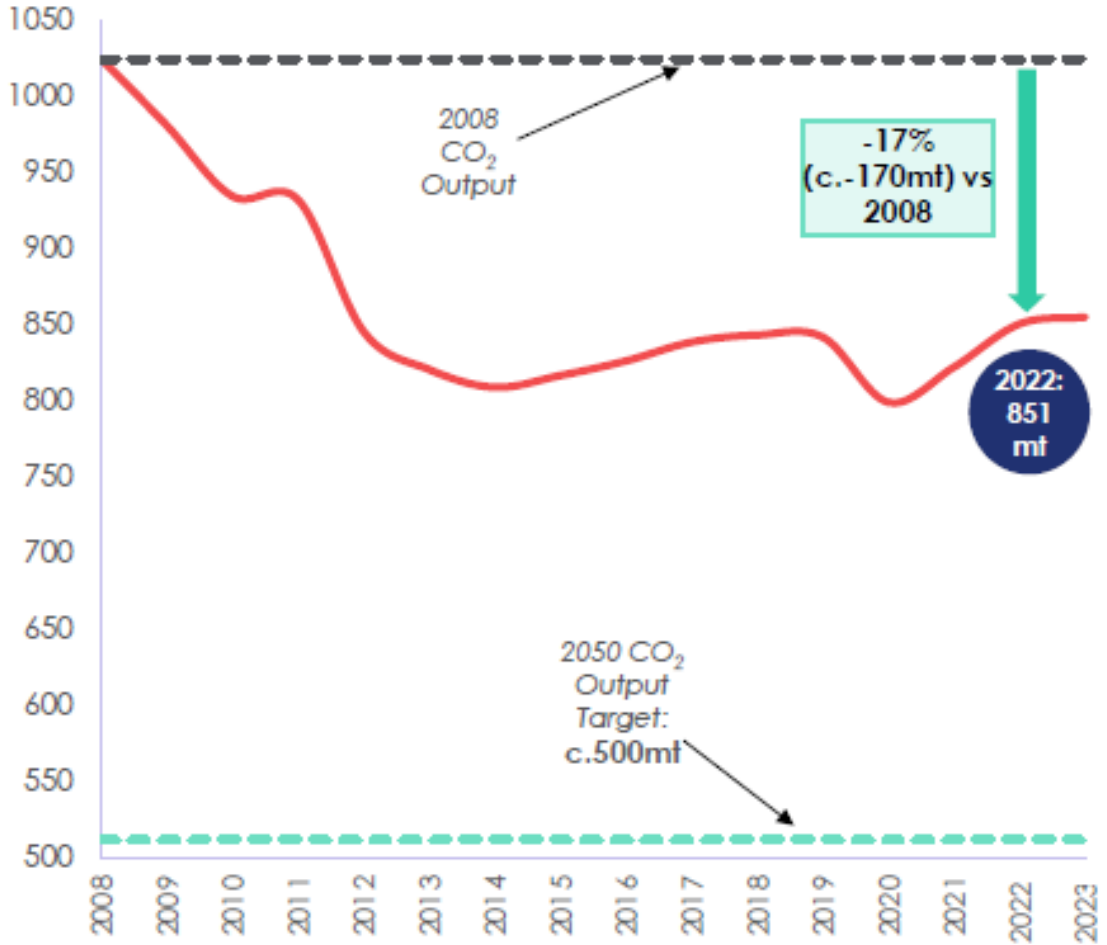
SHIPPING AND CARBON EMISSION

A push towards decarbonisation

Global CO_2 Emissions

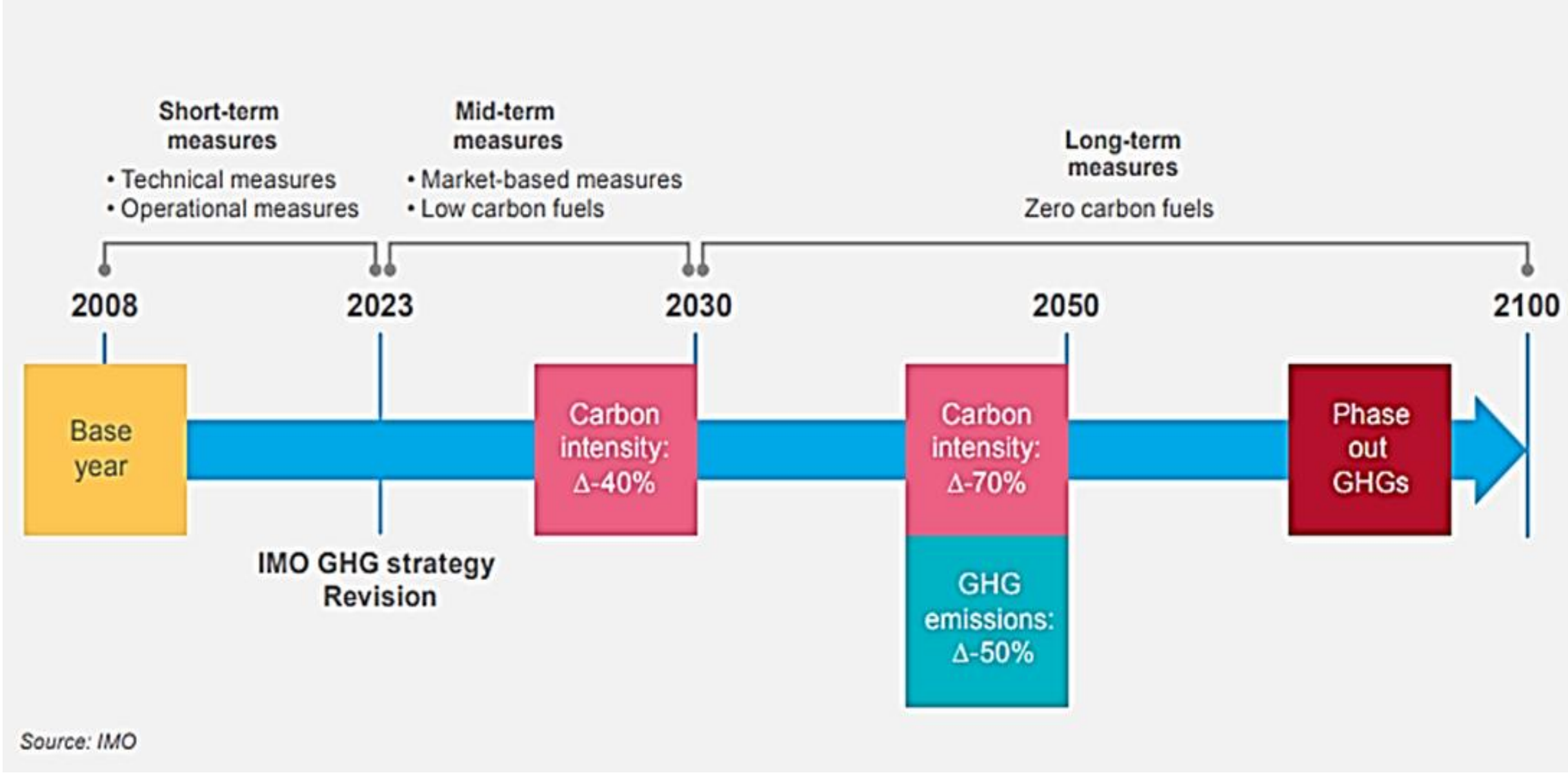


International Shipping CO_2 Emissions, tonnes CO_2



IMO’S INITIATIVES

IMO initial GHG Strategy



Current scenario

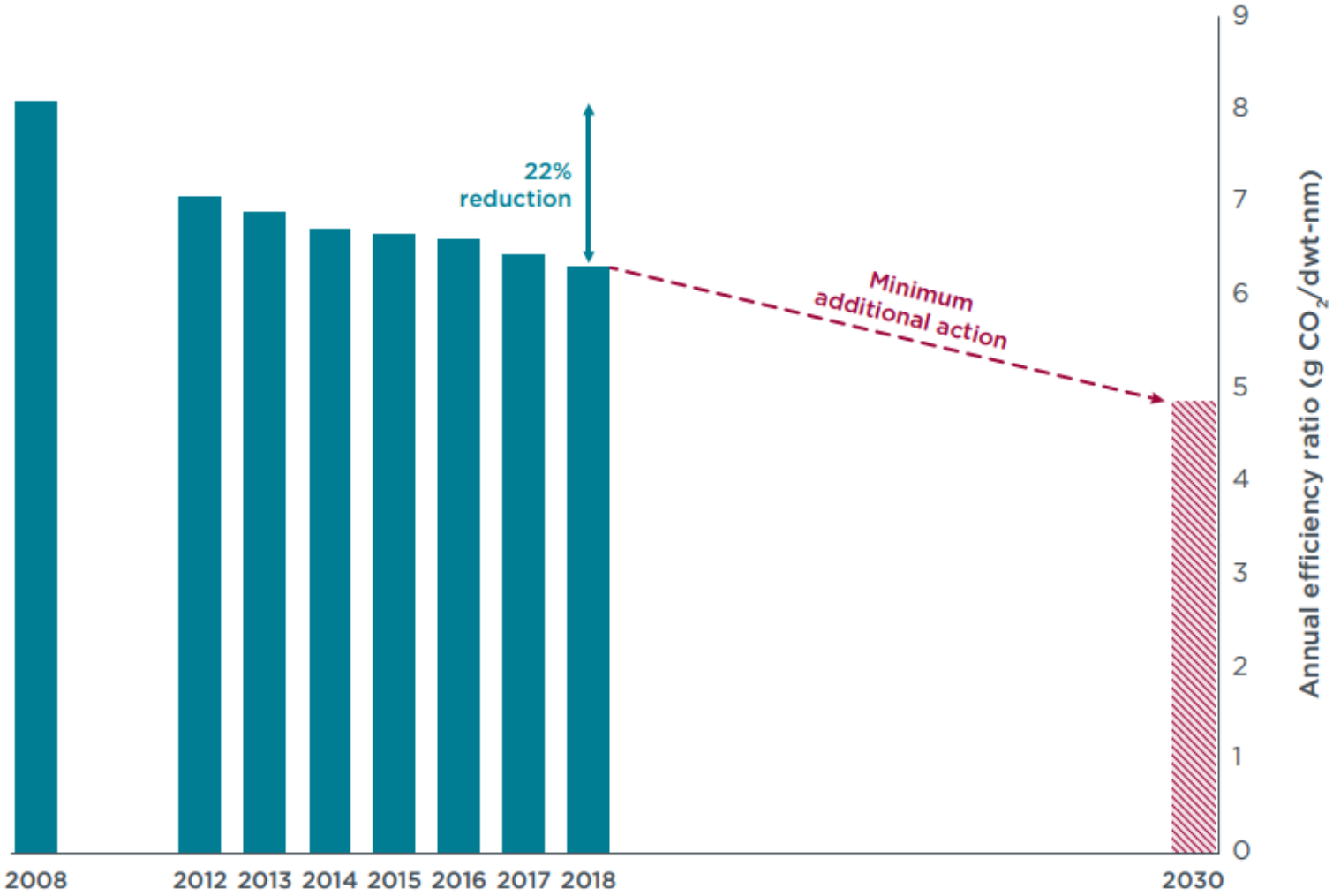
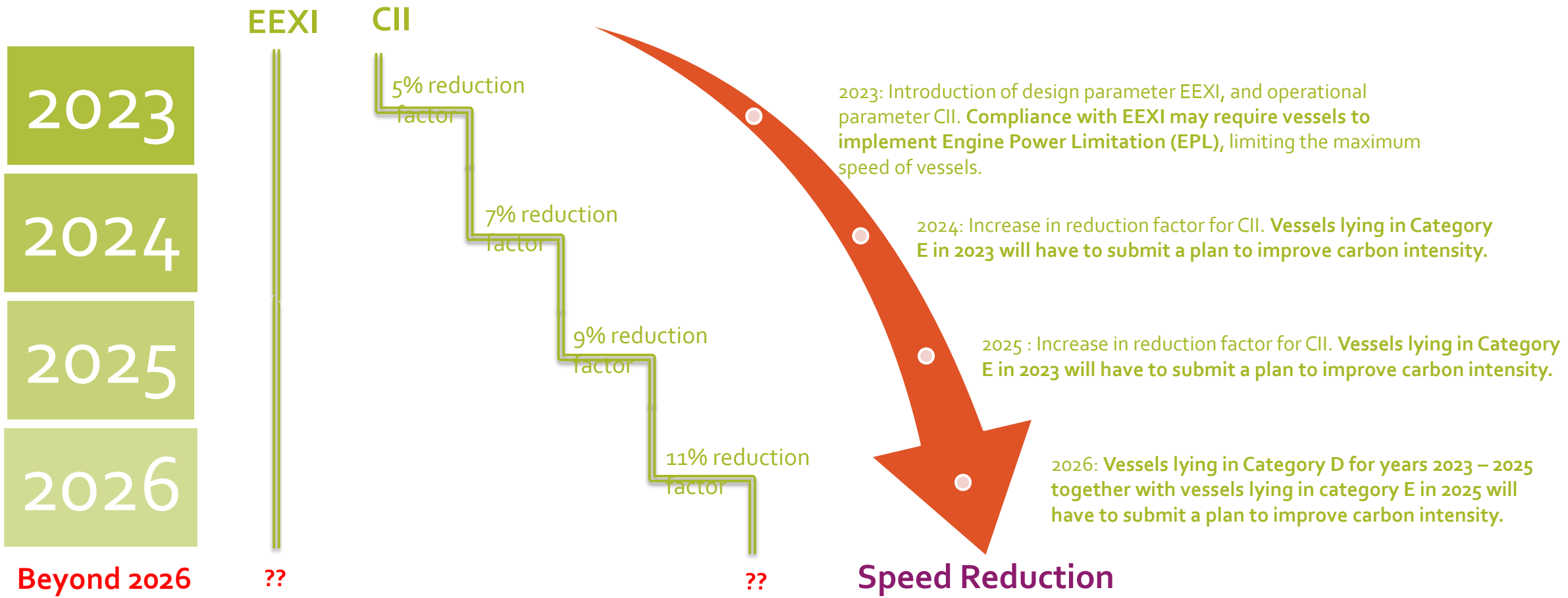


Figure 1. CO_2 intensity of international shipping, 2008 to 2018, compared to IMO's minimum 2030 carbon intensity target. *Note*. Derived from Faber et al. (2020).

- Energy efficiency can be improved either by reducing emissions by using alternative fuel, speed reduction, or by other means
- It can also be improved by increasing transport power, by installing Propulsion Improving Devices (PID)
- Therefore, vessels could reduce speed to comply with emission regulations, and this methodology does not involve any retrofitting or capex.

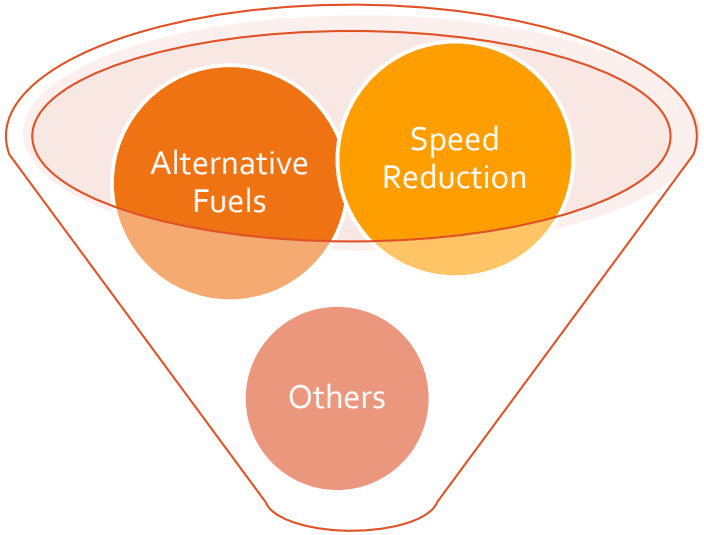
EEXI and CII

The introduction of EEXI and CII in 2023 would require an assessment of the design, and operational carbon intensity of the vessel. Requirements to comply are stringent with reduction factors increasing over the years.



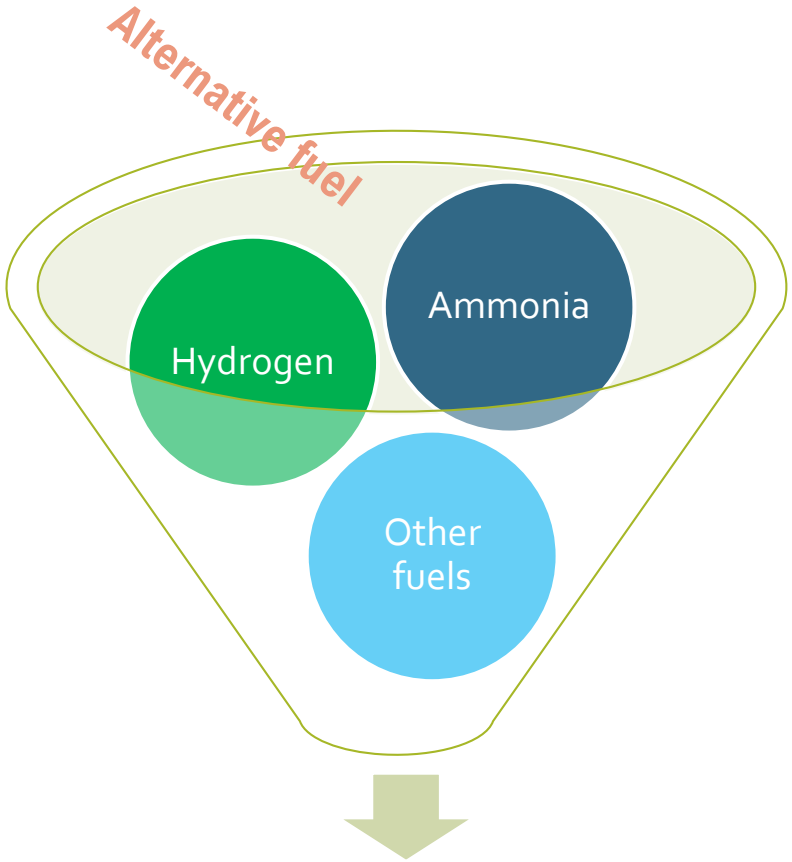
Note: The given percentages are carbon intensity reductions, not speed reductions.

Future?



