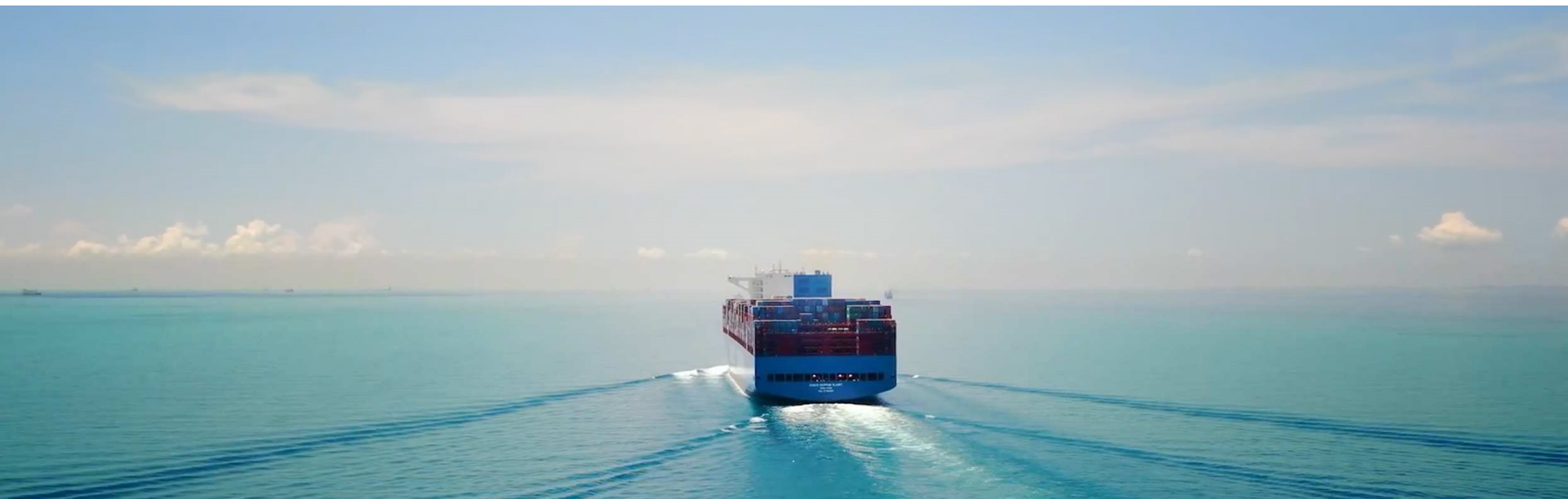




WHEN TRUST MATTERS

Alternative ship fuels – focus on biofuels & methanol

DNV webinar, 28 February 2023



The webinar presenters



Christos Chryssakis

*Business Development
Manager*

DNV Maritime



Øyvind Sekkesæter

*Consultant,
Environment Advisory*

DNV Maritime



Øyvind Skåra

*Principal Engineer,
Alternative fuels & piping
systems*

DNV Maritime



Simon Adams

*Senior Communications
Manager*

DNV Maritime

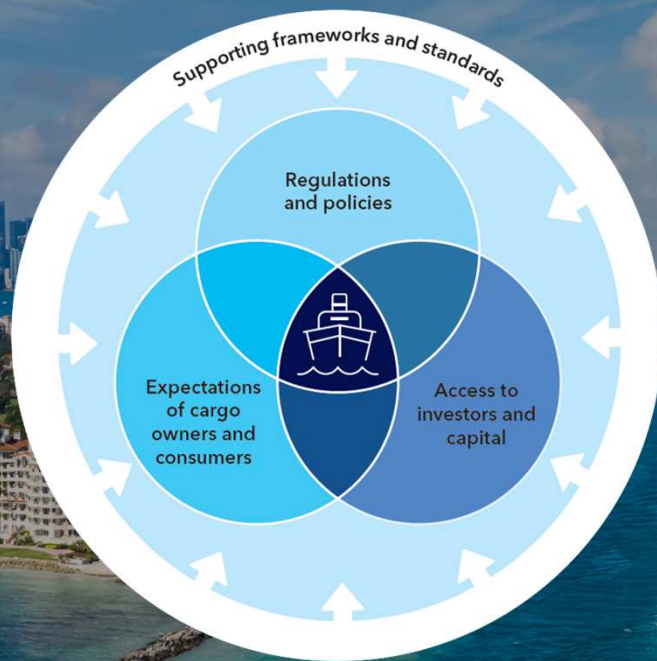
Webinar host

AGENDA

- **Introduction - Regulatory update & market drivers**
- LNG & LPG - Established alternatives, still gaining ground
- Ammonia & Hydrogen – Promising, but the future?
- Biofuels – A real option?
- Methanol – The interest is increasing fast: why?
- Q & A

Regulatory frameworks and new standards will drive the maritime decarbonization

5% of fuel will have to be carbon-neutral to achieve current IMO targets



IMO's ambitions will be reviewed and could be strengthened to decarbonize shipping by 2050

Lifecycle GHG emissions standards are being developed to ensure fuel sustainability

Major cargo owners expect low- and zero-emission shipping services to be in place this decade

Access to capital depends increasingly on environmental credentials

International & regional regulations are tightening



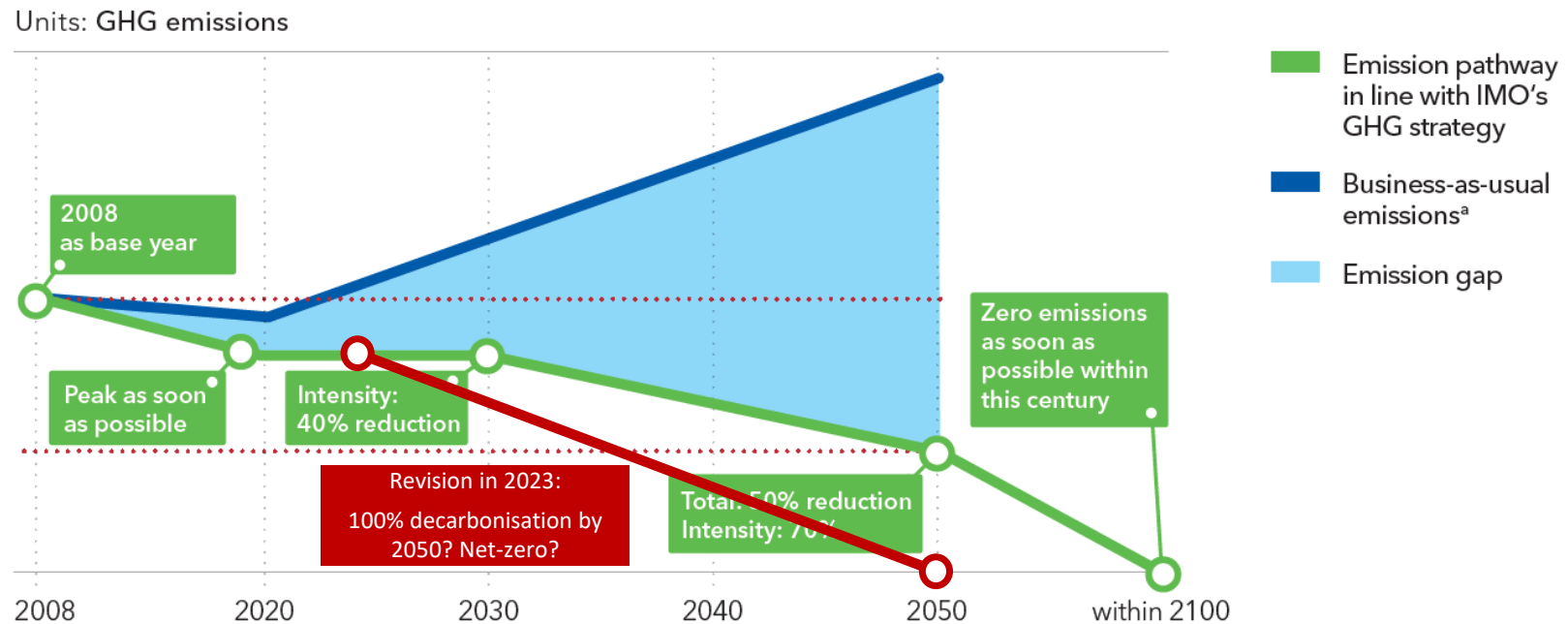
EEDI, EEXI, CII, SEEMP,...

Strategy review in 2023 and higher ambitions to be expected

Inclusion in EU Emissions Trading System (ETS)

FuelEU Maritime

IMO strategy on GHG reductions, decision point 2023



Total: Refers to the absolute amount of GHG emissions from international shipping.
Intensity: Carbon dioxide (CO₂) emitted per tonne-mile.

Inclusion of shipping in the EU ETS may be costly...