Reduce CO_2 emission

Others: Propulsion Improvement Devices (PIDs) and Energy Saving Devices (ESDs)

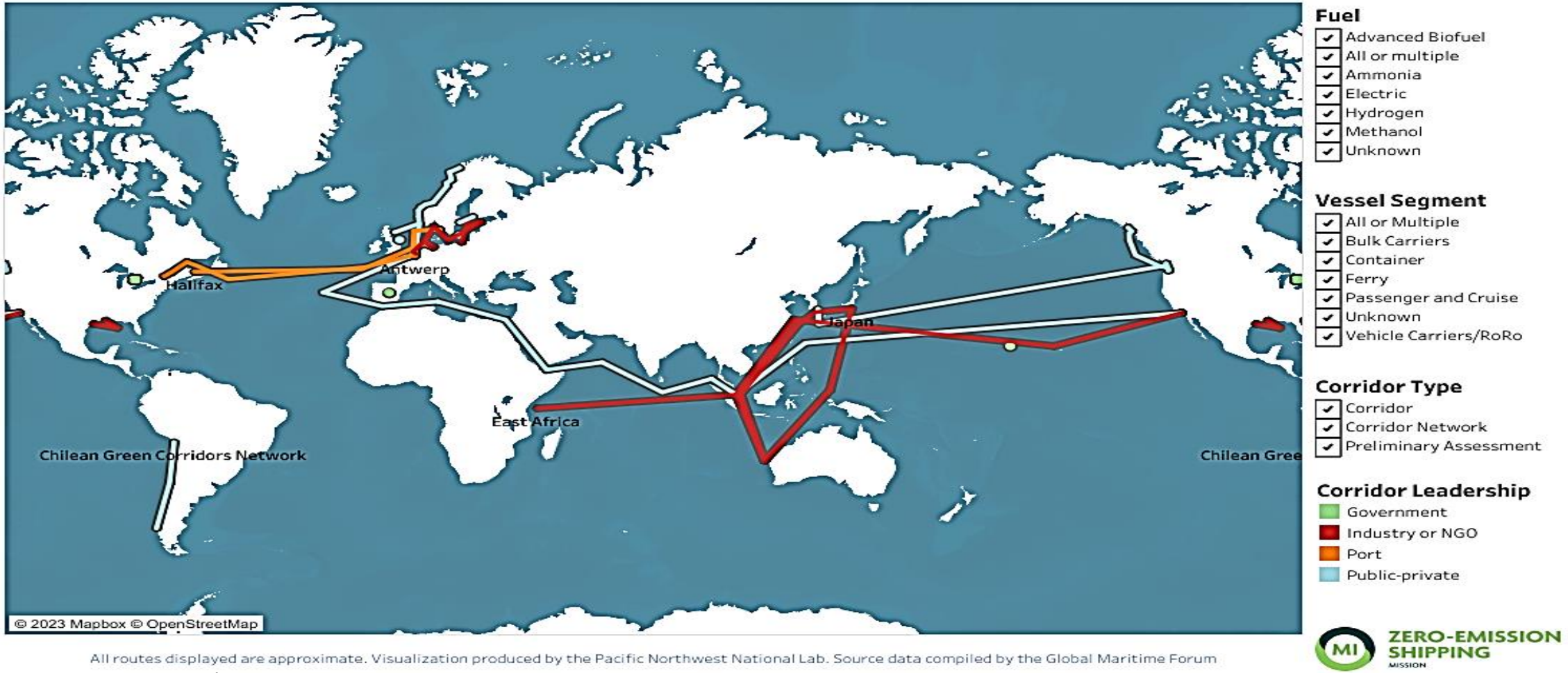


One long-term alternative fuel or "multi-fuel" future?

ALTERNATIVE FUEL

Formation of Green Corridors

As we start transitioning towards alternative fuels, the availability of fuels, their acceptability, etc. is expected to be challenging. Therefore, major stakeholders have joined forces to establish green corridors in some selected trade routes. In these green corridors, alternative fuel will be available, thereby encouraging ship owners to deploy alternative fuelled vessels.



All routes displayed are approximate. Visualization produced by the Pacific Northwest National Lab. Source data compiled by the Global Maritime Forum

Source: Zero-Emission Shipping Mission

Alternative fuels

- Alternative fuels include various fuels other than the conventional fuels that are currently used. - heavy fuel oil (HFO) and very low sulphur oil (VLSO)
- Alternative fuels can be further categorised into:
  - Grey fuels, which produce emissions that are not captured
  - Blue fuels, which produce carbon emissions that are captured
  - Green fuels, which do not produce any carbon emissions

Main alternative fuels

- Biofuel
- Methanol
- LNG
- Hydrogen
- Ammonia

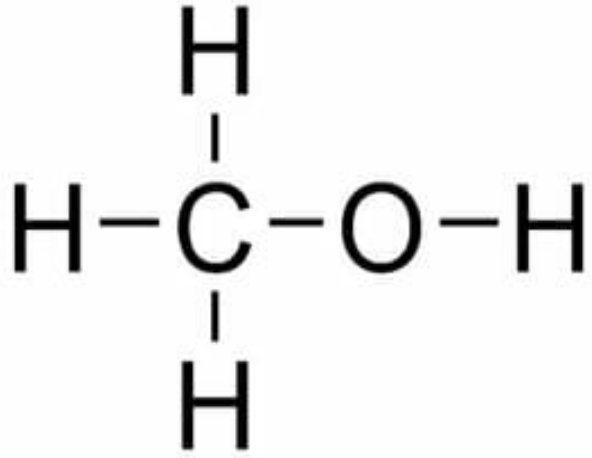
Various alternative fuels

Biofuels

- Biofuels are produced from vegetable and animal oils or their waste.
- They do not result in carbon emissions reduction during the combustion process. However, these emissions can be partially or fully offset during their production.
- They are a 'drop-in' fuel, which means that they can be directly used in place of an existing fuel with minimal alterations.
- Therefore, biofuels are an excellent alternative fuel for the short to medium term, provided that sufficient sustainable biofuels are available.

Methanol

- Currently, almost all methanol is produced using natural gas and coal. However, it can also be produced from biomass and renewable electricity.
- Methanol is becoming popular alternative fuel due to its ease of handling and lesser emissions.



Various alternative fuels

LNG

- LNG has gained considerable popularity as it is the most easily available alternative fuel because it has lower CO_2 emissions than conventional fuels.
- However, there is methane slip during its life cycle, from the process of its extraction to final combustion.
- Methane slip does not cause any CO_2 emission, but results in methane emission, which is far more harmful GHG.
- LNG can later be replaced with bio LNG and synthetic LNG, which have even lower emissions.

Hydrogen

- Hydrogen can be produced by various methods:
  - If produced from natural gas in conjunction with carbon capture, it is called blue hydrogen.
  - If produced using renewable electricity, it is called green hydrogen.
- Requires special storage tanks with temperatures of -253^{o}C to maintain hydrogen in a liquid state.
- Highly flammable and prone to leakage.
- Needs large storage space and is not expected to be directly used as fuel in cross-ocean voyages.

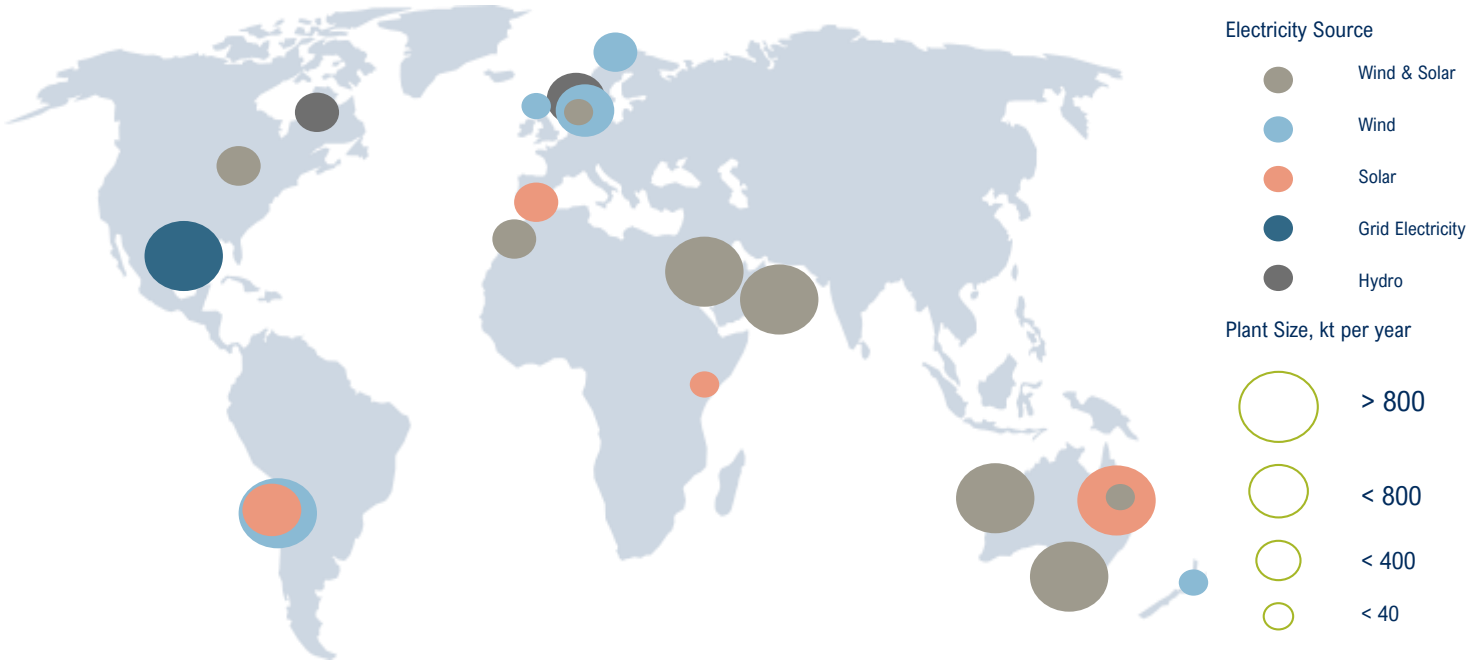
Ammonia

- Does not have carbon; therefore, it is a zero-carbon fuel.
- Needs lesser space than hydrogen and is considered one of the main fuels in the long run.
- Using Ammonia in engines produces nitrous oxide (laughing gas) which is a more potent GHG gas than CO_2.
- Ammonia engines are likely to be ready by 2024.
- Highly toxic to human and aquatic life.

STEPS TOWARD ALTERNATIVE FUEL

Investment pouring in ammonia

Ammonia is a promising alternative fuel to achieve zero-carbon target. There are more than 30 green ammonia projects globally, with a total potential capacity of over 35 mtpa.



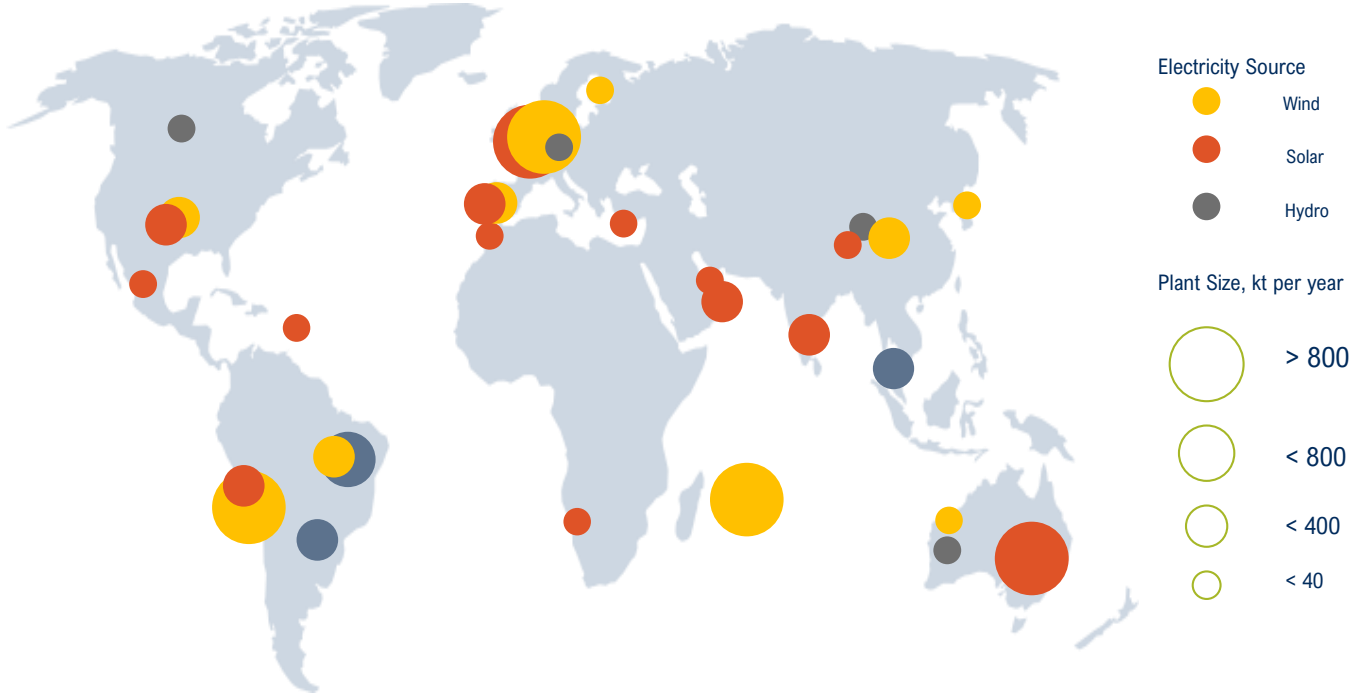
Most of the invested plants are planned to produce green ammonia which uses hydrogen produced by electrolysis with atmospheric nitrogen.

- **Key takeaways**
- The Japanese government has included ammonia as one of the important energy sources for the country and is likely to consume 3 mtpa by 2030.

- Itochu is set to begin commercial production (1 mtpa) of ammonia (with CCUS) in Canada in 2026. It will be shipped to Japan in Very Large Ammonia Carriers.
- Mitsubishi Power is developing a 40-MW class gas turbine that can directly combust 100% ammonia, expected by 2025.

Massive investment in hydrogen

Over 800 hydrogen projects globally in various stages provide an estimated overall capacity of 65 mtpa.



- Over 800 hydrogen projects globally in various stages providing an estimated overall capacity of 65 mtpa; aligned with the hydrogen demands of the Announced Pledges Scenario. These projects do not only aim to produce hydrogen as the end product, but also as intermediate and feedstock to produce other alternative fuels such as ammonia and methanol.
- A combined investment of more than USD$300 billion has been made for these projects, likely due for completion in 2030.

Key takeaways

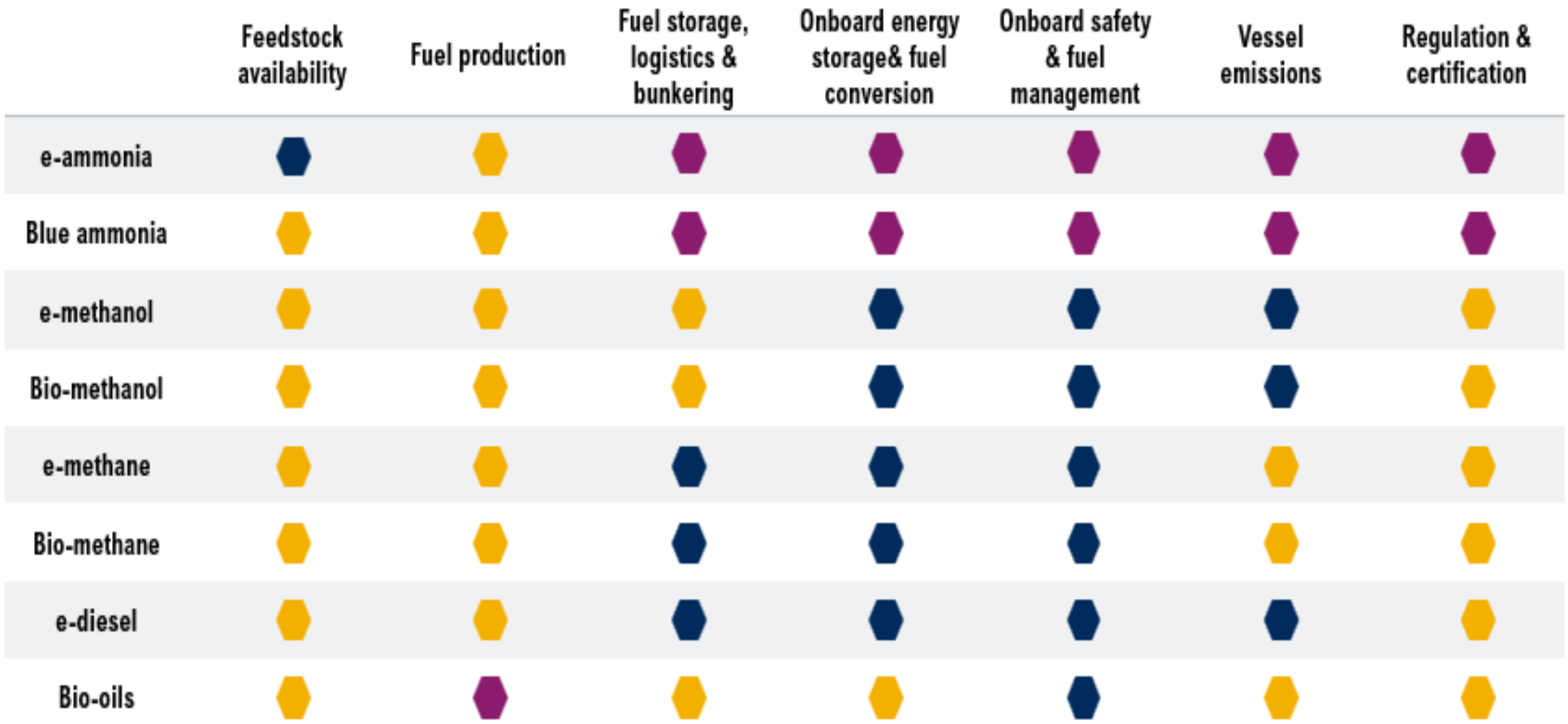
- According to Hydrogen Council, hydrogen can become a competitive low-carbon solution in more than 20 applications by 2030, including long-haul trucking, shipping and steel production
- Deepsea vessels however are not expected to be fuelled by hydrogen due to low energy density of hydrogen and space constraints on the vessel.

ALTERNATIVE FUEL – IS EVERYTHING GREEN?

Fuels available	Current status	Benefits	Restrictions
MDO/MGO/LSFO	Current standard fuel in the marine industry	Easy to adopt, fuel efficiency improving due to (i) general fleet renewal and (ii) new technologies, slow steaming can reduce carbon	High GHG, PM, Nox, low sulphur fuel more expensive
LNG	Requires LNG capable engines with different fuel handling system and increased fuel storage space required	Safe to use, proven technology, bunkering network evolving, very low Nox, Sox, PM>20% less CO_2. LNG carriers can use waste boil-off gas	Methane slips, still a fossil fuel, regional variation in bunkering availability, future LNG pricing uncertain, high CAPEX (especially retrofit), potential loss of cargo capacity
LPG	Requires LPG capable engineswith different fuel handling system	Low Nox, Sox, Lower CO_2, LPG carrier can use cargo as fuel, extensive terminal infrastructure	Limited uptake as a marine fuel to date outside of LPG carriers, still a fossil fuel, economic incentive depends on pricing.
Methanol	primarily produced from natural gas, although increased development of 'green' methanol. Can be used in dual-fuel oil/methanol engines	Fuel handling and risk management simpler than LNG, zero CO_2 emission for 'green' methanol reduced Nox, Sox, existing terminal infrastructure	Retrofit can be complex, low energy density, likely to be costly in the short term, toxic and flammable, global production limited
Biofuels	While many engines are compatible, some ships require modification to fuel system and engine	Some types of biofuels already widely available at competitive prices and can use existing waste products. Requires limited changes to engines and fuel handling	Typically no CO_2 reduction from vessel itself, emission vary according to supply chain, sustainability issue (e.g. land use for palm oil production)
Hydrogen	Development focused on zero-emission fuel cells, can also be used in specialist combustion engines	Potentially, both clean and abundant, attracting significant investment in technology, fuel cells more efficient than combustion engines	Fuel production is still energy intensive, large scale production expensive, undeveloped bunkering infrastructure, expensive to store at -253 degree Celcius
Ammonia	Can be produced from catalytic reaction of nitrogen from air and hydrogen from water and used in combustion engines or fuel cells	Already produced and traded at scale, zero emission from vessel itself, 'green' ammonia could be fully GHG emission free.	Current production process (Haber Bosch) is highly energy intensive, much less energy dense than oil-based fuels, toxic and corrosive, significant Nox emissions.
Batteries	Batteries can store electrical energy for propulsion by charging ships using High Voltage Share Connection	Ship itself does not generate emission, could be carbon free, if onland power source is green too, already in use for small ferries, expanding network of HVSC facilities at ports.	Impractical for larger vessels or those on long voyages, due to size of batteries needed, upstream emission still possible, potential loss of cargo space, unsuitable for many locations
Synthetic Methane	Fuel produced by combining Hydrogen produced using excess energy from renewables and waste CO_2	Fuel could be used in LNG capable engines, potential for extend LNG beyond 'bridging fuel, good method of Carbon capture and reuse.	Production process is still very energy inefficient and costly
Nuclear	Powered by small nuclear power plants	Extremely high power, mature technology, minimal emission from ships.	Emission still produced by fuel production, creation of nuclear waste, significant risks, adoption faces political and regulatory issues.

Alternative Fuel Pathway Maturity Map

There are major challenges in making ammonia a viable alternative fuel. The challenges pertaining to various aspects such as fuel storage, logistics and bunkering, onboard energy storage & fuel conversion, fuel management, regulation and certification etc. Hydrogen has not been included here as it will likely be used only for short-sea shipping.

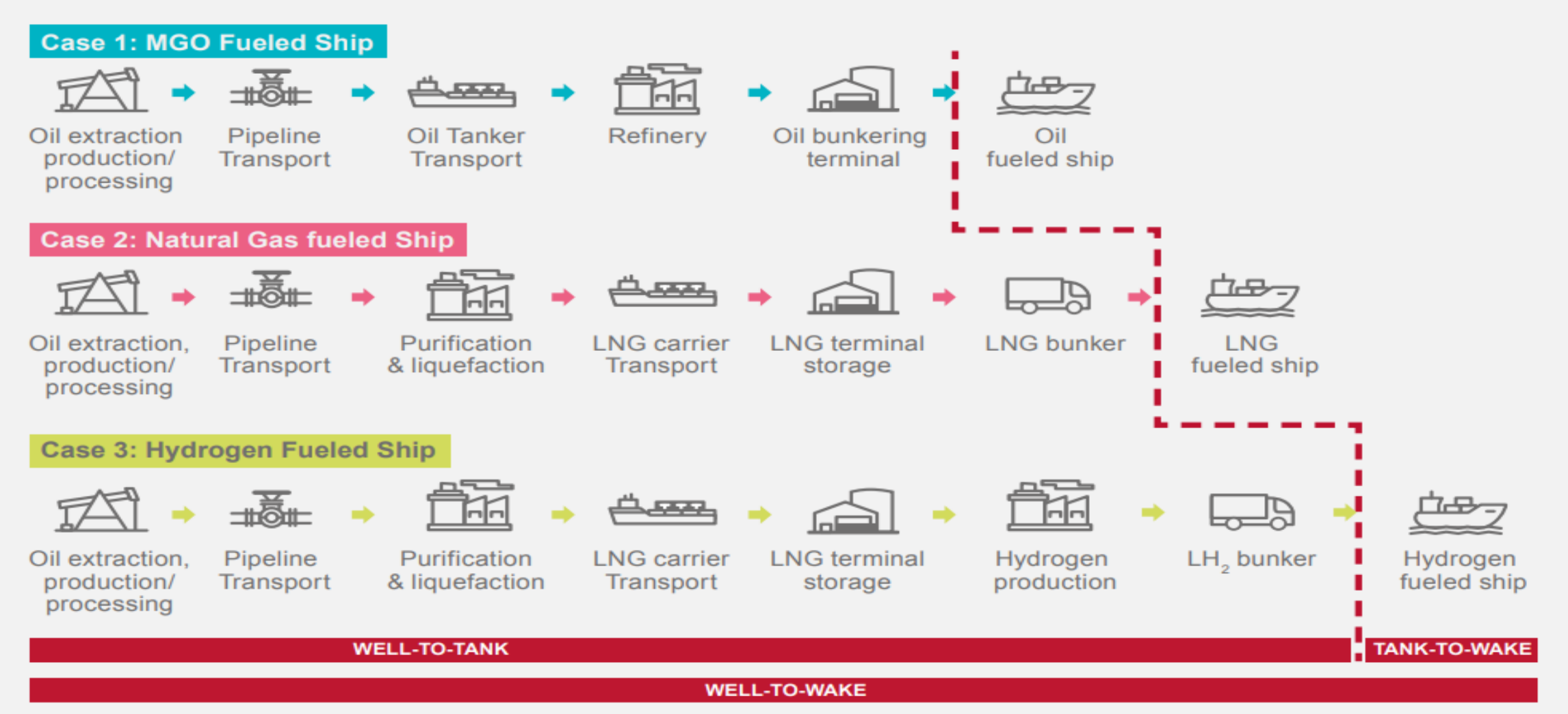


Mature
Solutions are available, and none or marginal barriers identified.

Solutions identified
Solutions are available, and none or marginal barriers identified.

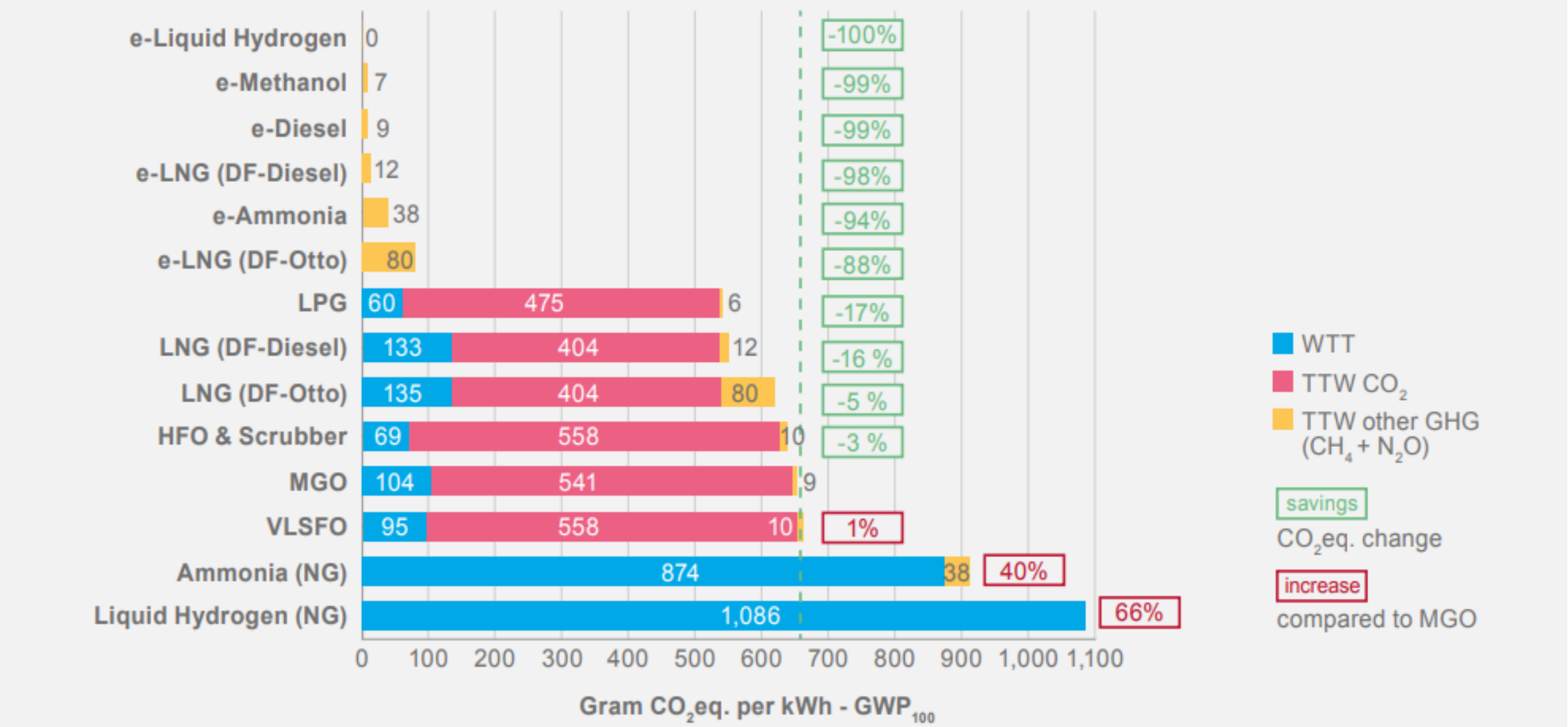
Major challenges
Solutions are available, and none or marginal barriers identified.

Understanding emissions



Source: Pusan University

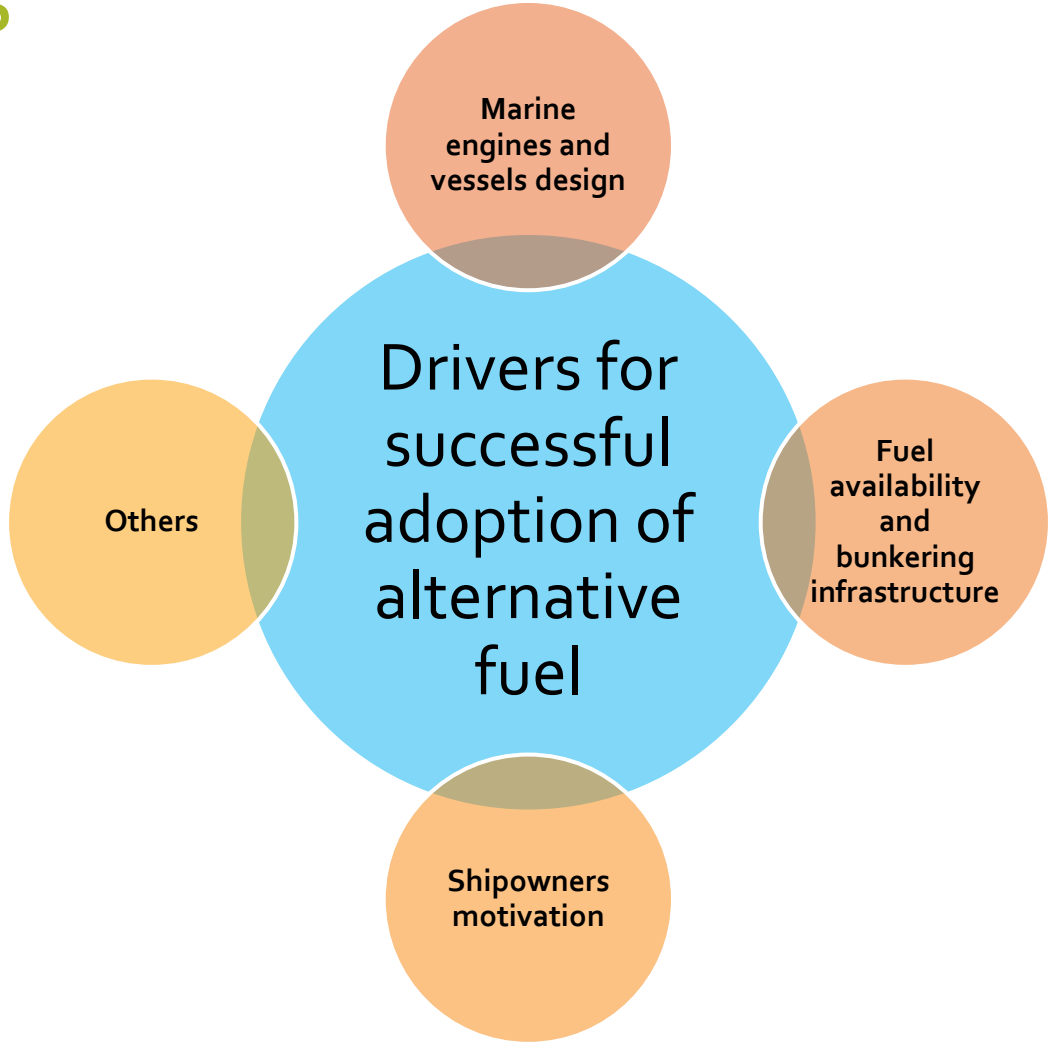
Well-to-wake emissions for different fuels



Source: NTNU

ALTERNATIVE FUEL – DRIVERS

Drivers and key issues for successful adoption of alternative fuels



Drivers and enablers

The first movers to take action are split into the transition drivers and market enablers. Everyone from alternative fuel producers, ports & terminals, vessel owners & operators to regulations & policies making, financing and cargo & customers would have to work hand in hand and step up in order for change to take place.

Transition drivers

Alternative fuel producers	Ports & terminals	Vessel owners & operators
Unlock barriers to enable all alternative fuel pathways	Re-purpose existing infrastructure to support uptake of alternative fuels	Order dual-fuel ships
Promote and scale commercially available alternative fuels	Share learnings and develop blue-prints on safe handling of all alternative fuels	Maximize energy efficiency
		Send demand signals to fuel producers
		Deepen dialogue and green service offering with customers

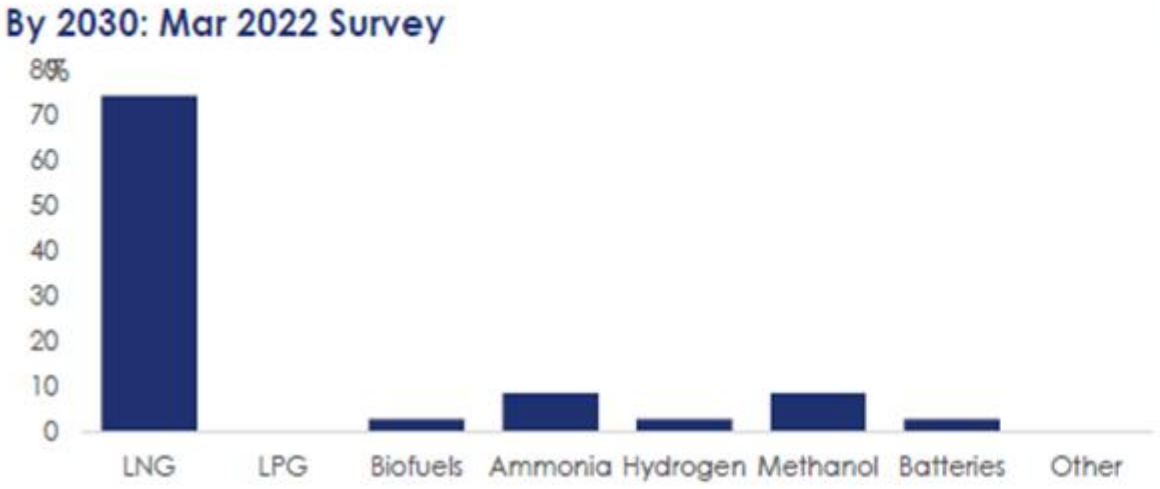
Market enablers

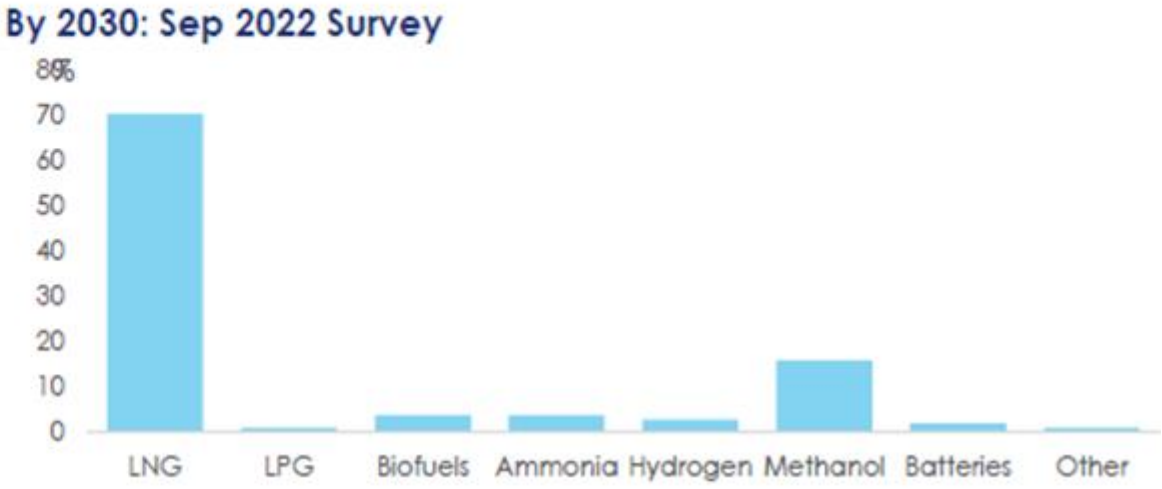
Regulation and policy making	Financing	Cargo owners & customers
Focus on removing barriers and closing cost-gaps	Mobilise capital to decarbonisation technologies	Be transparent about green shipping demand
Present long-term regulatory roadmaps and experiment with regulatory sandboxes to find solutions fast	Engage in private-public partnerships	Be willing to share some of the costs of alternative fuels
Introduce carbon pricing	De-risk investments by providing e.g. cheaper capital, governmental guarantees, subsidies	Work to find solutions to aggregate fragmented supply and demand

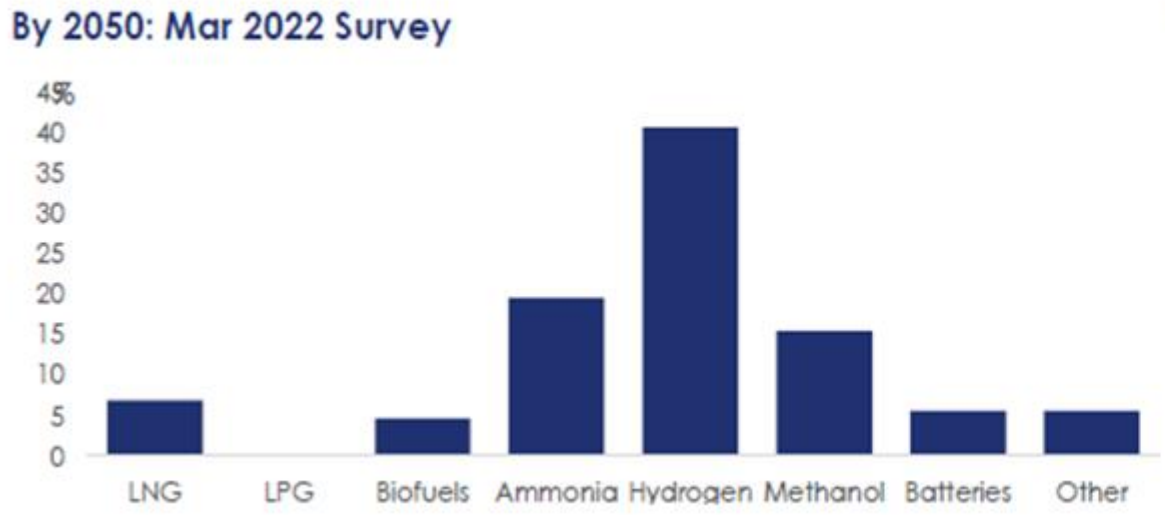
ALTERNATIVE FUEL – WHAT DO PEOPLE THINK?