EU emissions allowances – ETS spot and futures prices (€/t)



Source: tradingeconomics.com

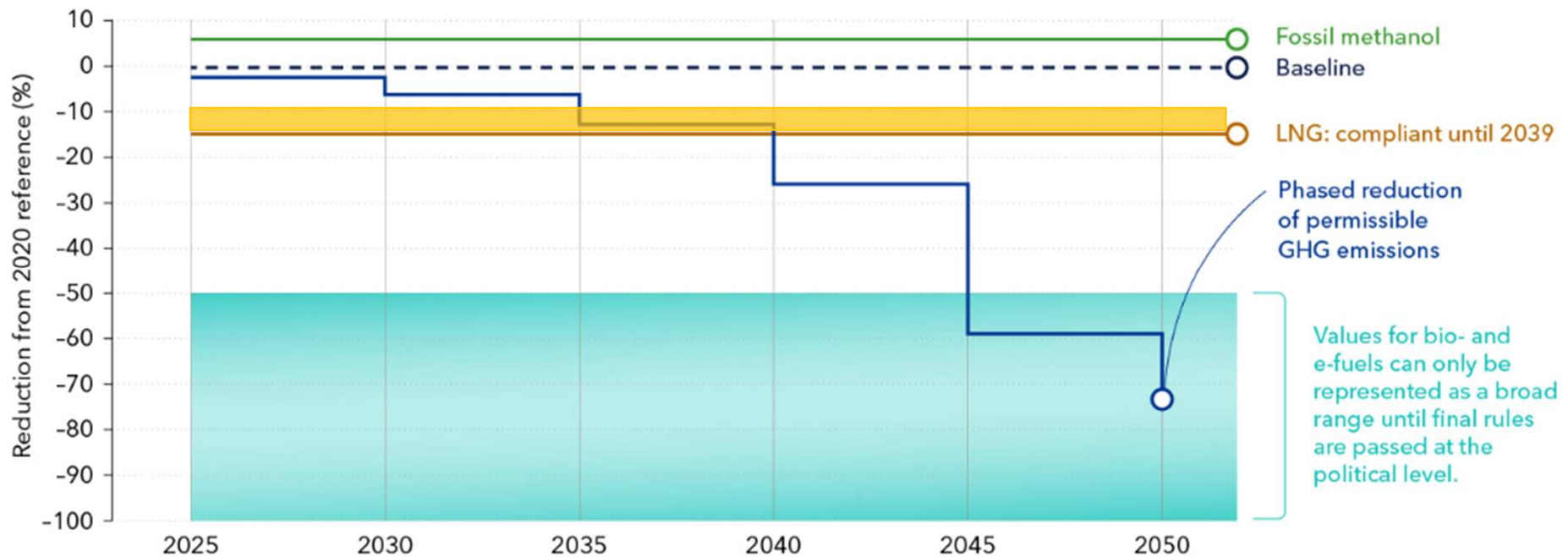
- Entry into force: 2024
- Transition period until 2026

Implications:

- 30-50% increase in effective fuel costs
- Commercial agreements needed to share cost with charterers
 - More complex for vessels on the spot market
- Focus on energy efficiency
- Use of **advanced biofuels**?

FuelEU Maritime requirements to lifecycle emissions

FuelEU Maritime will set requirements for well-to-wake emissions



Source: FuelEU Maritime proposal supplemented with calculations in ISWG-GHG 9/2

The new fuel value chain



BIOMASS



REFINERY



FUEL
DISTRIBUTION



FUEL PUMP



SHIP

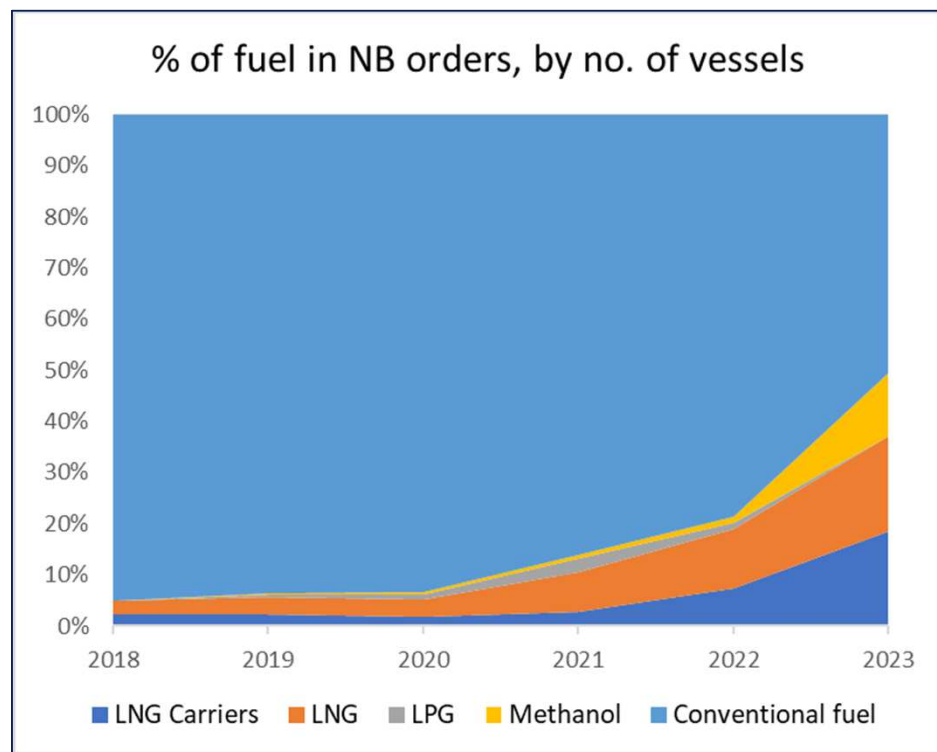
Certification of fuel production & distribution
Technology qualification, expert advice

Ships with dual-fuel capabilities
Emissions verification towards
cargo owners & authorities

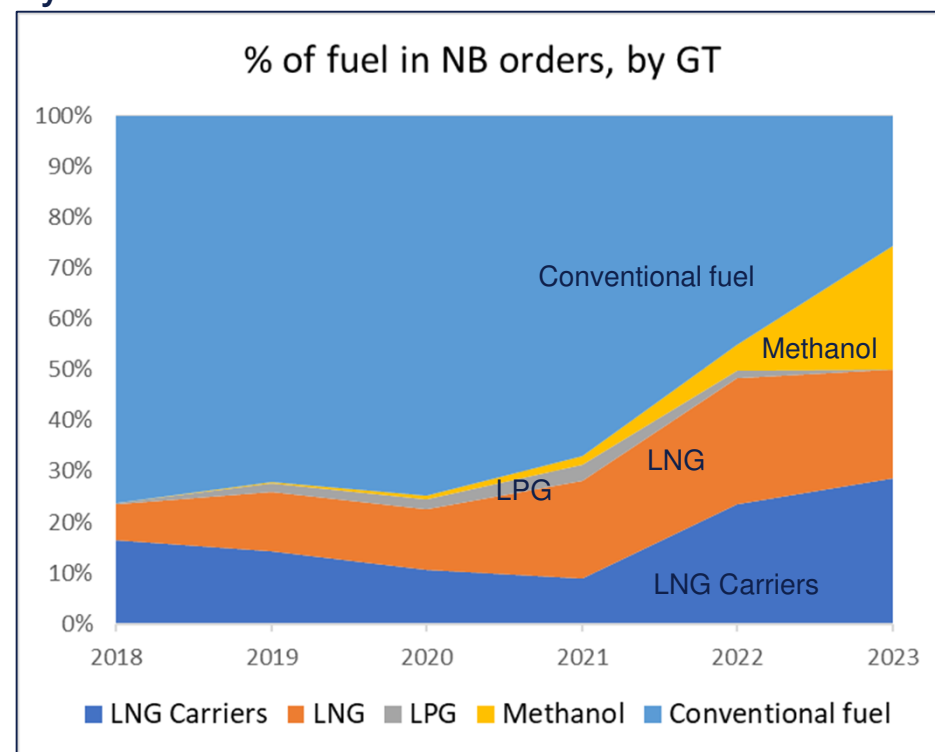
DNV: Your partner across the value chain

Newbuilding orders with alternative fuels

No of vessels:



By GT:



Source: DNV Alternative Fuels Insight - <https://afi.dnv.com/>.