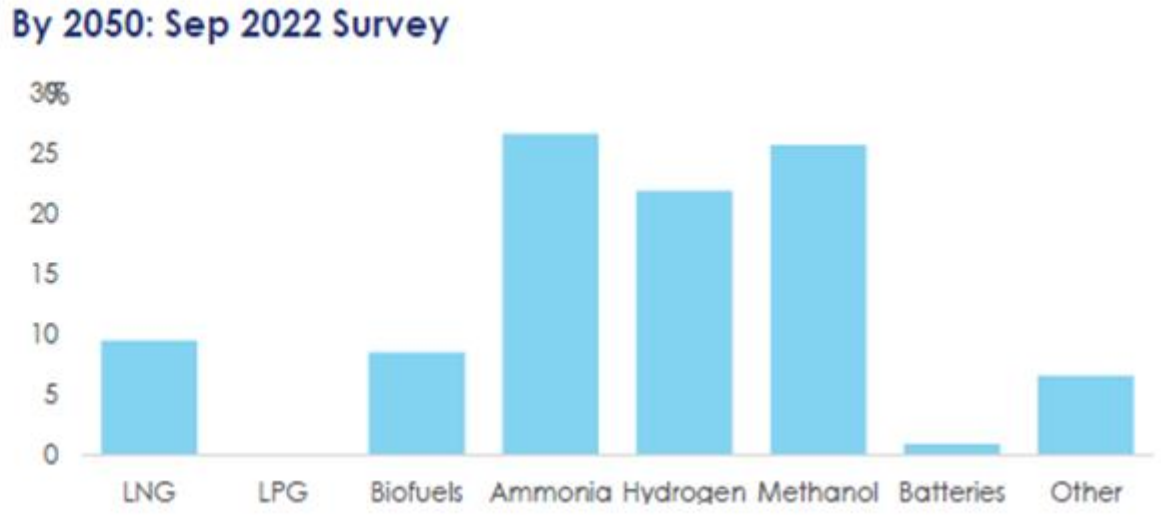
Which alternative fuel will have the highest uptake by 2030/2050?

Shipping & Shipbuilding Forecast Forum: 2022 Surveys



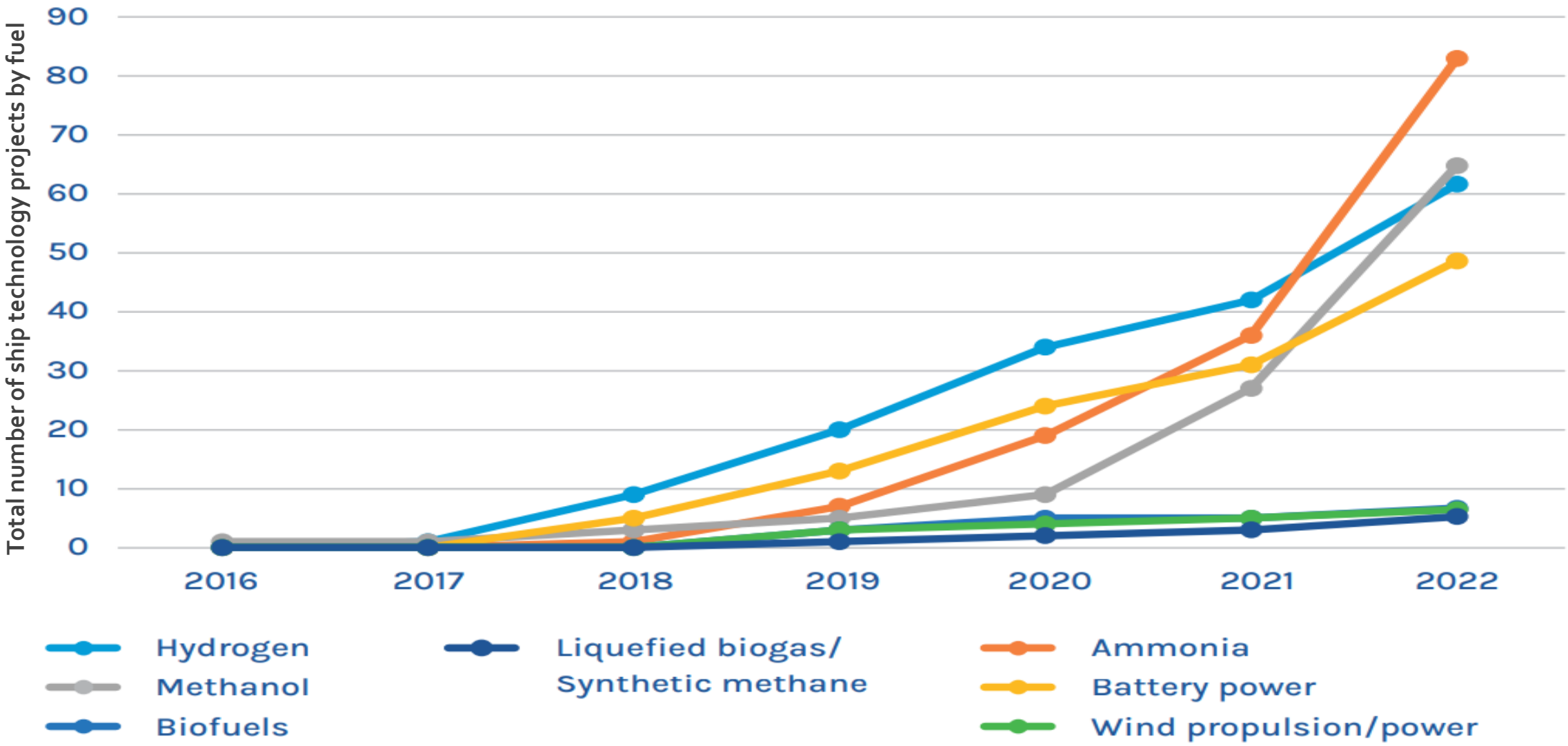






ALTERNATIVE FUEL – DEVELOPMENT

Developments in ship technologies

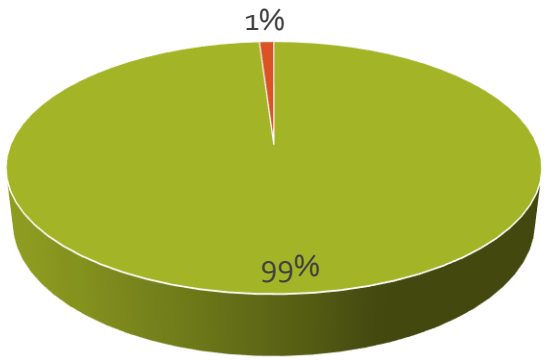


ALTERNATIVE FUEL – EXISTING FLEET

Alternative fuel uptake: Existing fleet

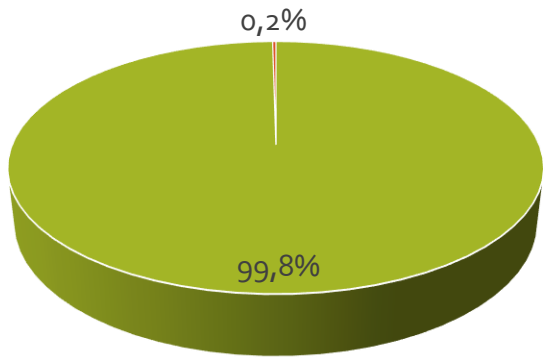
Currently, a meagre 1% of the global fleet has alternative fuel propulsion systems.

All ships



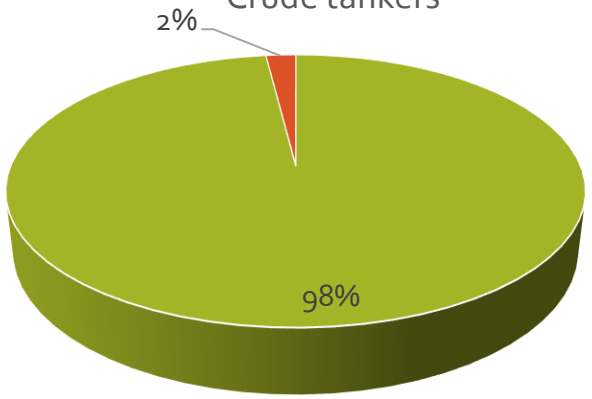
Conventional fuel Alternative fuels (including LNG)

Dry bulk



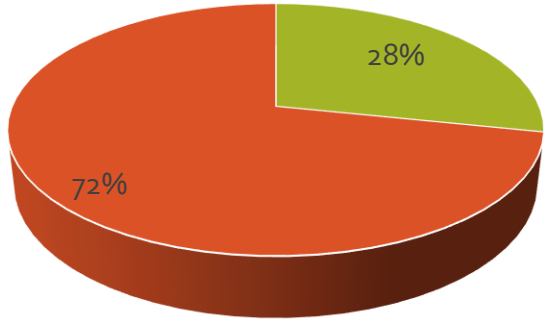
Conventional fuel Alternative fuels (including LNG)

Crude tankers



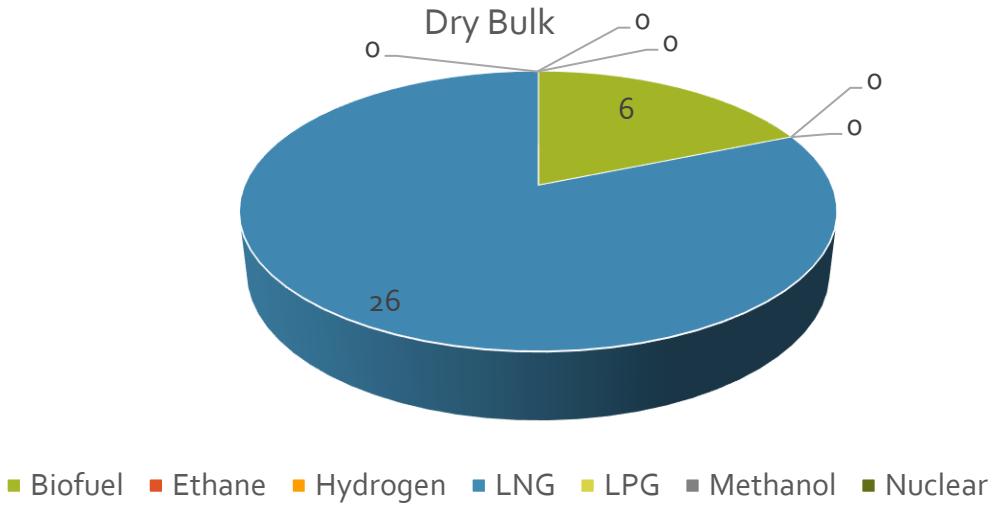
Conventional fuel Alternative fuels (including LNG)

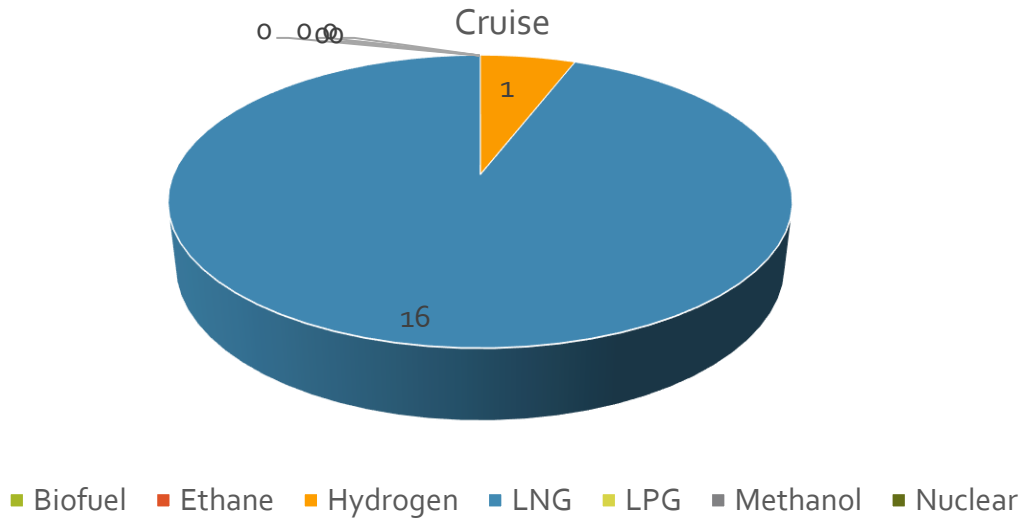
LNG

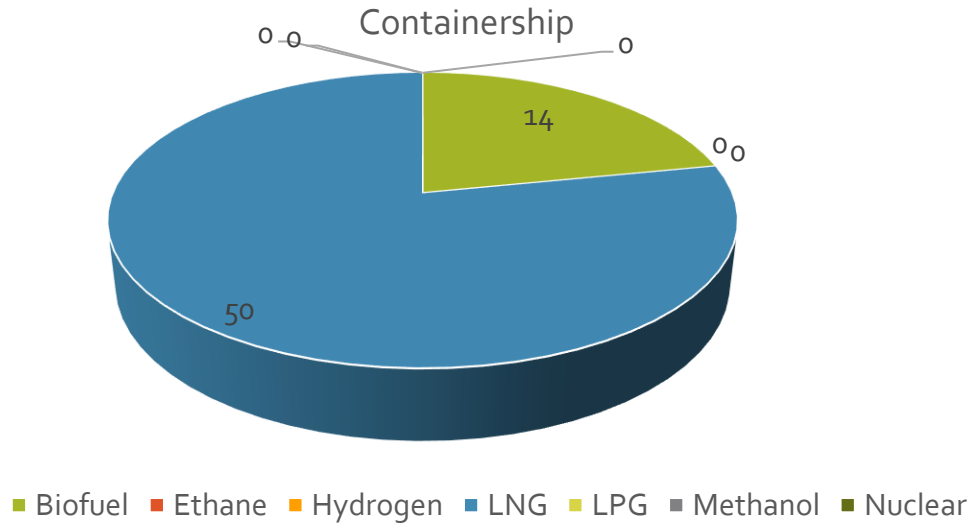


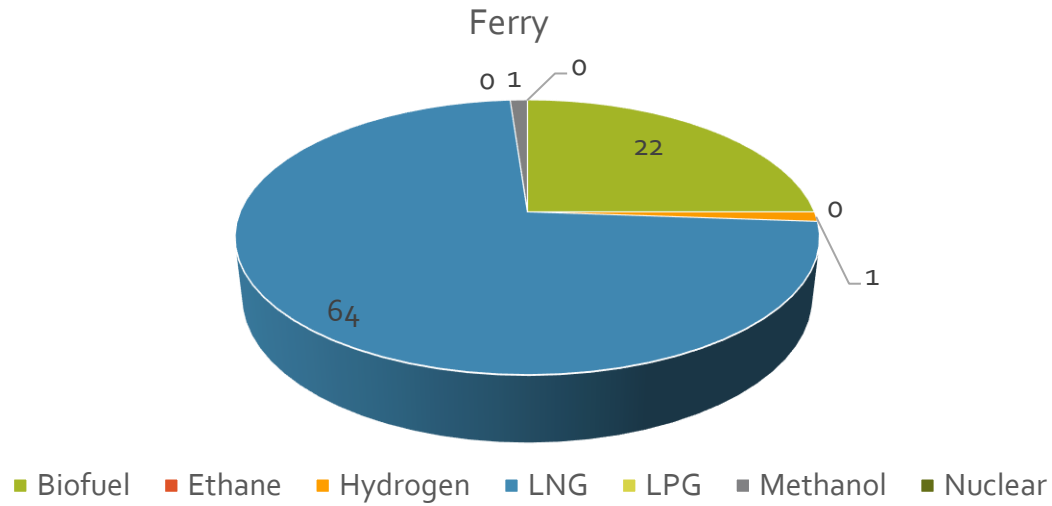
Conventional fuel Alternative fuels (including LNG)

Alternative fuel uptake: Existing fleet

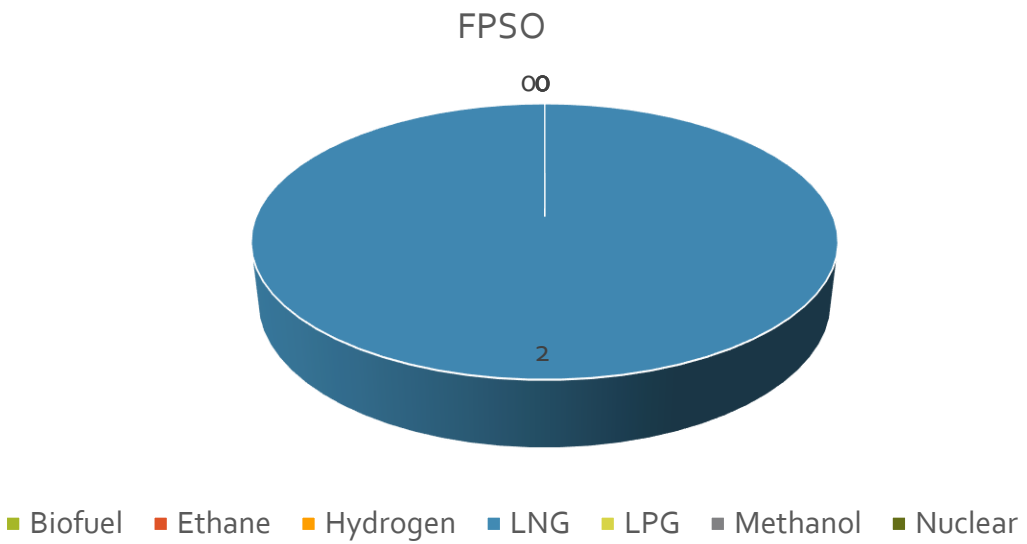


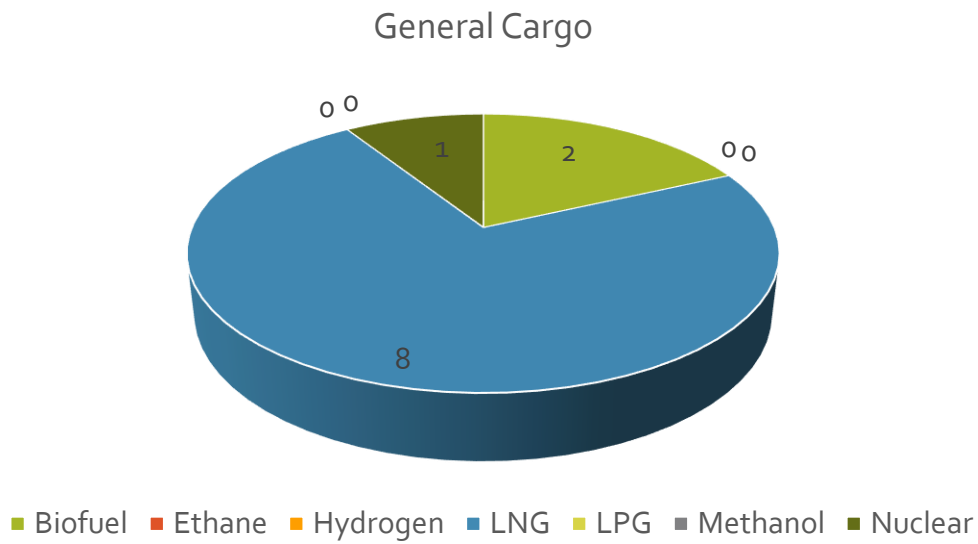


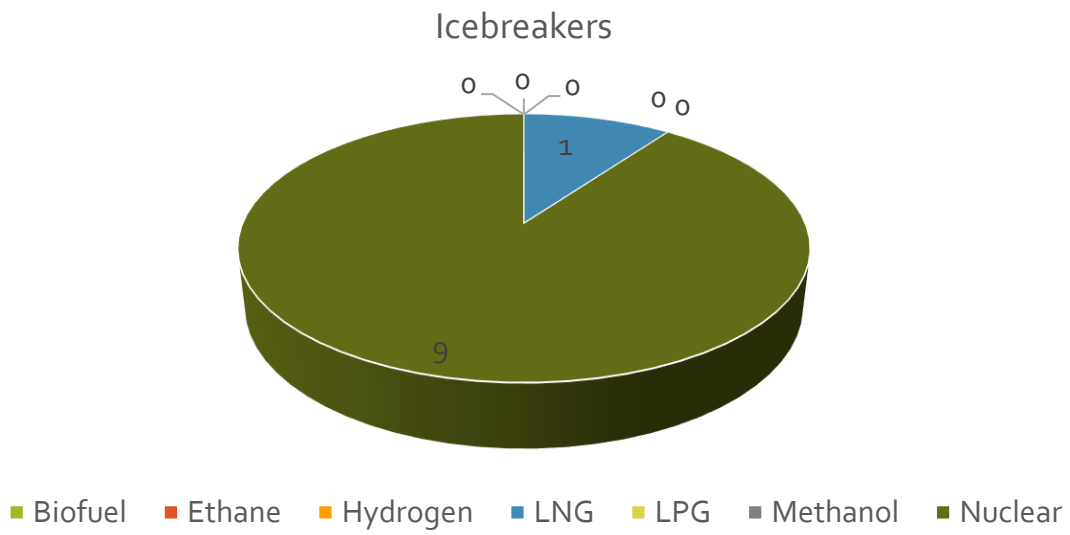


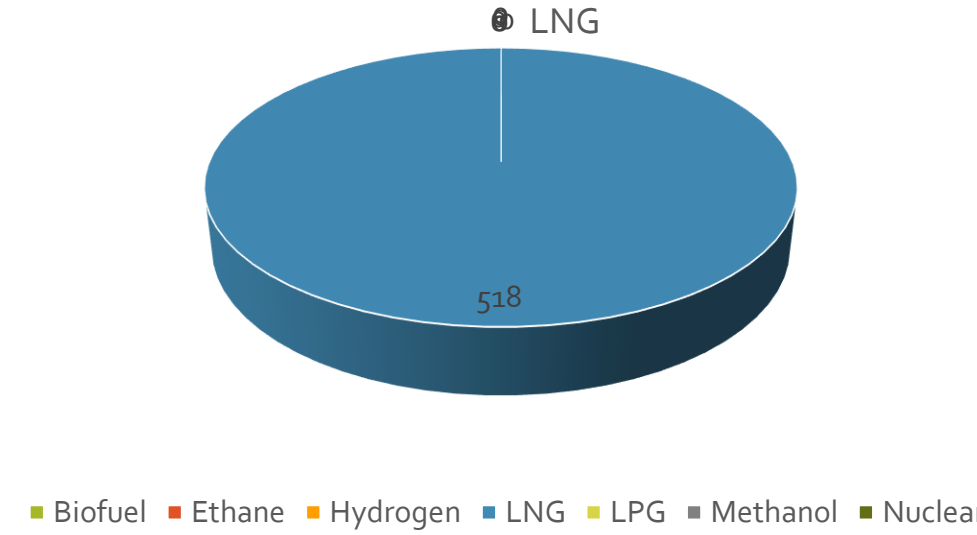


Alternative fuel uptake: Existing fleet

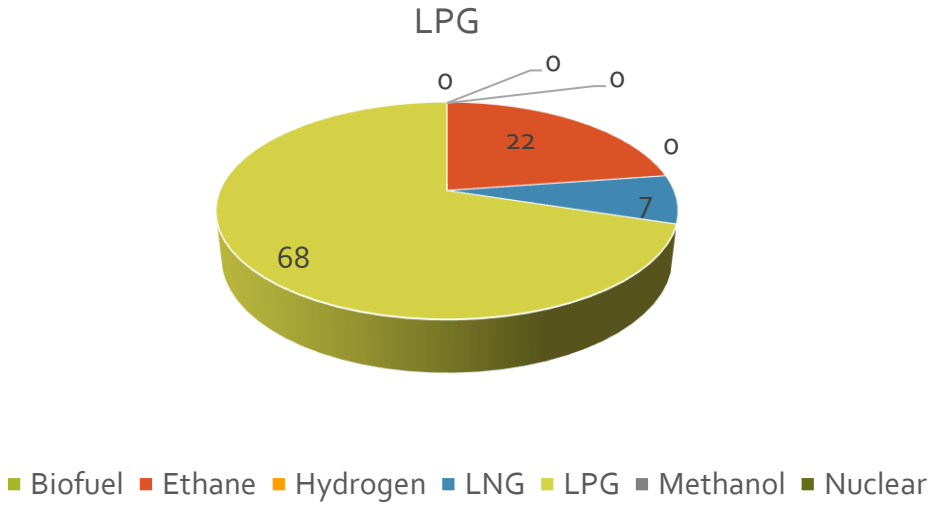


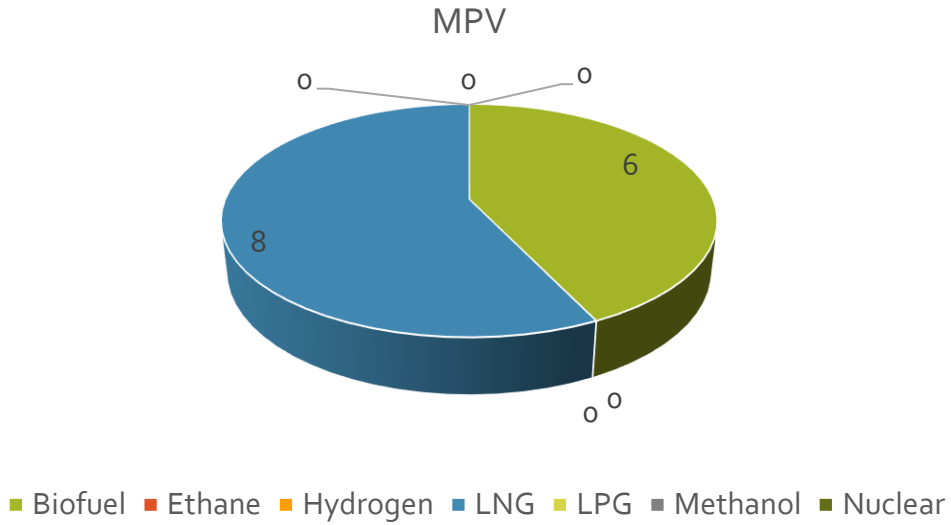


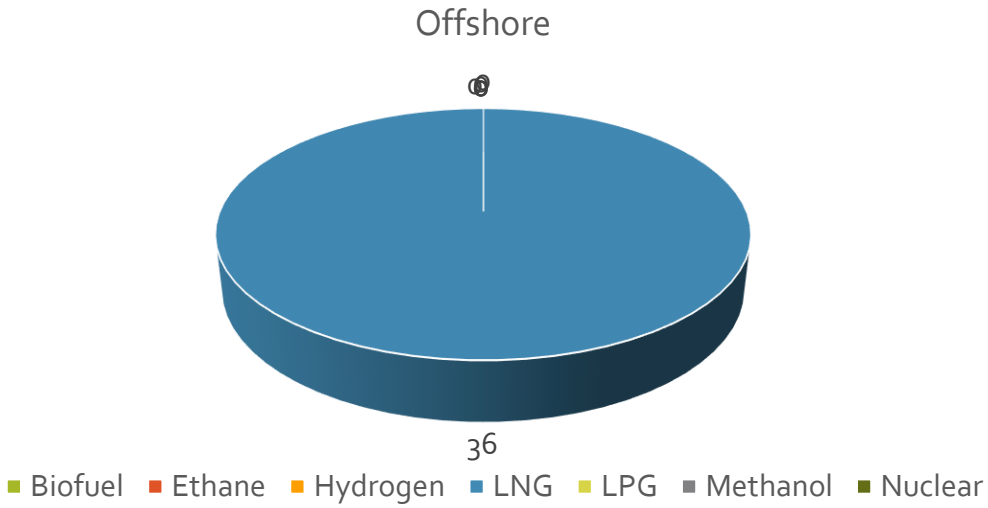


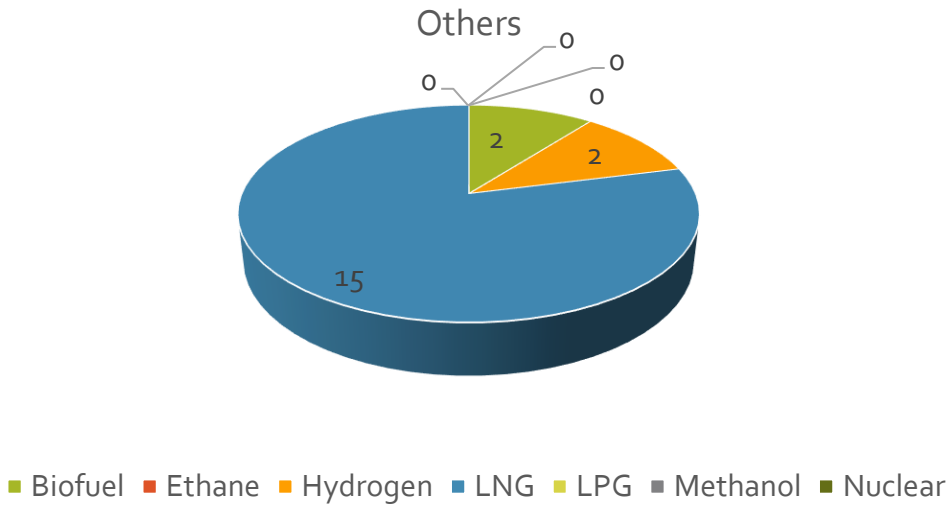


Alternative fuel uptake: Existing fleet

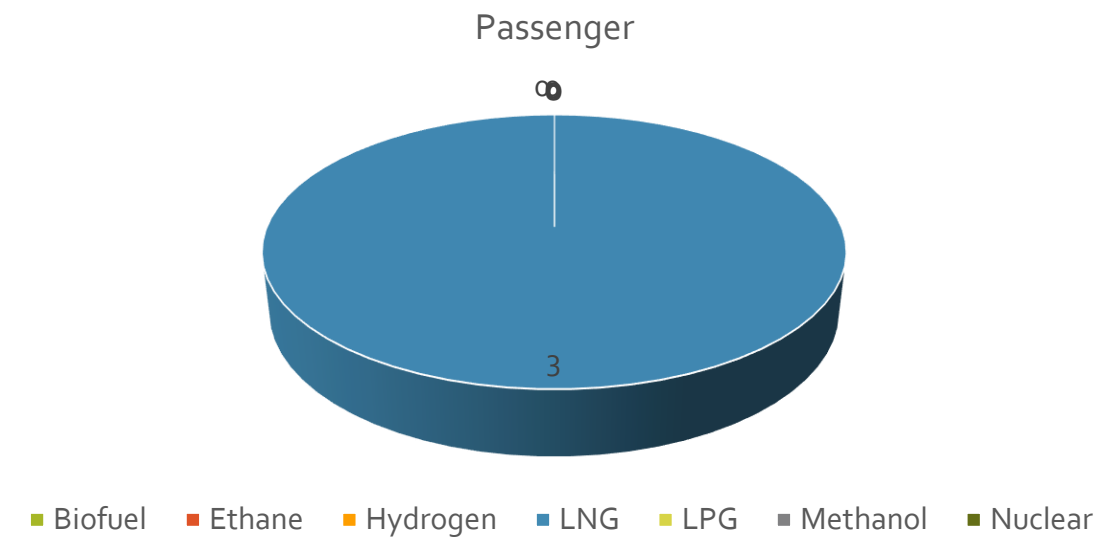


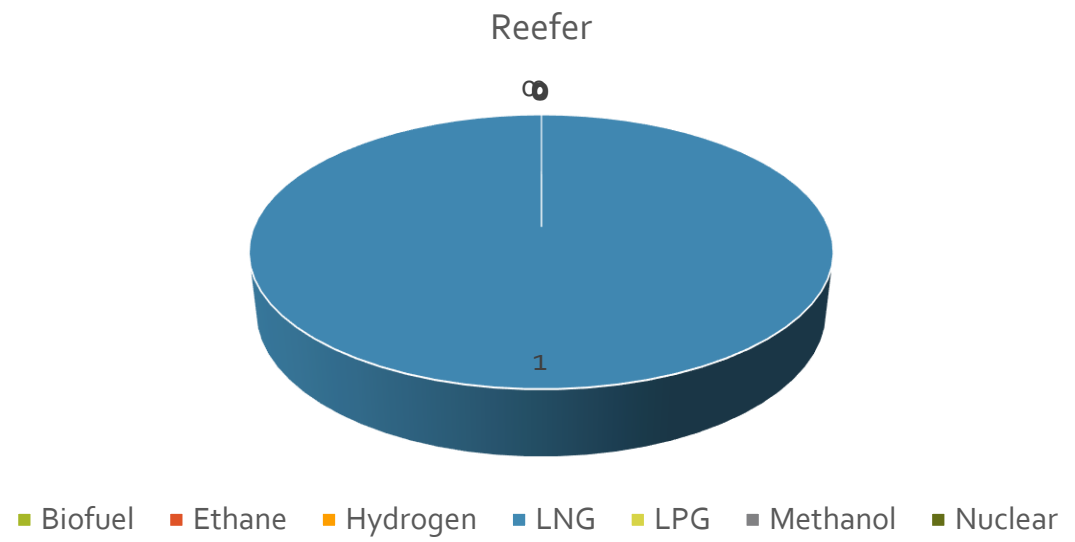


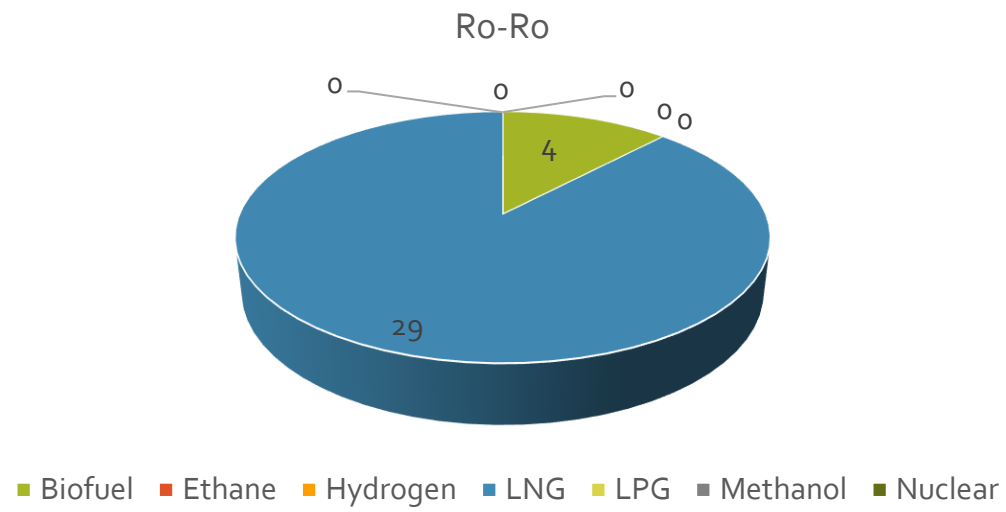


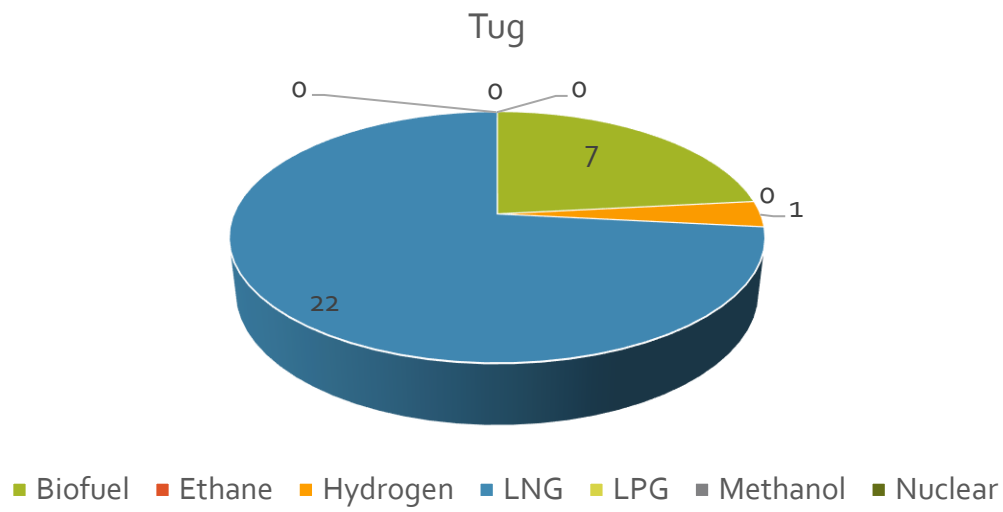


Alternative fuel uptake: Existing fleet

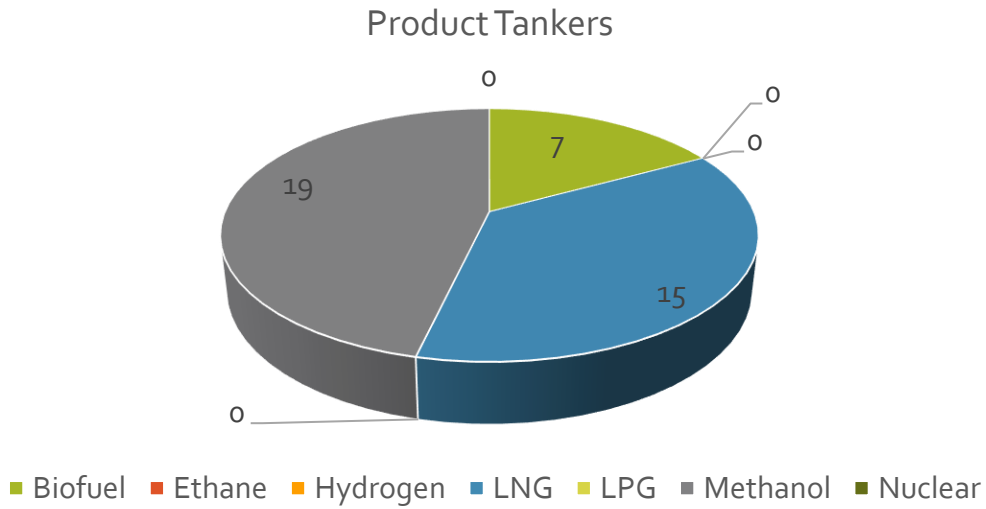


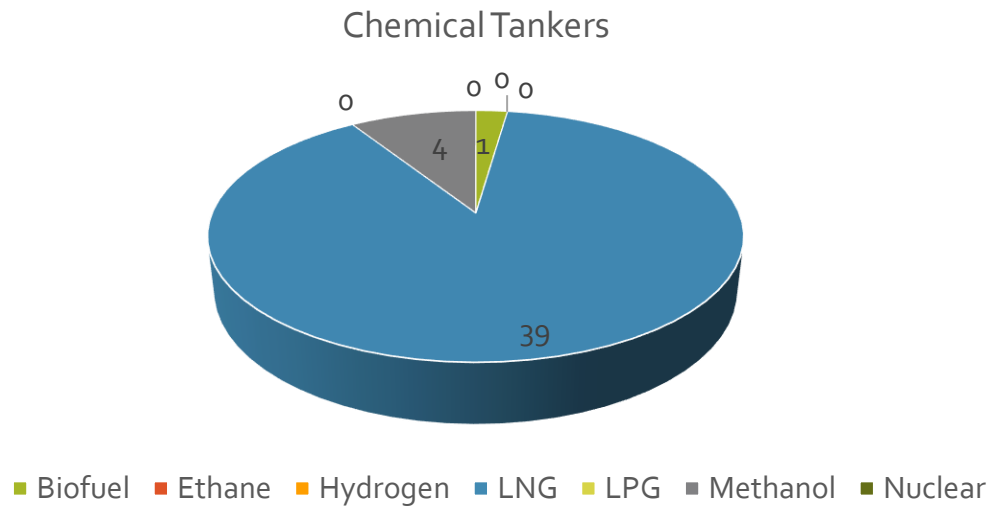


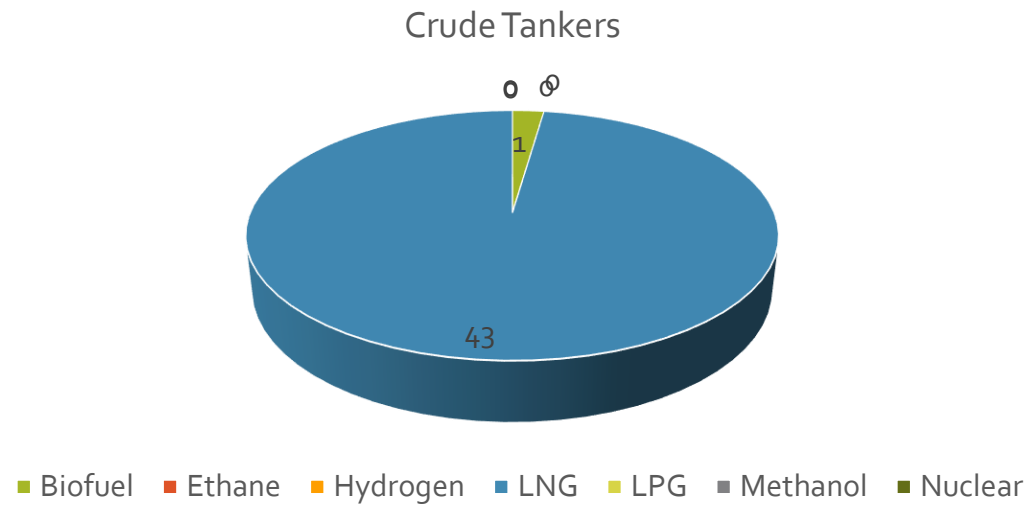