Note: 2023 figures are based on January 2023 orders only

Three key trends



SHARE OF ALTERNATIVE
FUELS INCREASING FAST



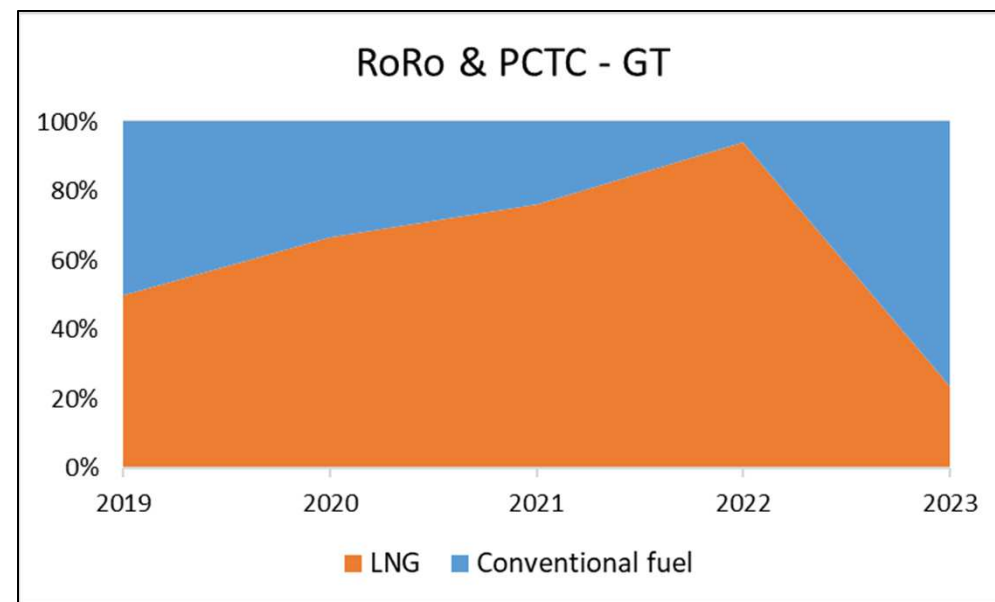
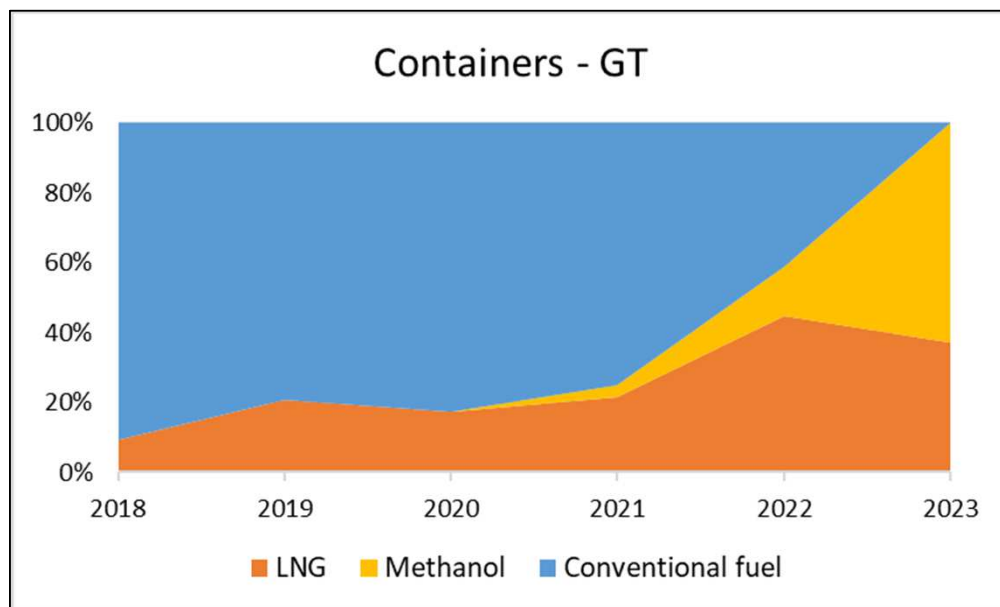
LARGE VESSELS DRIVING
THE CHANGE



MORE DIVERSE FUEL MIX

Vessel types selecting LNG & Methanol

Have we seen the last oil fuelled container vessels?



Source: DNV Alternative Fuels Insight - <https://afi.dnv.com/>.

Note: 2023 figures are based on January 2023 orders only

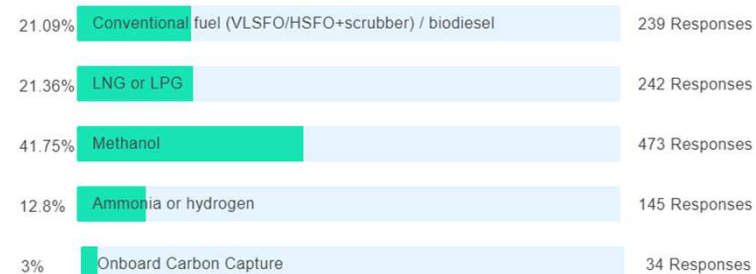
- 20% of **tankers** ordered since 2020 with LNG as fuel, based on GT
- 11% of **bulk carriers** ordered since 2020 with LNG as fuel, based on GT

Poll result

Session 1 (9AM CET)

1 of 1. If your company orders a newbuilding in the next 1-2 years, which solution would be your most likely choice?

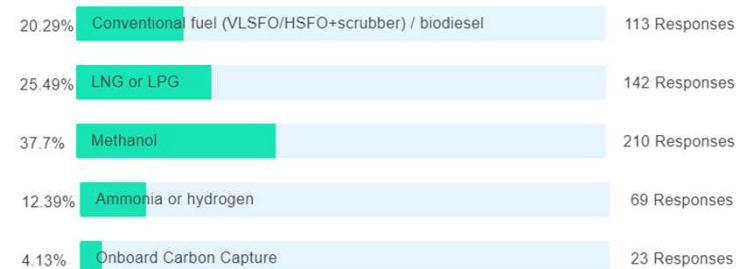
Multiple choice with single answer



Session 2 (4PM CET)

1 of 1. If your company orders a newbuilding in the next 1-2 years, which solution would be your most likely choice?

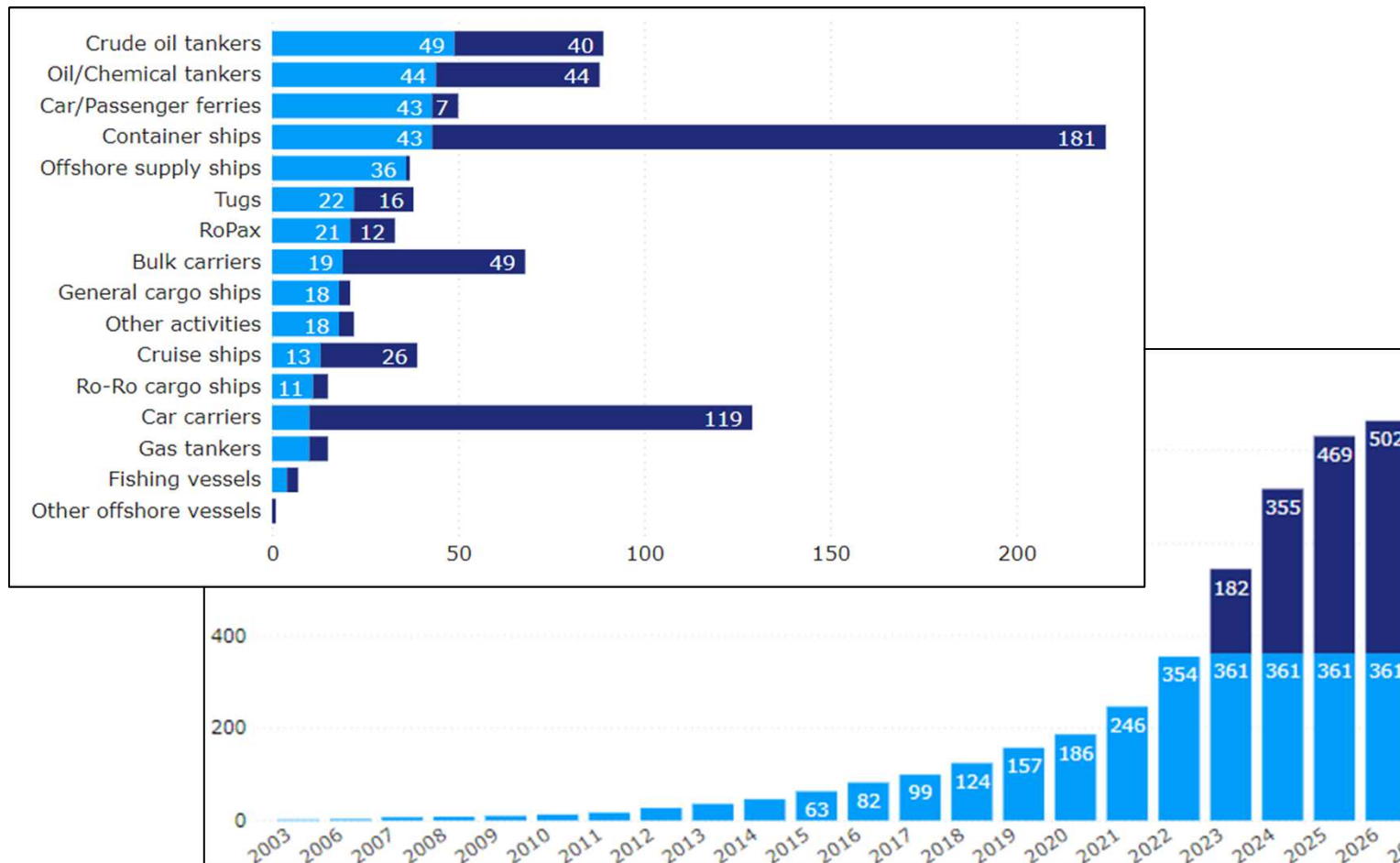
Multiple choice with single answer



AGENDA

- Introduction - Regulatory update & market drivers
- **LNG & LPG - Established alternatives, still gaining ground**
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LNG – continued strong interest