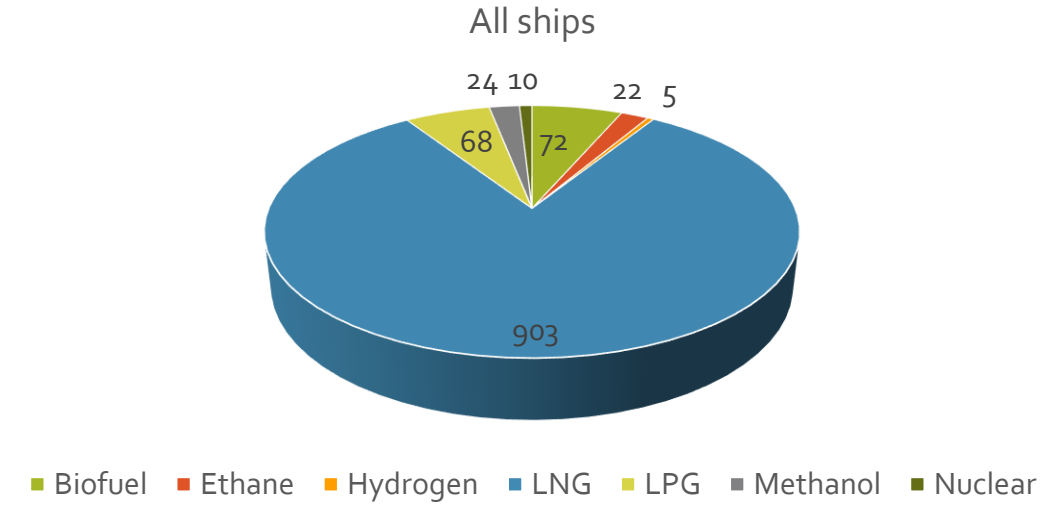


Alternative fuel uptake: Existing fleet







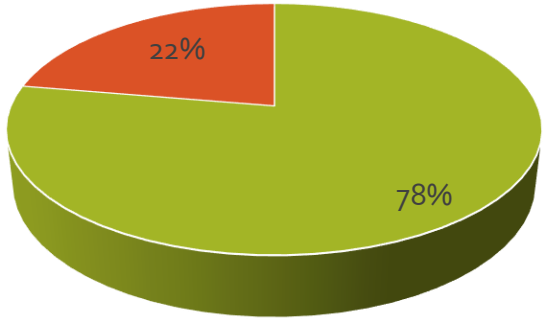


ALTERNATIVE FUEL – ORDERBOOK

Alternative fuel uptake: Orderbook

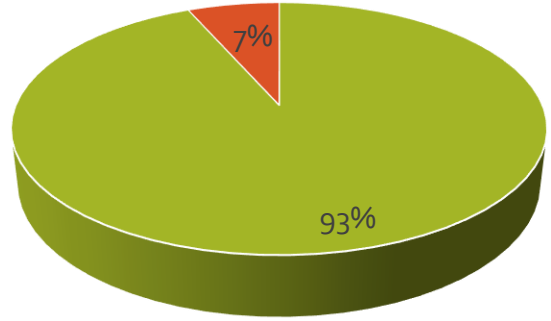
Orderbook is fast catching up with 22% of new orders having low or zero carbon propulsion system.

All ships



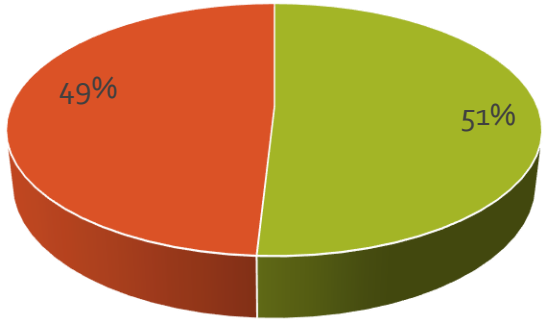
Conventional fuel Alternative fuels (including LNG)

Dry bulk



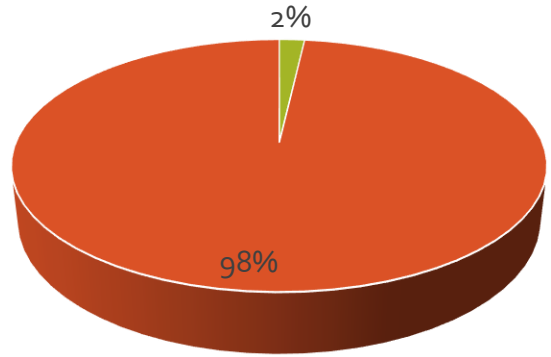
Conventional fuel Alternative fuels (including LNG)

Crude tankers



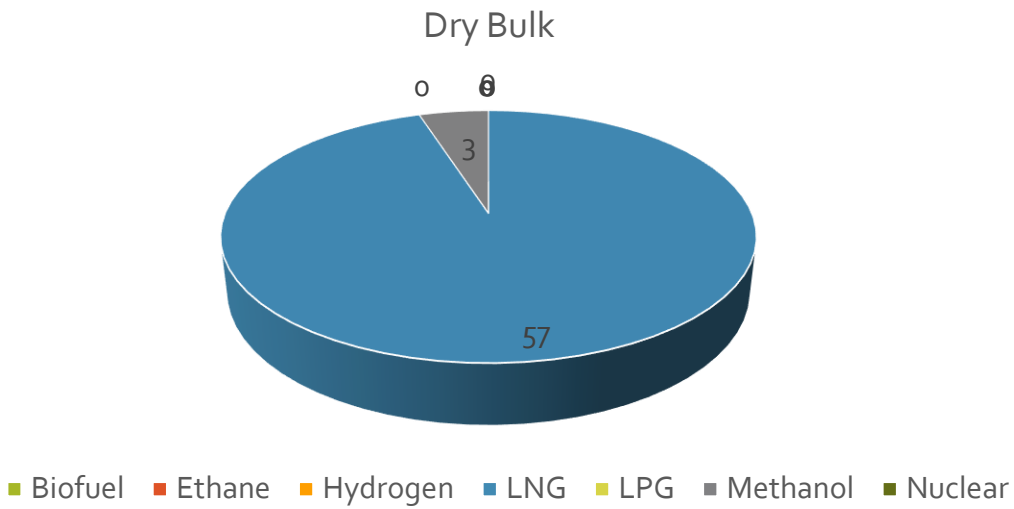
Conventional fuel Alternative fuels (including LNG)

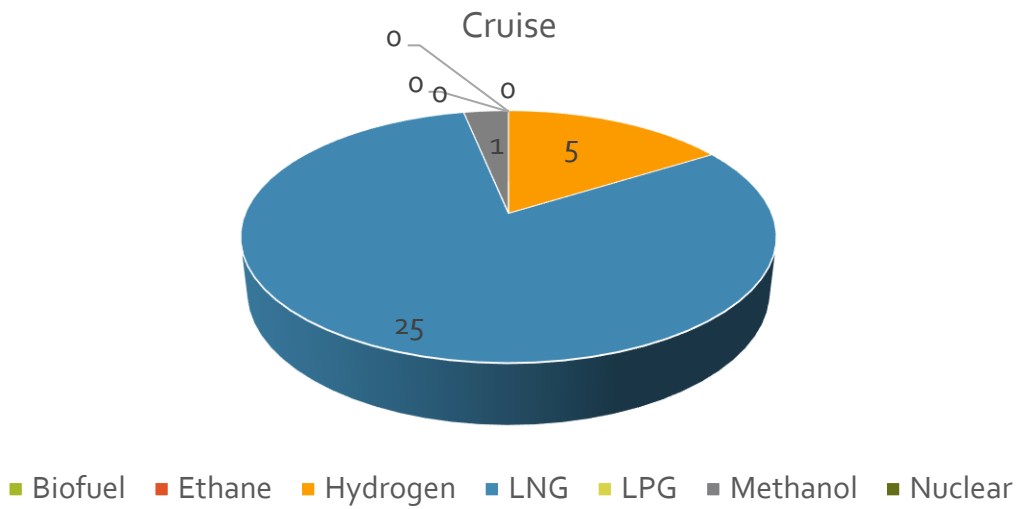
LNG

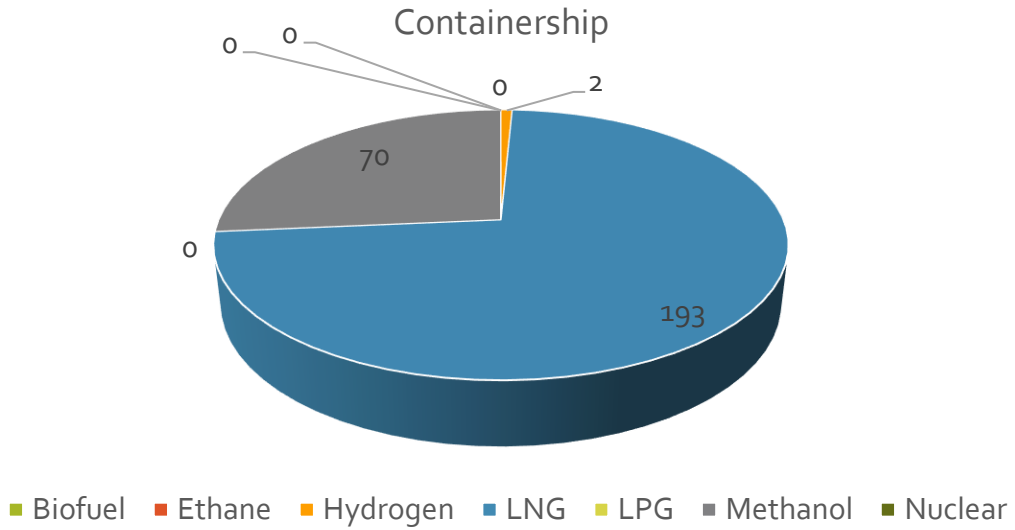


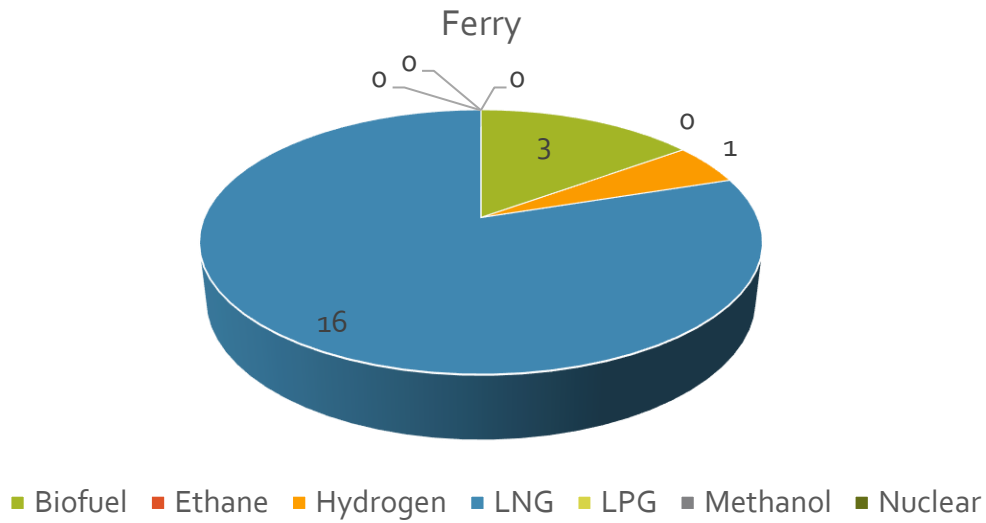
Conventional fuel Alternative fuels (including LNG)