Lower EEDI & CII

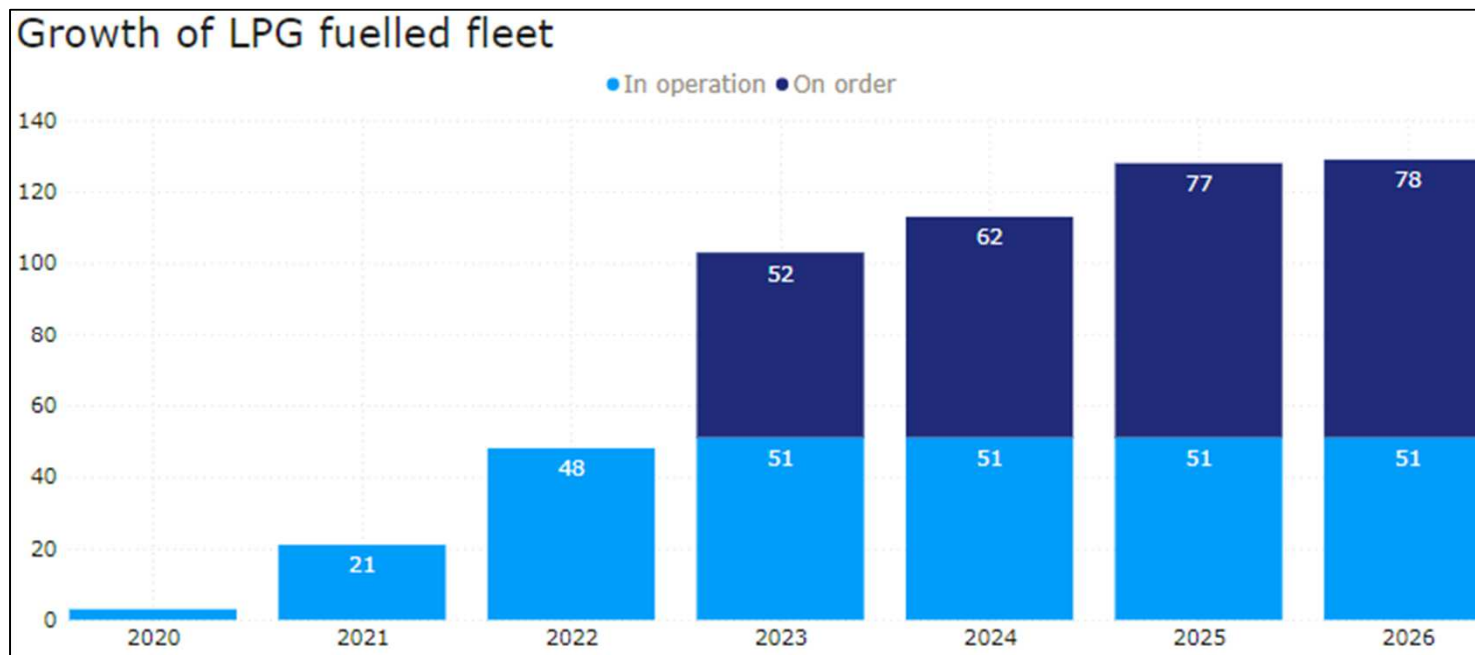


Higher CAPEX

Some loss of cargo space

Methane emissions to be restricted

LPG – a fuel for LPG carriers only?



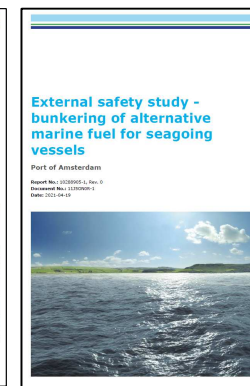
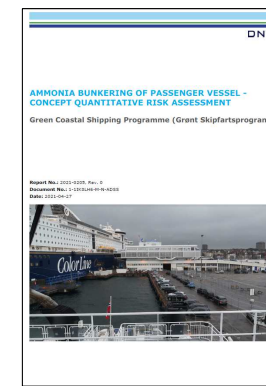
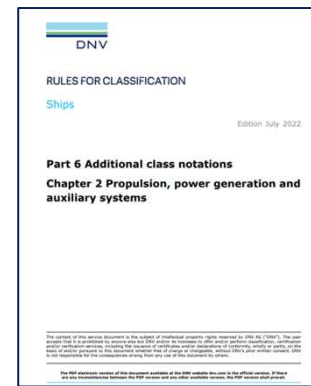
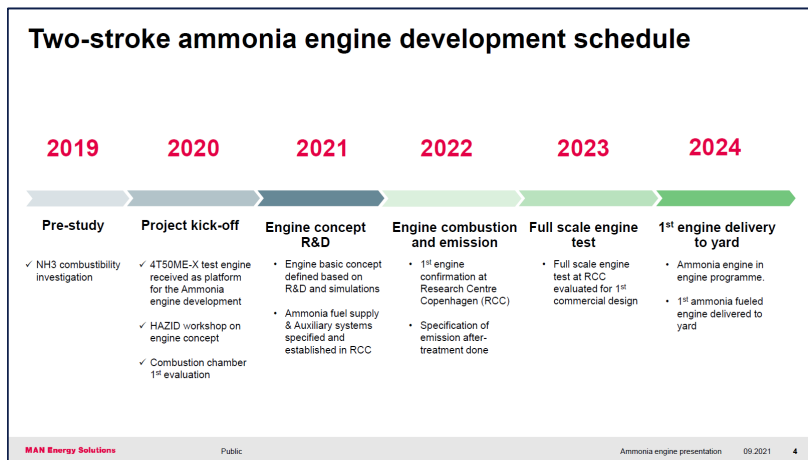
Source: DNV Alternative Fuels Insight - <https://afi.dnv.com/> , updated January 2023

- Currently only used by LPG carriers
- Up to 15% reduction in EEDI and CII
 - In practice $\approx 13\%$ due to lack of 4-stroke engines
- Lower CAPEX than LNG
- Limited range of 2-stroke engines commercially available

AGENDA

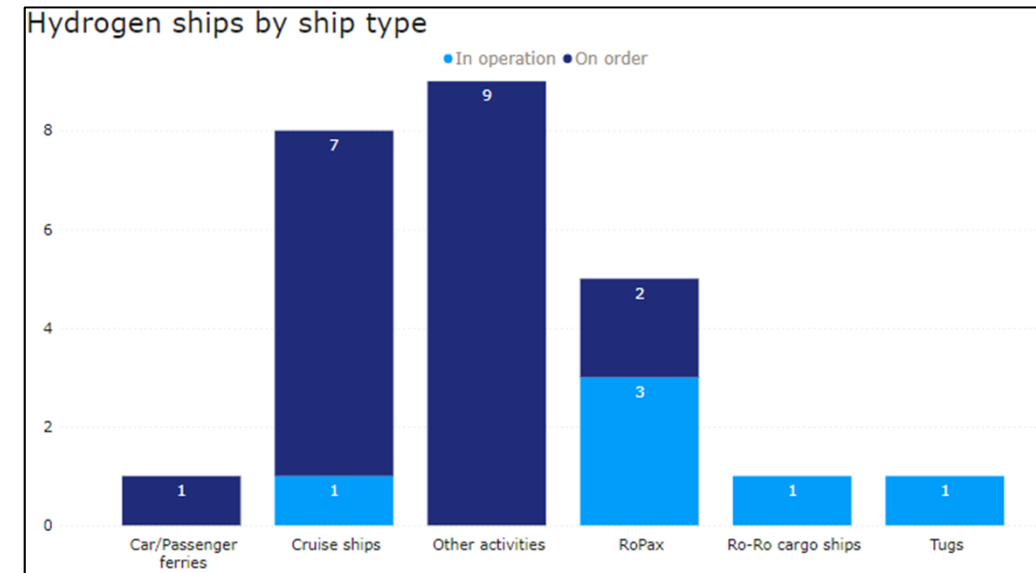
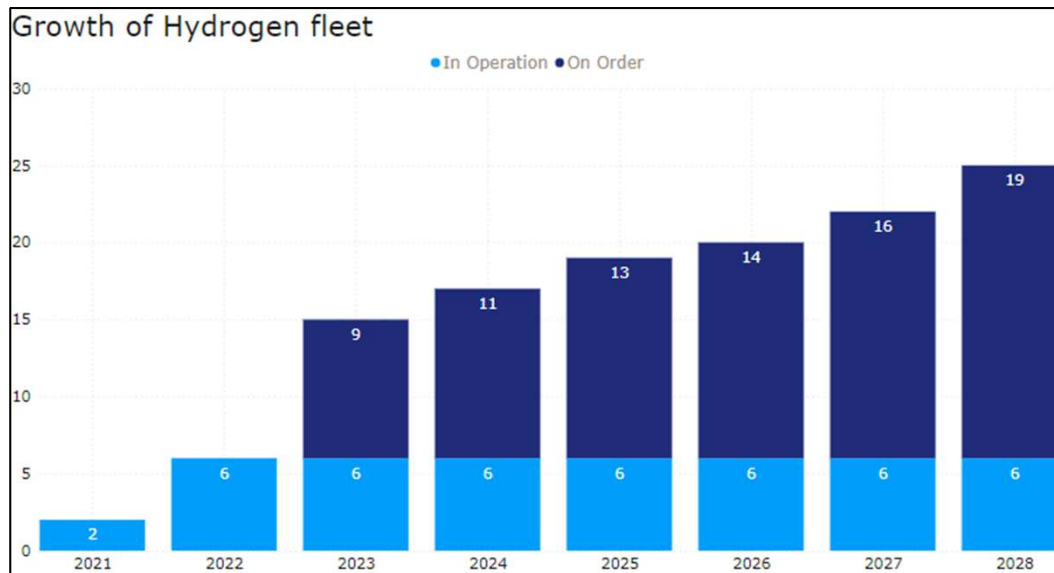
- Introduction - Regulatory update & market drivers
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Ammonia developments



2025-2030: Testing of ammonia technology & operations

Hydrogen

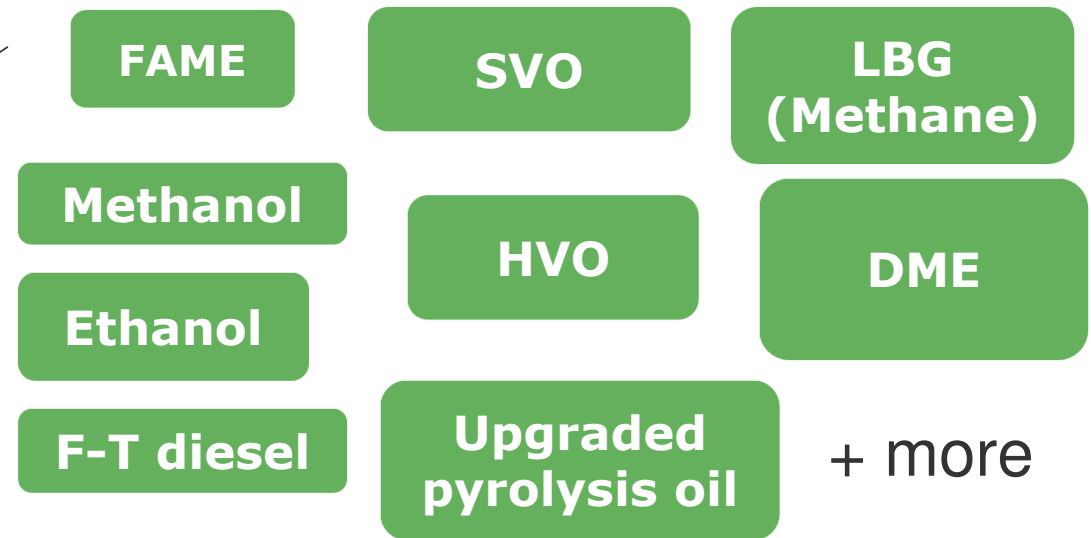
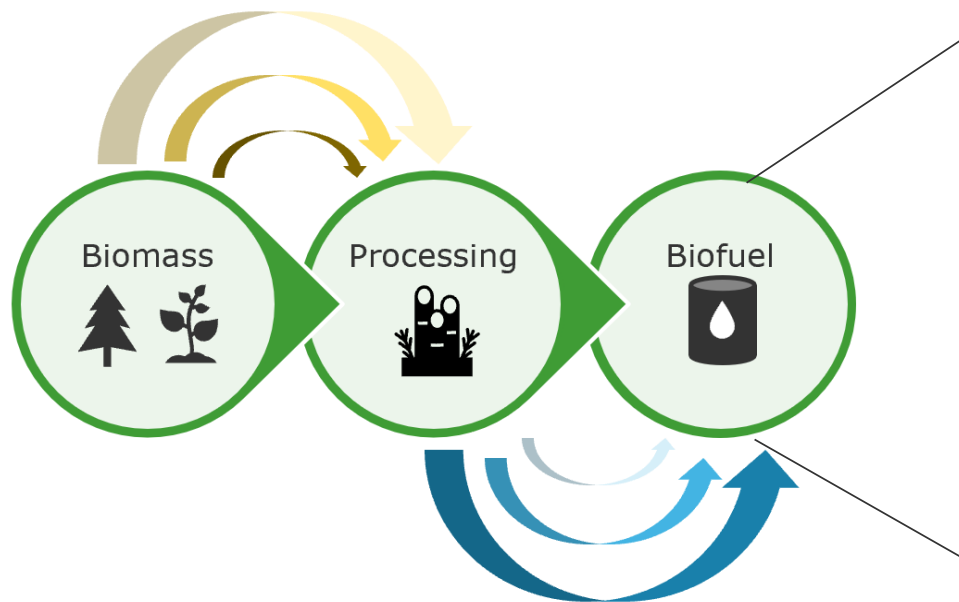


- Size and cost of fuel tanks remain a challenge
- Most applications are small vessels with possibility for frequent bunkering
- Cost of fuel cells decreasing and larger sizes being tested

AGENDA

- Introduction - Regulatory update & market drivers
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What are biofuels?



- HVO: Hydrotreated Vegetable oil
- SVO: Straight Vegetable Oil
- DME: Dimethyl Ether
- FAME: Fatty Acid Methyl Ester
- F-T diesel: Fischer-Tropsch diesel
- LBG: Liquefied biogas

Status for shipping today

Many ship owners are testing biofuel onboard vessels



CMA CGM Partners with IKEA to Test Marine Biofuel On Board Containership
gCaptain
March 12, 2023



Stolt Tankers launches biofuel trial in collaboration with GoodFuels

Tanker operator becomes the latest to test how biofuels can help decarbonise shipping
The Maritime Executive
March 12, 2023



Meriaura aims for carbon-neutral voyages with biofuel and battery ship

Finland group also looking at automation of cargo handling and more digital processes
The Maritime Executive
March 12, 2023

Marine Biofuel Successfully Tested by Stena Bulk in Vessel Operations



The Maritime Executive
March 12, 2023



UECC to Test Marine Biofuel on Ro-Ro Vessel

The Maritime Executive
March 12, 2023



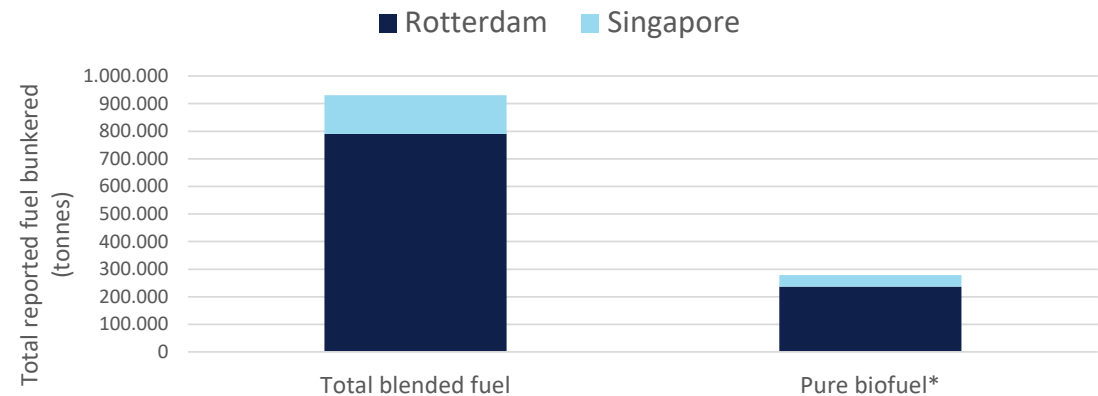
Alfa Laval set to begin marine biofuel testing
The Maritime Executive
March 12, 2023



UECC reveals 'stunning' 60% emissions cut in 'smoothie' biofuel trial

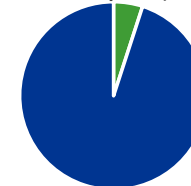
Norwegian owner says old car carrier tested data environmental footprint through new fuel
The Maritime Executive
March 12, 2023

Reported bunkering of biofuels in 2022 (Rotterdam & Singapore)



*assuming a weighted average blend consisting of 30% biofuel

Approx. 0.1% of total ship energy consumption (2022)



Sources: Tradewinds, Reuters, gCaptain, the Maritime Executive

Regulatory status of biofuels

GHG regulations

| GHG regulations | |
|-----------------|--|
| EEXI/EEDI | No effect |
| CII | Reduction of CII if accepted by flag |
| EU MRV | Reduction of the annually reported CO2 emissions |

- Use of biofuels under CII to be considered at MEPC 80
- IMO in the process of developing Lifecycle Assessment (LCA) guidelines for all marine fuels, including biofuels. First version expected to be ready at MEPC 80

NOx regulations

MARPOL Annex VI Regulation 18.3 for biofuels

| | |
|---------------------------------|--|
| Fuels with biofuel content <30% | No NOx testing or assessment required |
| Fuels with biofuel content >30% | If engine can run on the fuel without changes to NOx critical components or settings, use is permitted |

DNV Technical and Regulatory News

TECHNICAL AND REGULATORY NEWS No. 05/2023 - TECHNICAL

USE OF BIOFUELS IN SHIPPING

Relevant for shipowners, managers, shipyards, design offices and flag states.

February 2023



The use of biofuels or biofuel blends is one of many ways to comply with the IMO's strategy on the reduction of GHG emissions from ships, and DNV has seen an increasing interest in those new fuels. This technical news aims to clarify the regulatory status and other considerations on the usage of such fuels.

Biofuels and their effect on GHG regulations

EEDI and EEXI
The EEDI and EEXI only consider the so-called tank-to-water approach, meaning that only the carbon content of stored and reference fuels the vessel is designed for is considered. For that reason, the usage of biofuels has no effect on the EEDI or the EEXI.

CII (Carbon Intensity Index)
In view of IMO DCS reporting as well as the CII calculation methodology – as per the 2023 SEEMP Development Guidelines, Resolution MEPC.346(78), and the CII Calculation Methods Guidelines, Resolution MEPC.353(78) – in case of fuel types not covered by the guidelines, the conversion factor C₁₉ to be obtained from the fuel oil supplier and supported by documentary evidence.