Alternative fuel uptake: Orderbook

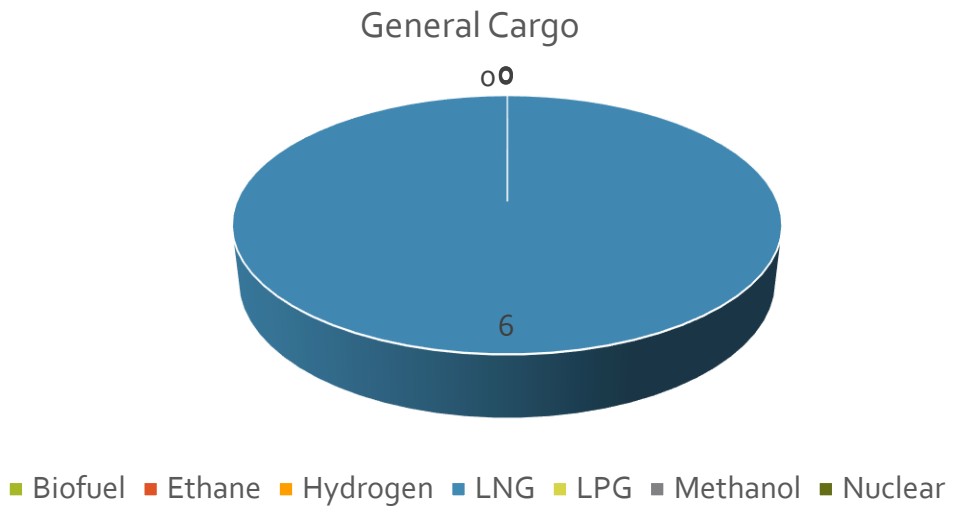


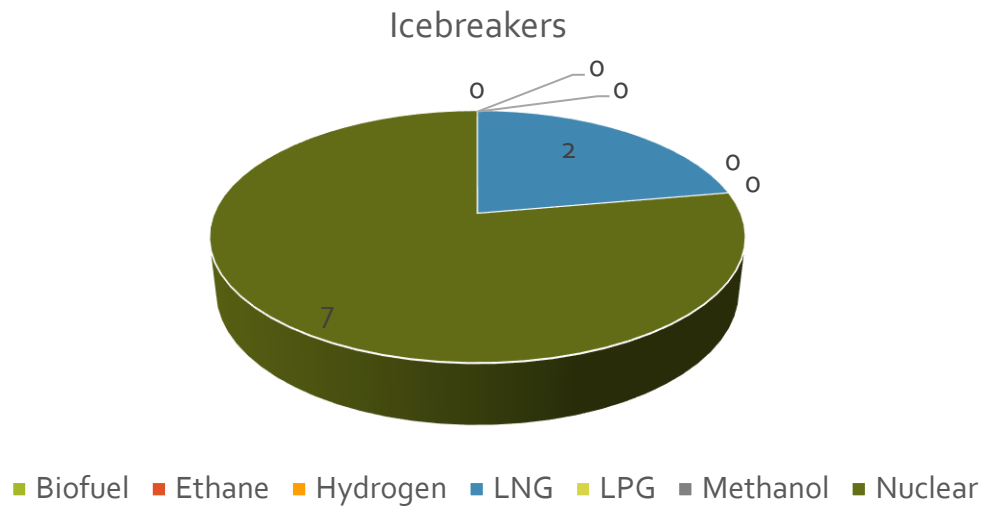


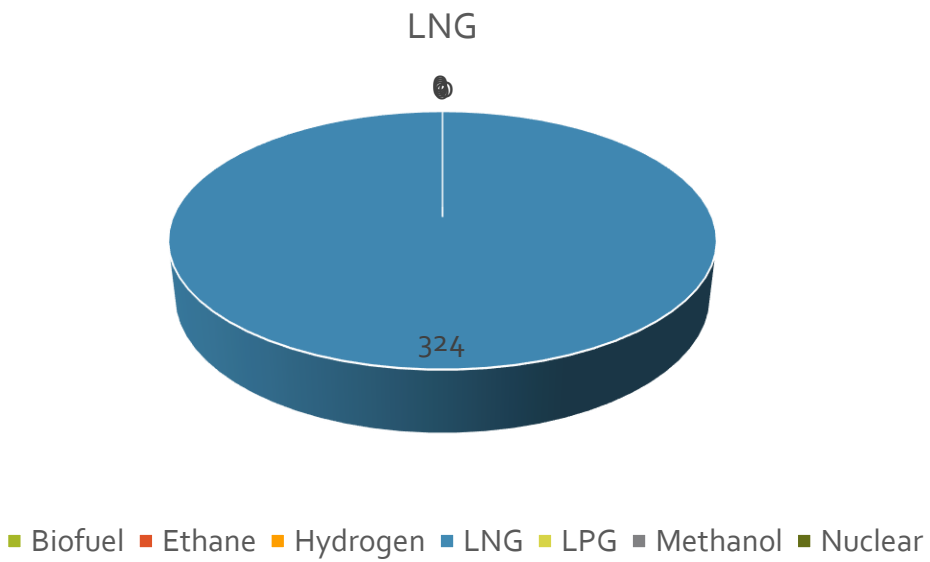


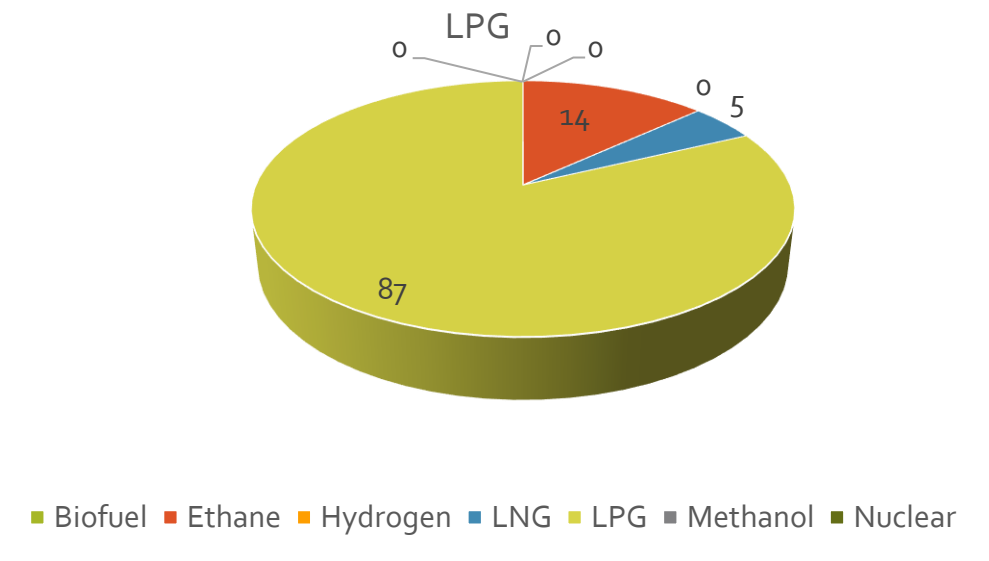


Alternative fuel uptake: Orderbook

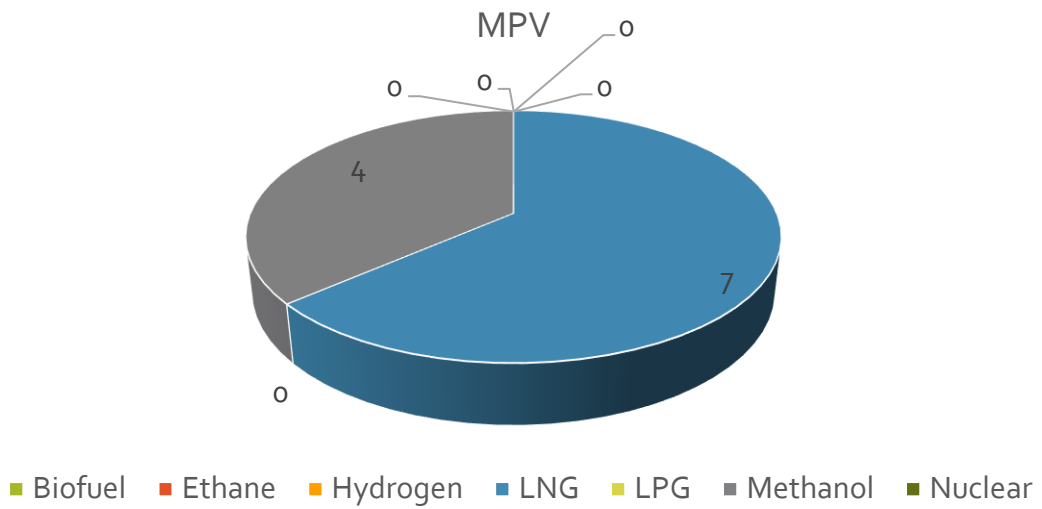


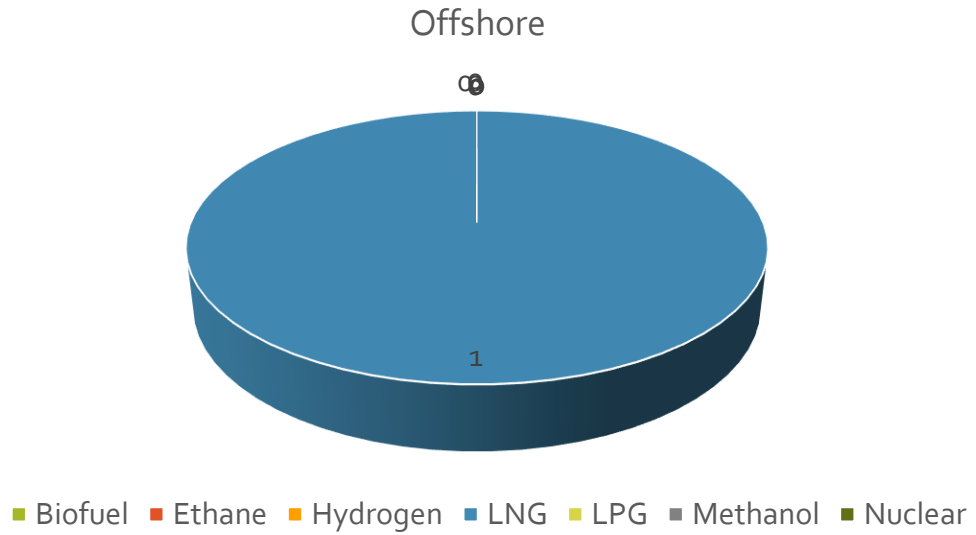


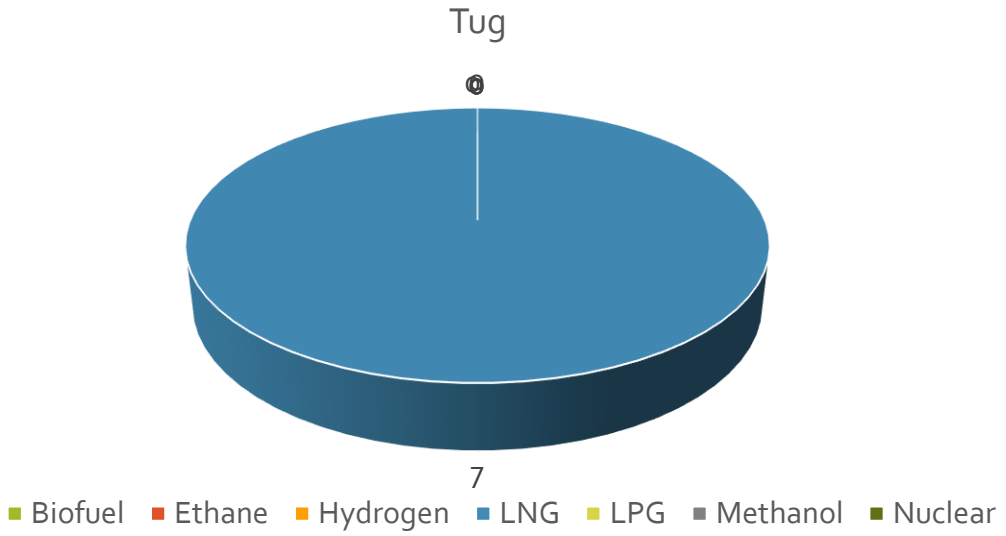


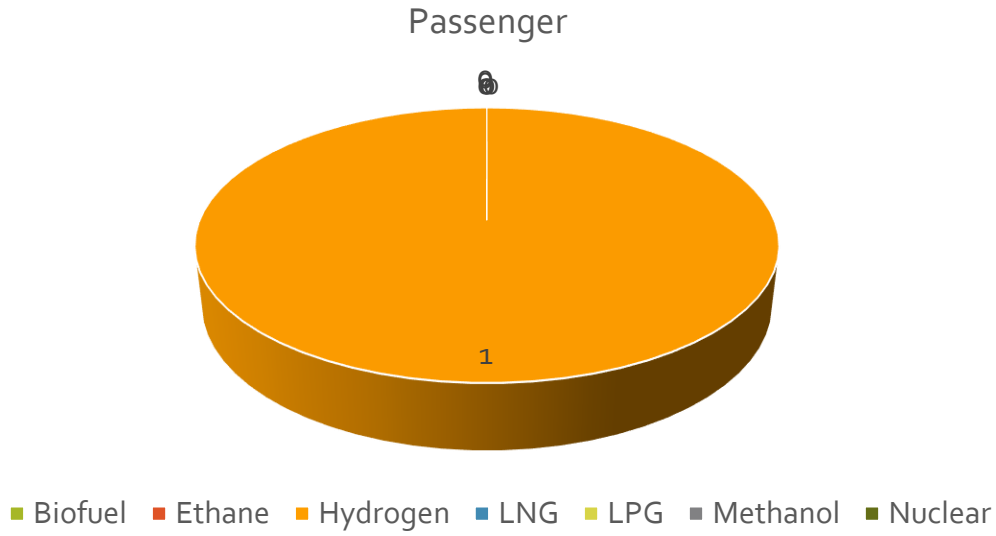


Alternative fuel uptake: Orderbook

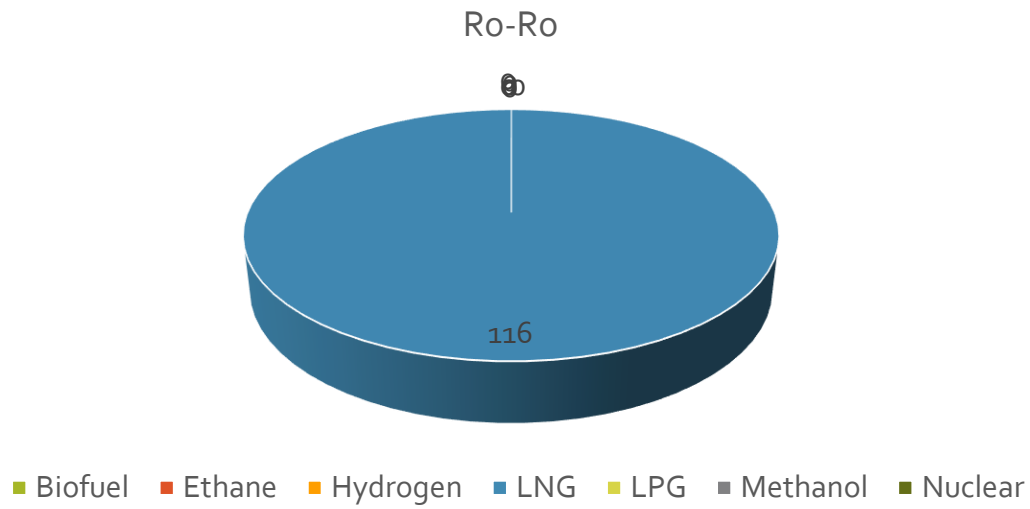


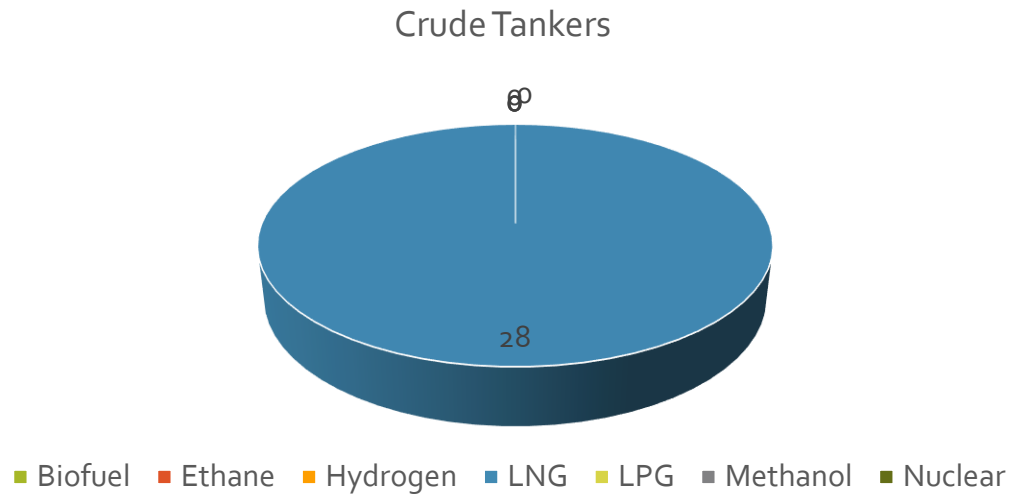


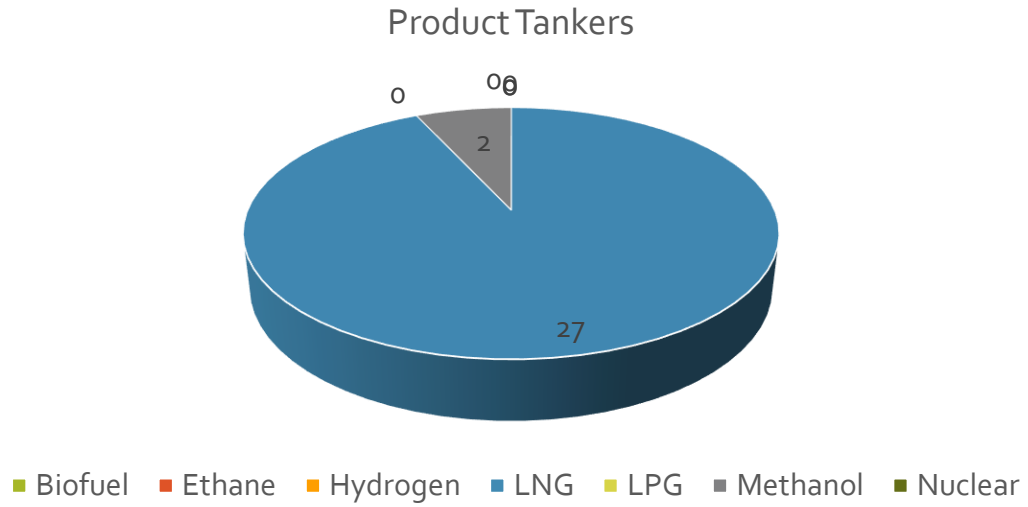


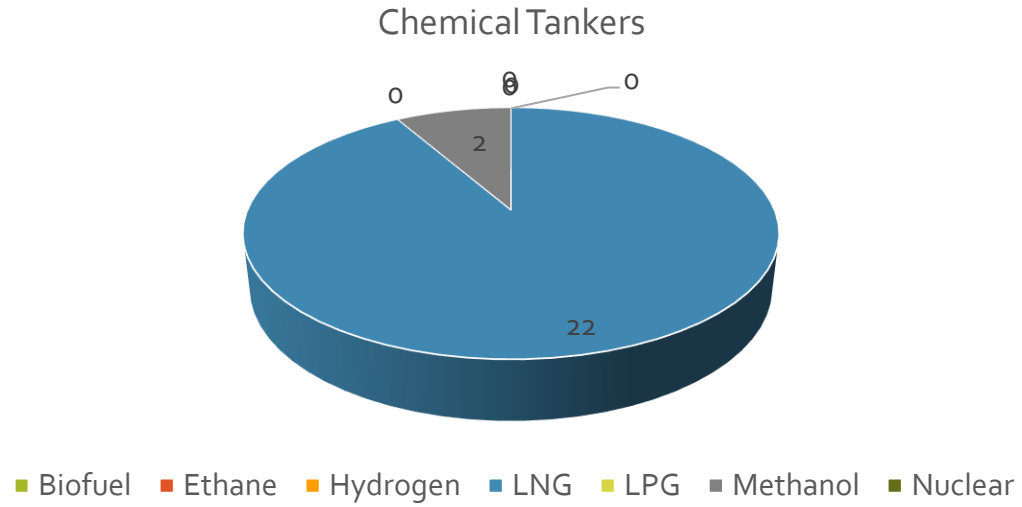


Alternative fuel uptake: Orderbook

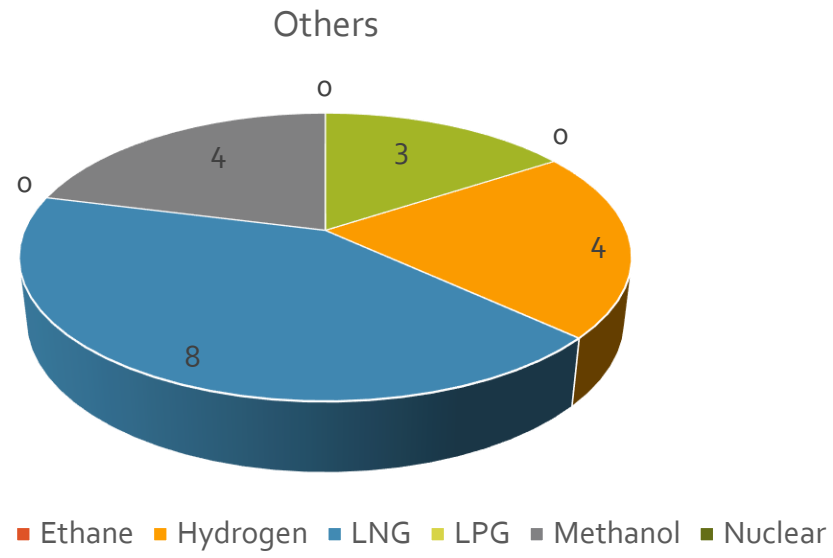


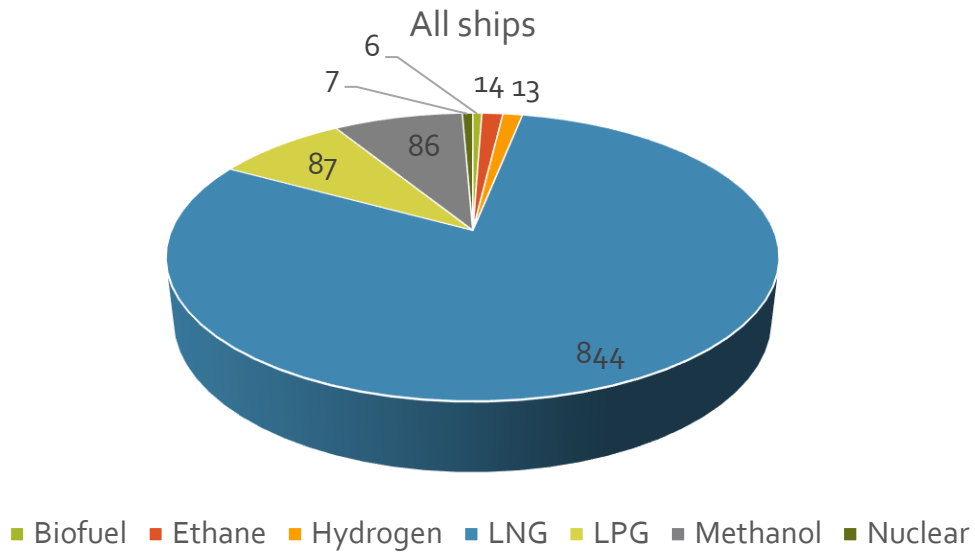






Alternative fuel uptake: Orderbook

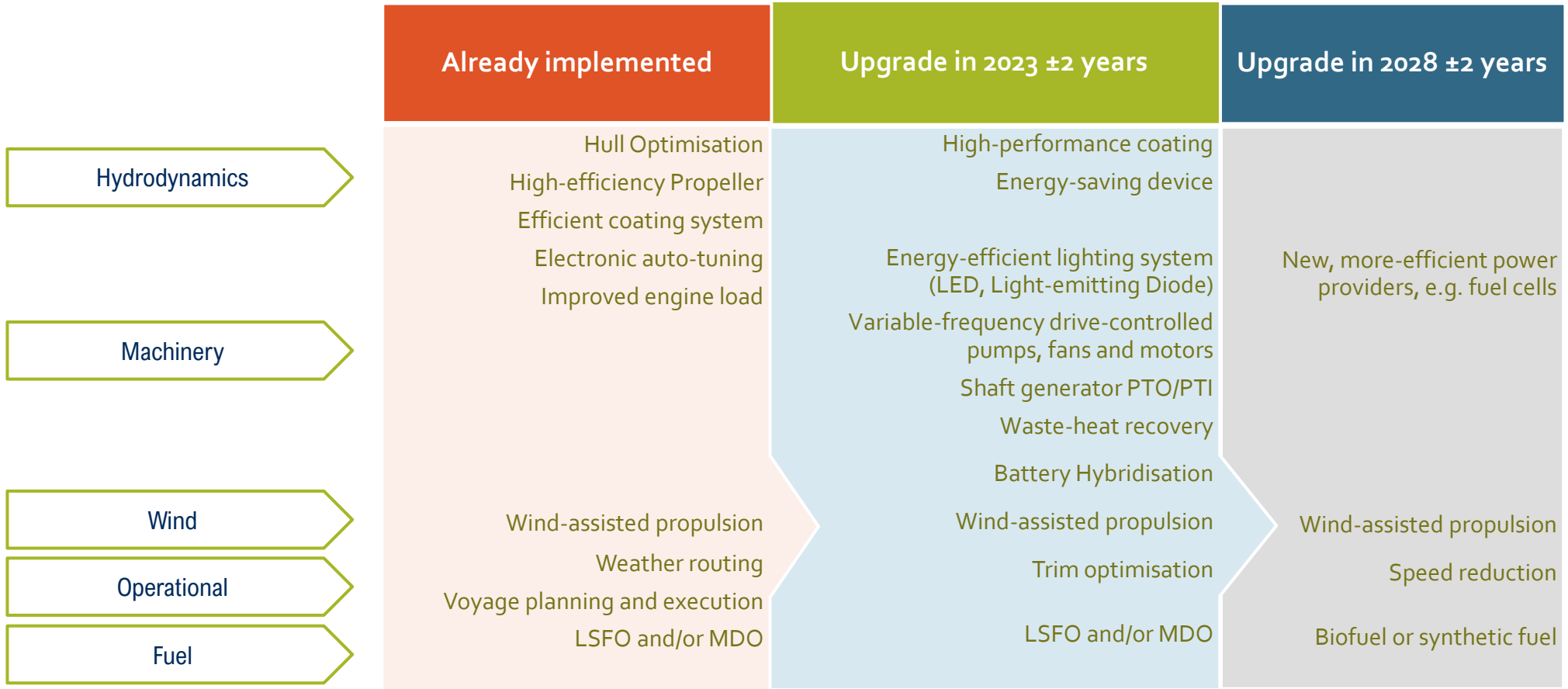




ALTERNATIVE FUEL – THE WAY AHEAD

Expected path to decarbonisation

Decarbonisation measures and upgrades are necessary for the short run. Some require investments, and some are operational in nature. Most of these require small investments, which can be financed from the equity of the large shipowners or through corporate debt. There will be a significant need for capital investment after 2025 when ships powered by alternative fuel start to be ordered. Some estimates suggest needing for above USD3 trillion to achieve decarbonisation in shipping.



Initiatives for decarbonisation spread across all elements of the maritime ecosystem

Voyage Optimisation

- Weather routing: setting the optimal route between two points.
- Zeronorth platform consists of Voyage Planning and Execution, Hull Performance Monitoring, Technical Optimisation, Bunker Optimisation, Chartering Optimisation, Vessel Reporting Platform
- Blue Visby: A multilateral platform for reducing shipping GHG emissions by 15% through eradicating the practice of “Sail Fast, then Wait” without the obstacles of “just in time”. It focuses on single type of vessel for a specific port.
- Just in time: IMO has been promoting just in time ship operations.

Financing framework

- Sustainability linked loans/bonds (2020) aim to facilitate and support environmentally and socially sustainable economic activities and growth. These principles are voluntary recommended guidelines for loans/bonds to be recognized as sustainable. The sustainability linked loans/bonds enable lenders/investors to incentivize the sustainability performance of the borrower/issuer and align the cost of financing with a borrower's performance measured against prescribed sustainability performance targets. Sustainable linked finances have clearly defined sustainability targets. Improvements in CO_2 intensity are measured using Average Efficiency Ratio (AER). Across all shipping sectors, 15 sustainability-linked deals worth USD3 billion were concluded from Jan-Aug 2021.

Government incentives

- Green Shipping Programme of Norway focusses on incentivising net-zero emissions from vessels
- European Union’s Horizon 2020 programme.
- Development Bank of Japan Inc. (DBJ) and ClassNK established "Zero-Emission Accelerating Ship Finance (Program)" to support the maritime industry's transition toward decarbonization.

Investment in hydrogen

- There are currently more than 800 hydrogen production projects. With more than 220 of these projects considered to be large-scale. These projects are regardless of the hydrogen’s end goal – be it for producing ammonia, methanol, iron & steel, biofuels, etc. These hydrogen production plants come with a total potential capacity of over 65 mtpa.

Investment in ammonia

- There are more than 30 green ammonia projects globally, with a total potential capacity of over 35 mtpa. While it is seen that a high concentration of proposed plants are based in Australia, there are notable developments from other regions of the world – such as Europe, Americas and the Middle East. Some projects are expected to commence operations as early at 2023.

Initiatives for decarbonisation spread across all elements of the maritime ecosystem

Government collaboration

- Clyde Bank Declaration (2021): It is a coalition of 22 governments to support the establishment of green shipping corridors – zero-emission maritime routes between 2 (or more) ports. It aims to establish at least 6 corridors by 2025.
- The Pacific Blue Shipping Partnership (PBSP)-2019
  - Fiji, Marshall Islands, Vanuatu, Tuvalu, Solomon Islands, Tonga, Kiribati launched a partnership to make shipping in the Pacific Ocean zero carbon by 2050.
  - Developing a blended finance package exceeding US$500 million to enable a 10-year initial work programme

Class Society

- Giving approval in principle for ammonia ready vessels.
- Developing bunkering processes, safety guides and other technical documents.

Engine Makers

- MAN Energy Solutions aims to have a commercially available two-stroke ammonia engine by 2024, followed by a retrofit package for the gradual rebuild of existing maritime vessels by 2025.
- Wärtsilä has already proven an engine concept running on blends of up to 70% ammonia so far and will have a concept running on pure ammonia by 2023

Cross-sectoral collaboration

- The Getting to Zero Coalition (2018) is an alliance of more than 200 organizations (including 160 companies) within the maritime, energy, infrastructure and finance sectors, supported by key governments and Intergovernmental Organisations. It is aimed at accelerating maritime shipping's decarbonization with the development and deployment of commercially viable deep sea zero emission vessels by 2030 towards full decarbonization by 2050.
- Global Centre for Maritime Decarbonisation (2021): with funding from the Maritime and Port Authority of Singapore (MPA), and six founding partners, namely BHP, BW, DNV Foundation, Eastern Pacific Shipping, Ocean Network Express and Sembcorp Marine. Focussed on Ammonia, Sustainable biofuel, methanol.
- Mærsk Mc-Kinney Møller Center for Zero Carbon Shipping aims to sustainable decarbonization of the maritime industry by 2050 through collaboration, applied research and regulatory reform.

Private initiatives

- Market-based Measures, such as a GHG levy/Carbon taxation, Emissions Trading Scheme or other economic instrument is being considered as one of the tools for promoting decarbonisation. They, as well as, other forms of fund raising, can help finance research and development in the decarbonisation ecosystem such as alternative fuel, bunkering infrastructure etc and provide level playing field for alternative fuels. It may help in reducing the risk of investment in alternative fuel. Ships continuing to consume HFO may require to pay carbon taxes or participate in emissions trading depending on the final legislation.

Initiatives for decarbonisation spread across all elements of the maritime ecosystem