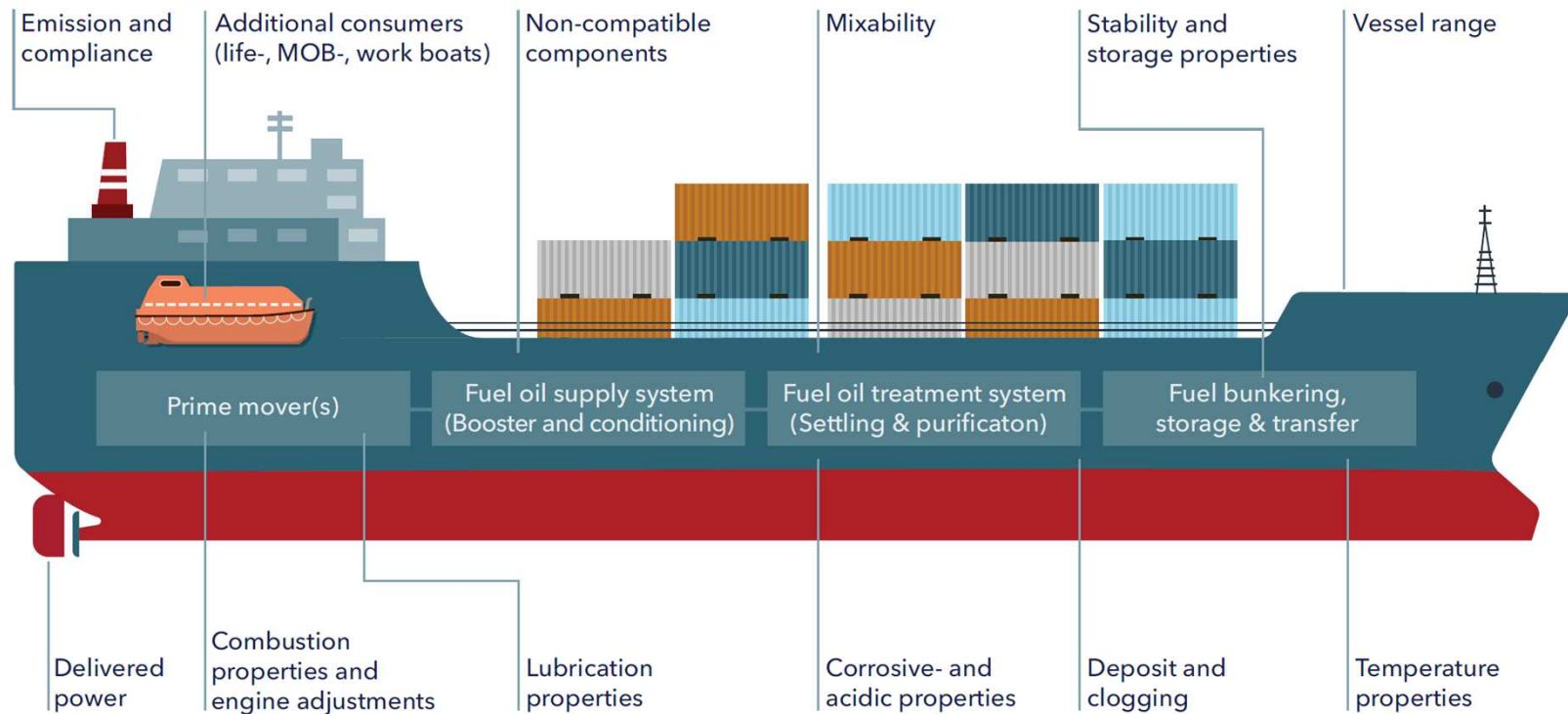
Any non-standard approach in the determination methodology of tank-to-water emissions for biofuels is subject to acceptance by the vessel's flag administration as well as the RO handling the IMO DCS and CII verification on behalf of the flag, where an addition to the list of fuel types used and applicable conversion factors needs to be reflected in the SEEMP Part B.

EU MRV
As per Regulation (EU) 2015/757, in case of alternative fuels, the monitoring plan shall contain "the methodologies for determining the emission factors, including the methodology for sampling, methods of analysis and a description of the laboratory used, with the ISO 15020 accreditation of those laboratories, if any." It is worth noting that Directive (EU) 2018/2001 (EU RED II), Annex V, Part C, provides

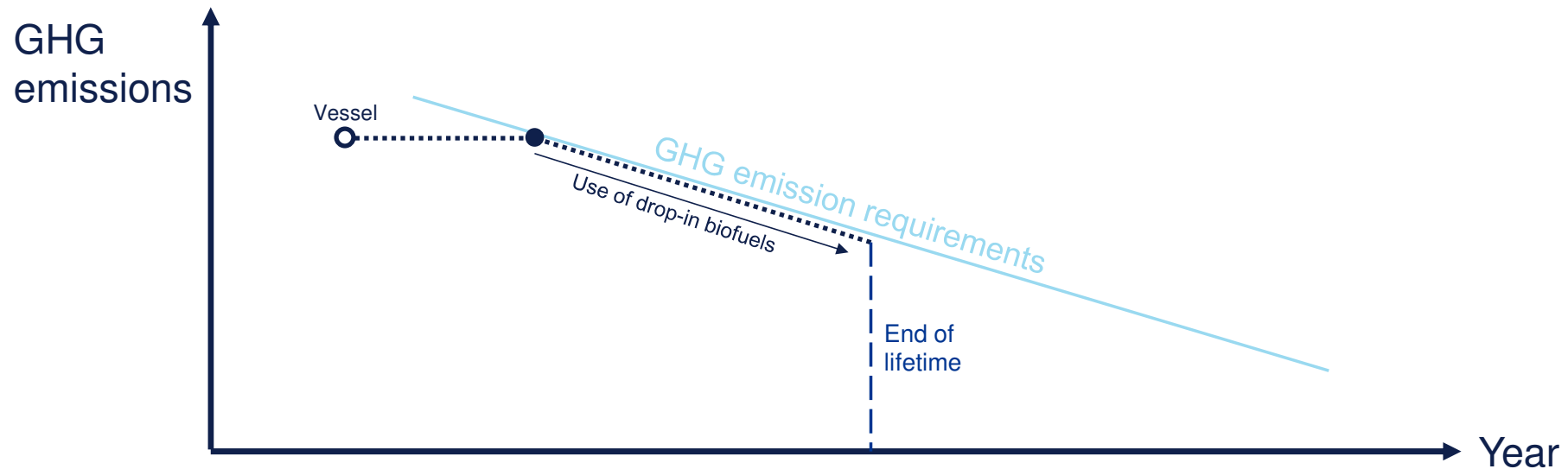
DNV AS, Verftet 1, 1203 Høvik, Norway. Phone: +47 67 57 99 00, www.dnv.com/technical dnv.com/technical Page 1/9

www.dnv.com/tecreg

Technical compatibility of biofuels with onboard systems – focus areas



Prospects for biofuels in shipping

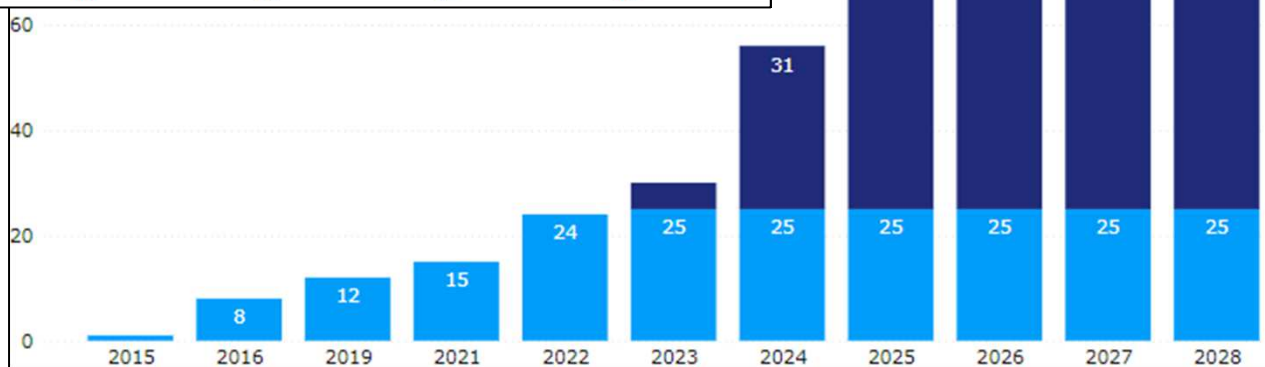
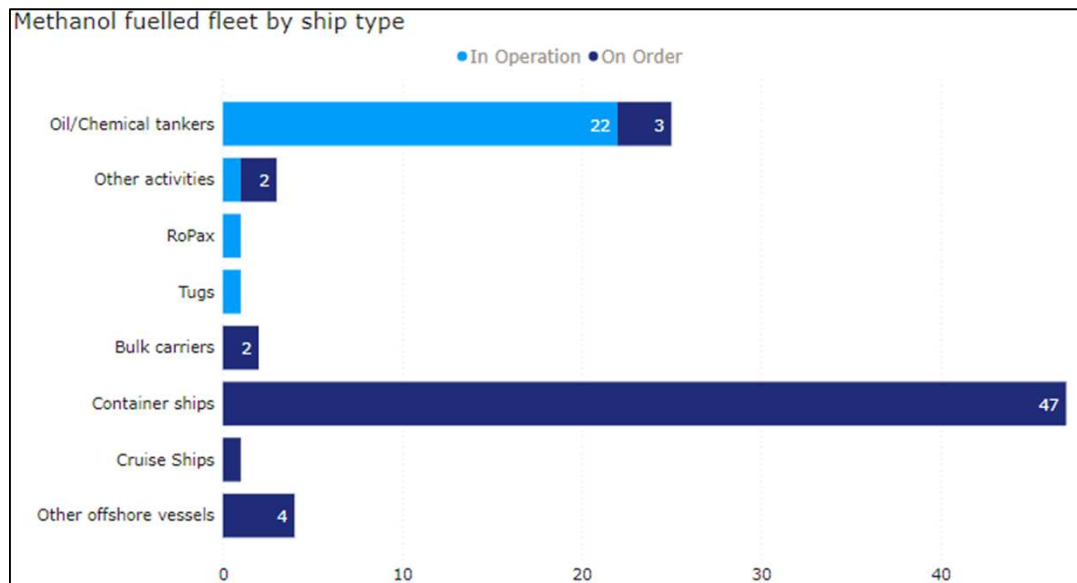


- Biofuels can serve as one of few short-to-medium term decarbonization pathways, especially for older vessels
- Uptake will be incentivized by GHG regulations such as CII and EU ETS, as well as pressure for stakeholders such as cargo-owners and banks
- Although there is a significant potential to increase uptake of biofuels in shipping, expanded use must be based on biofuels made from sustainable feedstock

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- **Methanol – The interest is increasing fast: why?**
- Q & A

Methanol – rapid growth



Relatively low CAPEX

Easy to handle/operate



Availability of green methanol

Some loss of cargo space

Methanol – the chosen fuel for many MR tankers

21 MR tankers in operation

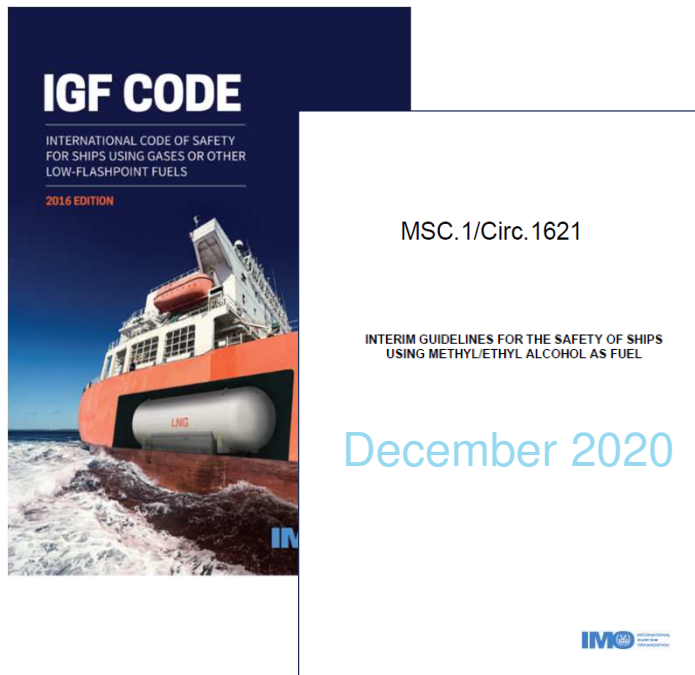
- Owners: MOL, Westfal-Larsen, Marininvest, Waterfront Shipping, Proman Stena Bulk
- Class: DNV (16), NK (5)

5 MR tankers under order

- Owners: Proman Shipping / Stena Bulk / KSS Line / Mitsui OSK Line
- Class: All to DNV



Regulatory status for methanol



The IMO interim guidelines, supplement to the IGF Code, provides an international standard.



DNV class rules *LFL fuelled* and *Fuel Ready(methanol)* are available.

Regulatory status, cont'd

- IMO MSC. Circ. 1621 still the statutory instrument. DNV has contacted flag administrations in order to obtain acceptance for this as approval basis in lieu of a full alternative design process.
- The IMO is in the process of including the guidelines as part of the IGF code. Text is aimed to be concluded in 2025 and entry into force in 2028.
- Further improvements of the rule text is ongoing.
- DNV will accept alternative PV-venting solutions in order to mitigate challenges with gas zones.
- DNV has increased the focus on the toxicity of methanol compared to existing guidelines.



Methanol spills or leaks

- Significantly less impact than conventional hydrocarbon fuels.
- Dissolves readily in water.
- Only very high concentrations create lethal conditions or any changing effect on the local marine life.

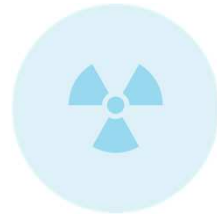


- **A methanol spill results in limited damage to the environment** except for the release of carbon into the marine ecosystem.
- Methanol in the ocean is common, produced naturally by phytoplankton, and is readily consumed by bacteria microbes, thus entering, and supporting the food chain.



Methanol and safety risks

Toxicity to humans:

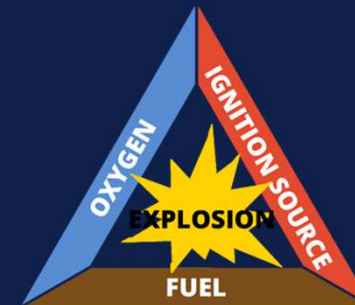


- Methanol is toxic and poisonous to the central nervous system
 - may cause blindness, coma, and death if ingested in large quantities
 - to be handled carefully if spilled or leaked in confined spaces or on deck
- Since its vapor is heavier than air, it increases the risk of inhaling the vapor by the onboard crew.
- At high vapor concentrations, methanol can also cause asphyxiation.

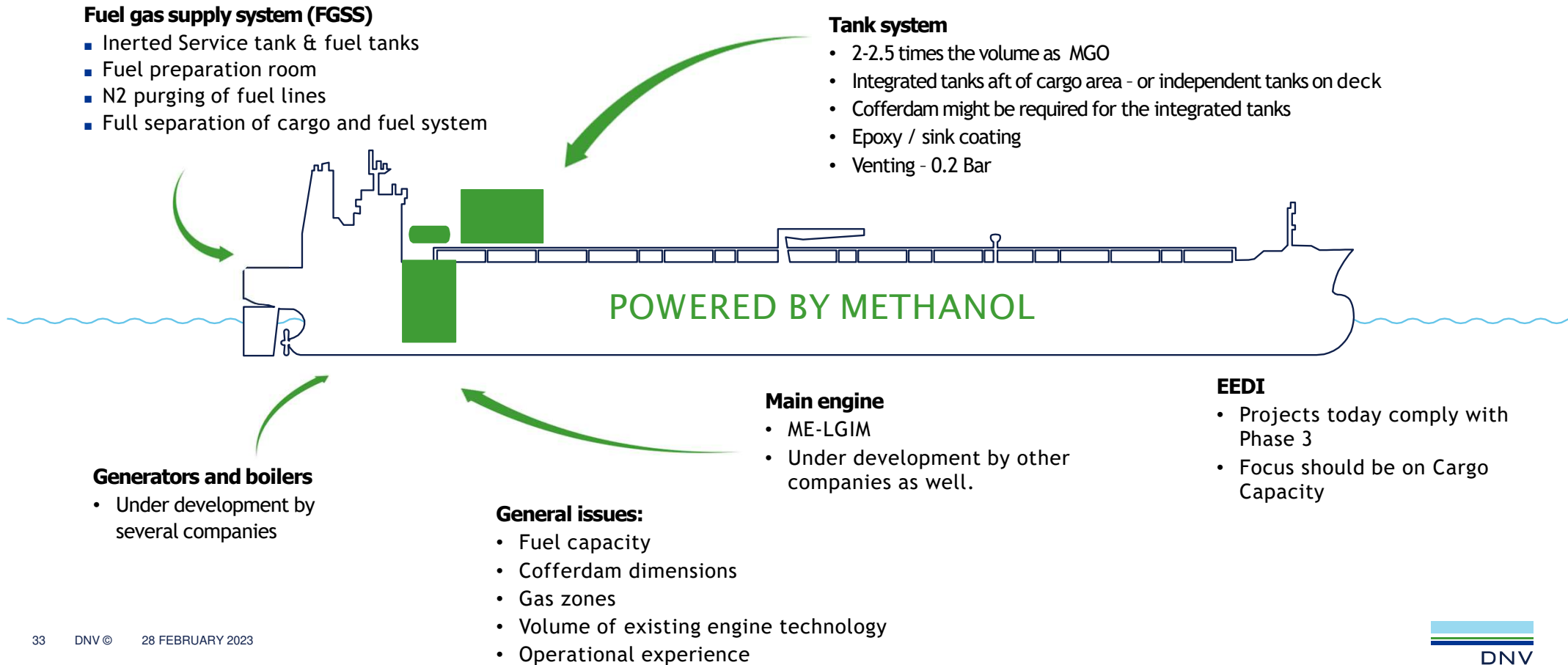
Explosion risk:



- Fuel vapours in tanks and enclosed spaces after a spill
- Air in ullage spaces
- Sparks, static discharge, lightning, tank entry, etc.



Technical challenges with methanol. Case: methanol as fuel for tankers - some issues...



Some wild cards – What if?

Nuclear power

Technical Developments

Extensive experience with nuclear propulsion in naval vessels

- Not commercially feasible
- Safety and security risks

Molten Salt Reactors (MSR)

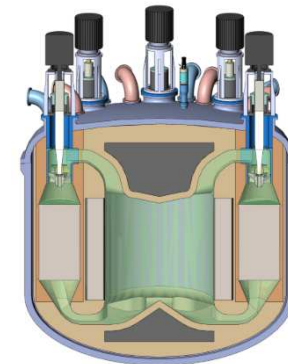
- Inherently safe technology
- Demonstrator expected by 2024 (100kW-1 MW)
- First marinized reactor by 2020-2030
- Leasing scheme to make cost competitive

Other considerations

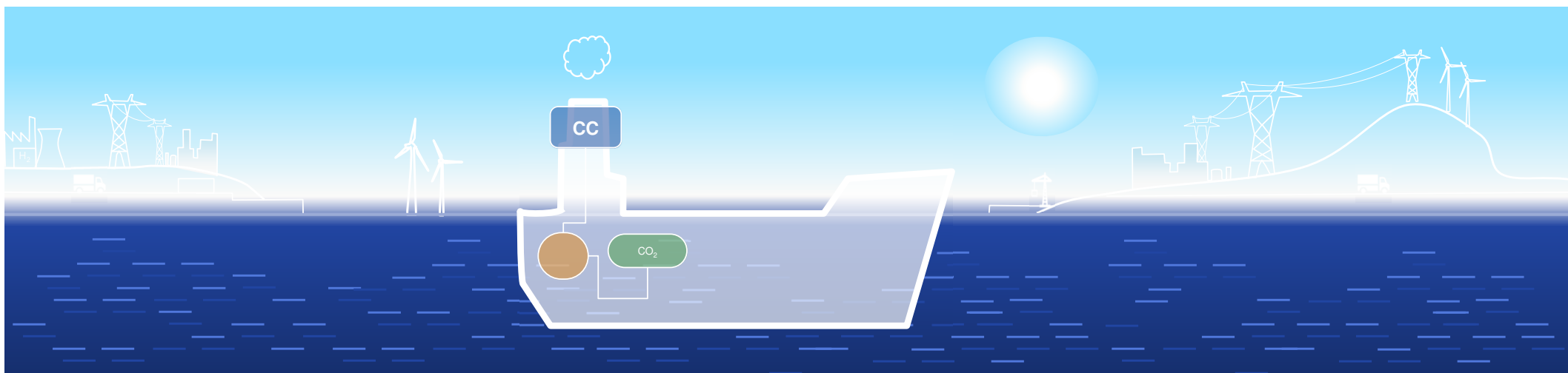
International regulations: SOLAS has to be modernized and updated

Public perception

Commercial uptake not before 2035 (?)