Banks and Financial institutions	• Poseidon Principles (2019): World's first sector-specific, self-governing climate alignment agreement amongst 30 financial institutions (with equivalent to more than USD200 billion (>50%) of global shipping loan portfolio) to integrate the IMO's policies on climate change into ship finance decision making processes. • The Global Environment Facility Trust Fund (2020): IFC-GEF Green Shipping Investment Platform was approved in 2020. The Green Shipping Platform aims to create a first-of-its-kind global investment vehicle solely focused on decarbonizing the shipping industry.
Insurers	• Poseidon Principles for marine insurers (2021): Group of nine insurers. The aim is to enable insurers to assess and disclose their portfolios with responsible environmental impacts and incentivize international shipping's decarbonization
Charterers	• Sea Cargo Charter (2020): A group of 34 bulk ship charterers. It is a global framework that allows for the integration of climate considerations into chartering decisions to favor climate-aligned maritime transport.
Cargo owners	• coZEV (2021): Cargo Owners for Zero Emission Vessels: cargo owner-led network to enable maritime freight customers to come together to accelerate maritime shipping decarbonization through a series of actions and projects. • ZEMBA: Zero Emission Maritime Buyers Alliance: to accelerate commercial deployment of zero-emission shipping, enable economies of scale, and maximise cargo owners' collaborative emission reduction potential beyond what one freight buyer could accomplish alone.
Shipyard	• Japanese shipyards aim to commercialise a zero-carbon emitting vessel by 2028. • Proof of concept and pilot projects for ammonia and hydrogen propelled vessels are accelerating.
Shipowners ongoing initiatives	• Shipboard carbon capture • Switching to alternative fuel such as LNG, methanol, • Harnessing wind and solar power • Electrification of vessels such Swappable battery • Retrofitting energy saving devices such as air lubrication system • In addition, investment in new class of assets such as CO_2 carrier, Hydrogen carrier, large ammonia carriers are taking place increasingly.

Energy Transition in shipping: Issues and Constraints

Issues

1. Currently fuel emission is measured from tank to propeller. There has been a gradual transition towards well-to-propeller measurement method.

2. Slow uptake of alternative fuel in global tonnage (0.9% in fleet and 20% in orderbook).

3. Green Ammonia and Green Hydrogen are touted as zero emission fuel.

4. Currently, LNG, LPG and Methanol are the preferred fuel.

1. No consensus on measurement method.

2. Higher capex for dual fuel vessels. In addition price of alternative fuel is significantly higher. Given greater space requirement for alternative fuel, shipowner has to compromise on revenue earning space.

3. Lack of sufficient production of zero/low carbon bunker fuel. In addition, there is low technological readiness in ammonia / hydrogen-propelled vessels. The safety concerns associated with ammonia and hydrogen fuel still remains. There is also a lack of operational procedures and regulation.

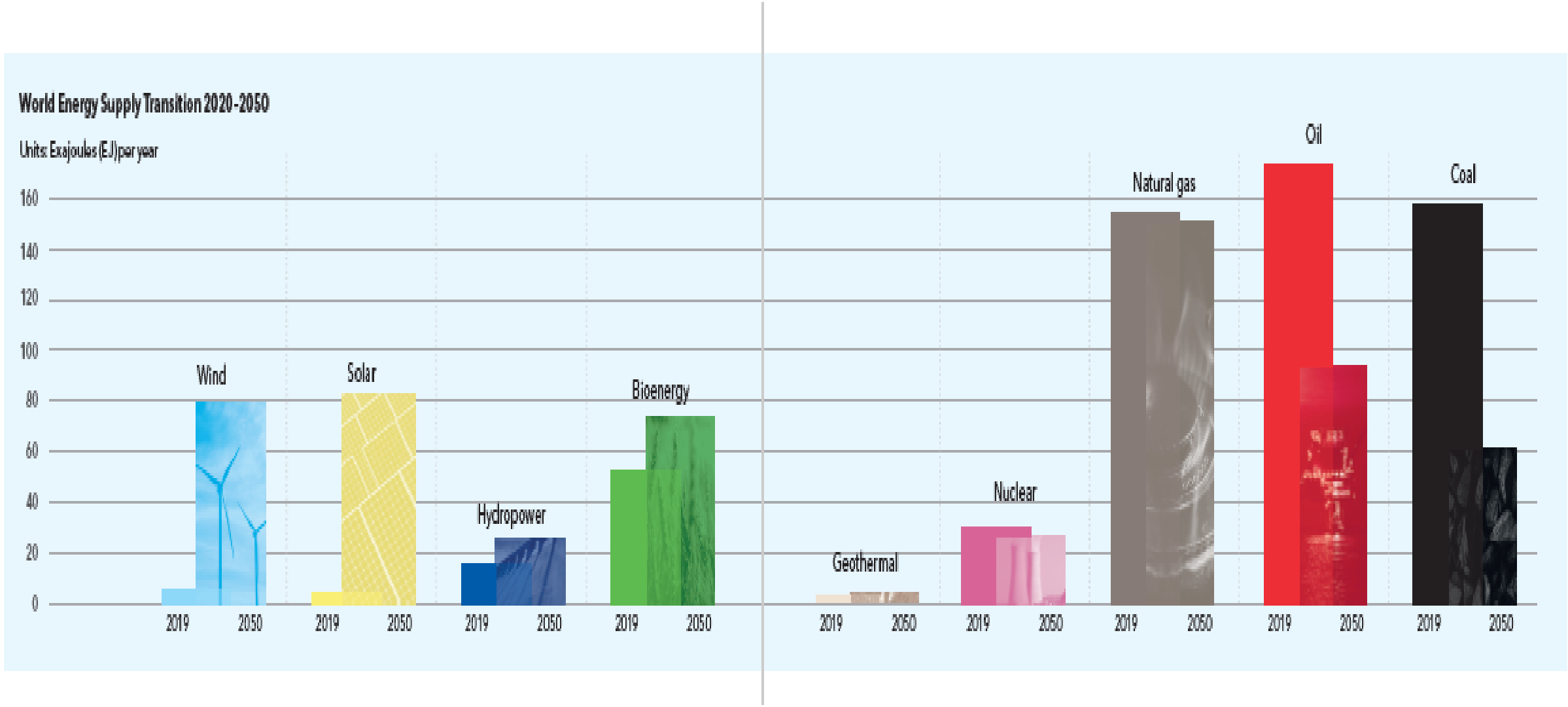
4. Lack of LPG and methanol bunkering facility in the world. Therefore, some of the large shipowners are having to secure long term alternative fuel supply.

Constraints

Key takeaway

- 1% of the existing global tonnage is capable of burning alternative fuel.
- About 22% of global order book is alternative fuel capable.
- LNG is the preferred fuel for shipowners followed by methanol.
- There is a lack of alternative fuel bunkering (particularly low/zero carbon) facilities.
- Higher capex and high fuel costs for alternative fuel vessels
- The shipowners have to secure long-term supplies before investing in alternative fuel-propelled ships either by investing in fuel production or contracting with the fuel producers.
- These constraints have dissuaded owners from ordering alternative fuel propelled ships.

ALTERNATIVE FUEL – SUMMARY


World Energy Supply Transition 2020-2050
Units: Exajoules (EJ) per year
160
140
120
100
80
60
40
20
0
Wind
Solar
Hydropower
Bioenergy
Geothermal
Nuclear
Natural gas
Oil
Coal
2019
2050

Summary: Alternative fuel uptake

- About 1% of the existing global tonnage is capable of burning alternative fuel. LNG is the preferred fuel for shipowners; about 22% of the vessels on orderbook are alternative fuel capable. LNG is also the preferred fuel, and methanol is gaining momentum.
- About 0.3% of the existing global MPV tonnage is capable of burning alternative fuel. LNG is the preferred fuel for shipowners. About 9% of the MPV vessels on orderbook are alternative fuel capable. LNG is the preferred fuel, and methanol is gaining momentum.
- About 0.3% of the existing global MPV tonnage up to 10,000 dwt is capable of burning alternative fuel. LNG is the preferred fuel for shipowners. About 5% of the MPV vessels upto 10,000 dwt on orderbook are alternative fuel capable. LNG is the preferred fuel.
- The higher emissions from older vessels will pose a challenges for their employability as charterers will prefer higher-rated vessels.

- There are major challenges in making ammonia a viable alternative fuel. The challenges pertaining to various aspects such as fuel storage, logistics and bunkering, onboard energy storage & fuel conversion, fuel management, regulation and certification etc. Hydrogen has not been included here as it will likely be used only for short-sea shipping.
- The first movers to take action are split into the transition drivers and market enablers. Everyone from alternative fuel producers, ports & terminals, vessel owners & operators to regulations & policies making, financing and cargo & customers would have to work hand in hand and step up in order for change to take place.
- Decarbonisation measures and upgrades are necessary for the short run. Some require investments, and some are operational in nature. Most of these require small investments, which can be financed from the equity of the large shipowners or through corporate debt. There will be a significant need for capital investment after 2025 when ships powered by alternative fuel start to be ordered. Some estimates suggest needing for above USD3 trillion to achieve decarbonisation in shipping. Fundings will only be available for climatically aligned projects from some financiers.
- There is a lack of alternative fuel bunkering (particularly low/zero carbon) facilities. Because of higher capex and high fuel costs for alternative fuel vessels; the shipowners have to secure long-term supplies before investing in alternative fuel-propelled ships either by investing in fuel production or contracting with the fuel producers.
- The order for low carbon fuel vessels will continue to rise over the next five years with increasing pressure of compliance with upcoming decarbonisation regulations.

THANK YOU