Onboard Carbon Capture (CCS) – emerging new alternative?



Onboard technology - piloting

- Post-combustion CO₂ separation
- Treatment system
- Storage – typically liquefied

Regulatory development

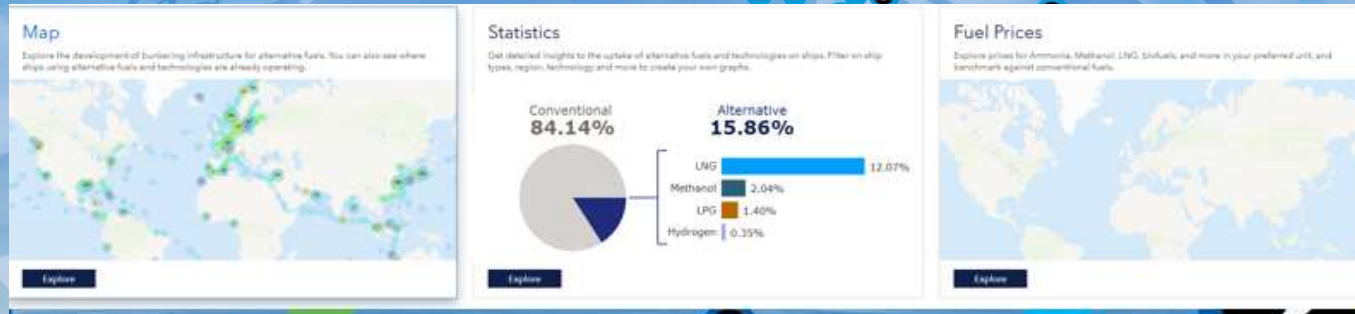
- On the IMO agenda for MEPC 80
- Possible under EU regulations

Land-based infrastructure

- Delivery at port facilities
- Transport for long-term storage
- Utilization (e.g. for fuel production)

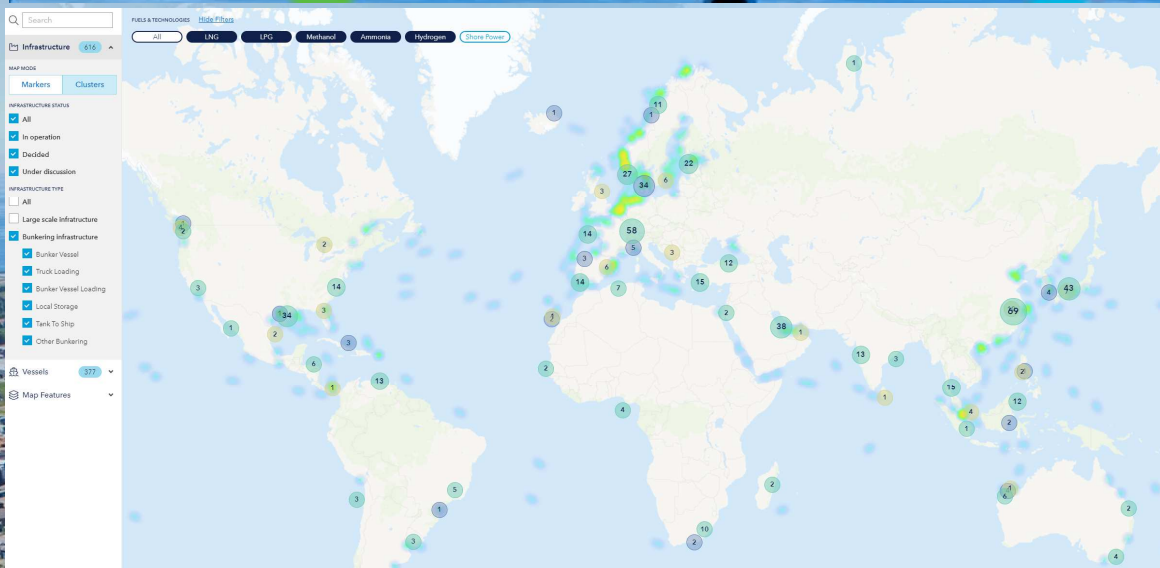
Can be an attractive for certain ship types and trade patterns

www.dnv.com/afi



11,800 AFI subscribers

Partners:



- Overview
- Batteries
- Bunker Vessels
- Hydrogen
- LNG**
- LPG
- Methanol
- Scrubbers

LNG

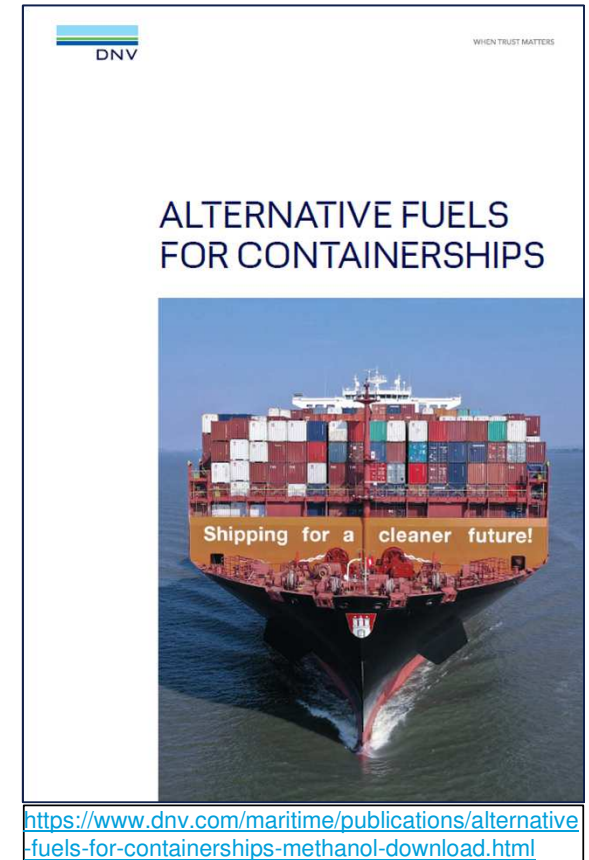
LNG Premium report



Relevant reports



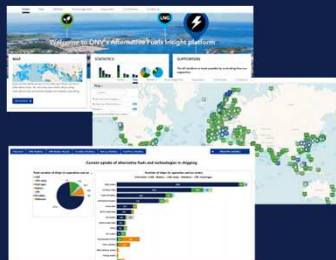
Launch: May 2023



<https://www.dnv.com/maritime/publications/alternative-fuels-for-containerships-methanol-download.html>

DNV tools and resources on decarbonization (selection)

Alternative Fuels Insight



www.dnv.com/afi

Emissions Insights

CII ratings and more
(included in DNV's
DCS solution)



www.dnv.com/dcs

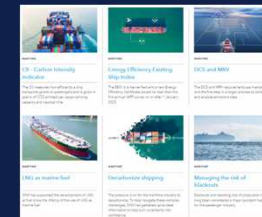
Decarbonization hub



www.dnv.com/decarb

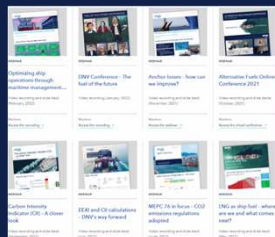
Topic pages

EU ETS, MRV, DCS, EEXI,
CII, SEEMP III, etc.



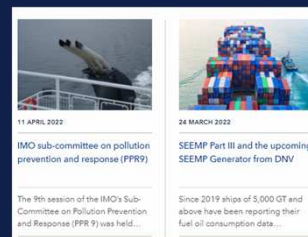
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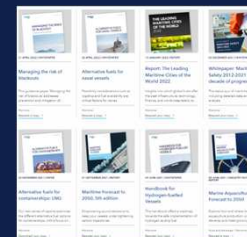
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Publications

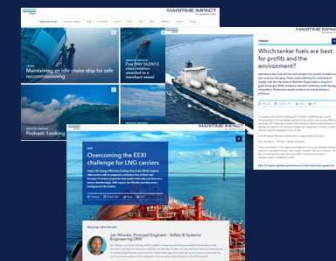
Alternative fuels, Ammonia
as fuel, etc.



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Key takeaways

Regulatory drivers (CII, EU ETS) incentivizing use of alternative fuels

More diversified fuel mix:

- Continued strong interest for LNG
- Rapid growth for methanol
- Biofuels: increasing demand – how about availability?

Ongoing developments for ammonia & hydrogen

Wild cards: onboard carbon capture, nuclear propulsion

WHEN TRUST MATTERS

Thank you!

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