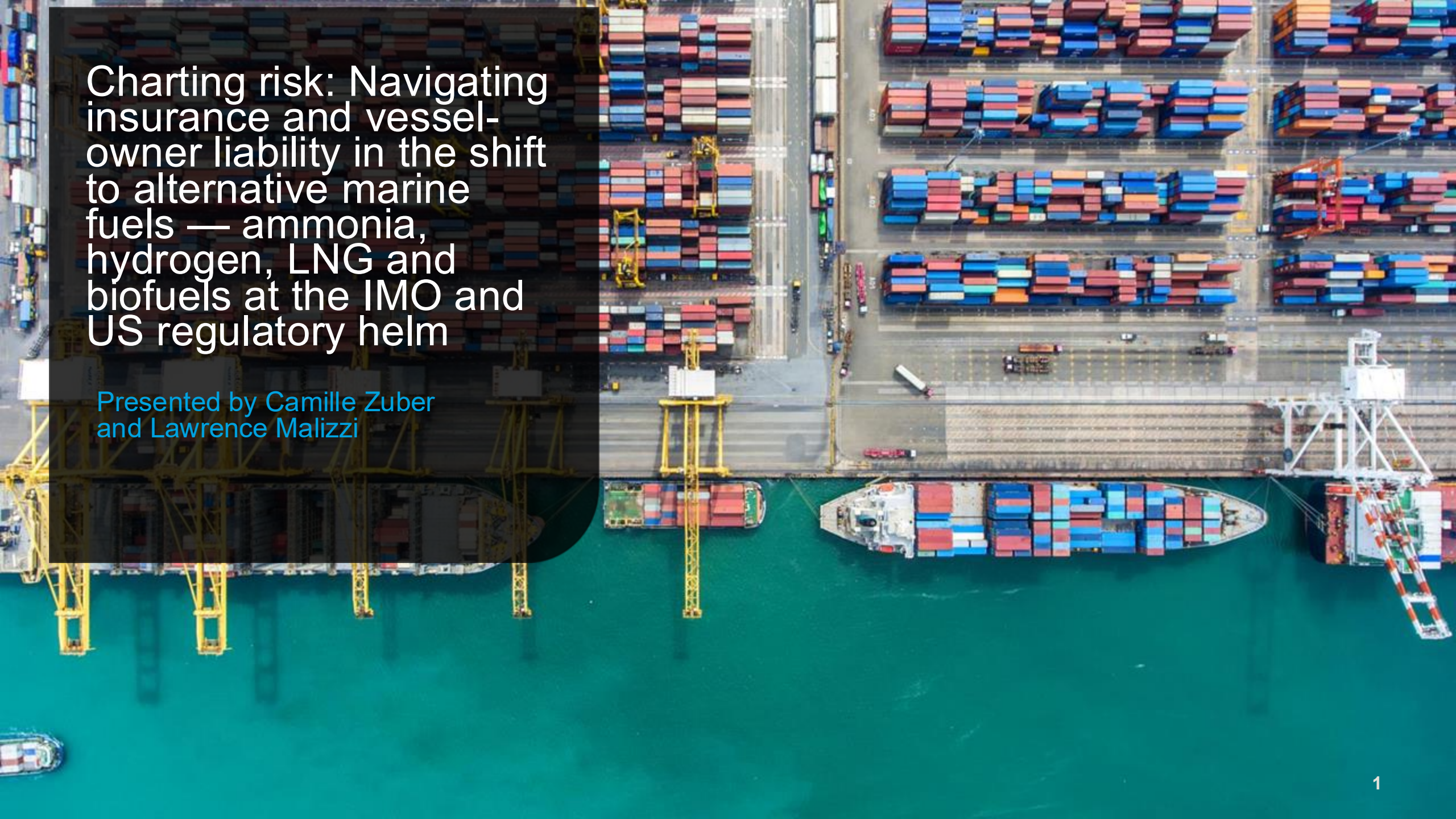


Charting risk: Navigating insurance and vessel-owner liability in the shift to alternative marine fuels — ammonia, hydrogen, LNG and biofuels at the IMO and US regulatory helm

Presented by Camille Zuber and Lawrence Malizzi

LOS ANGELES, CA

Camille L. Zuber

Senior Associate at Nicoll Black Altenbrun & Feig

UK/French/Norwegian trained attorney, barred in CA

- International & cross-state litigation, commercial, business, and maritime (fluent in English, French & Italian)
- Maritime & commercial regulatory work (OFAC, FMC)
- Maritime defense litigation (P&I, cargo, environmental, shipowners, terminal operators, property damage, personal injury…)
  - Oil spill response & litigation;
  - International maritime & commercial litigation;
  - Recreational vessels (yachts) transactional work
  - OFAC/FMC regulatory work
  - Personal Injury defense litigation
  - Fishing vessels claims & litigation

NBA&F

CTEH®

ELKTON, MD

Lawrence Malizzi

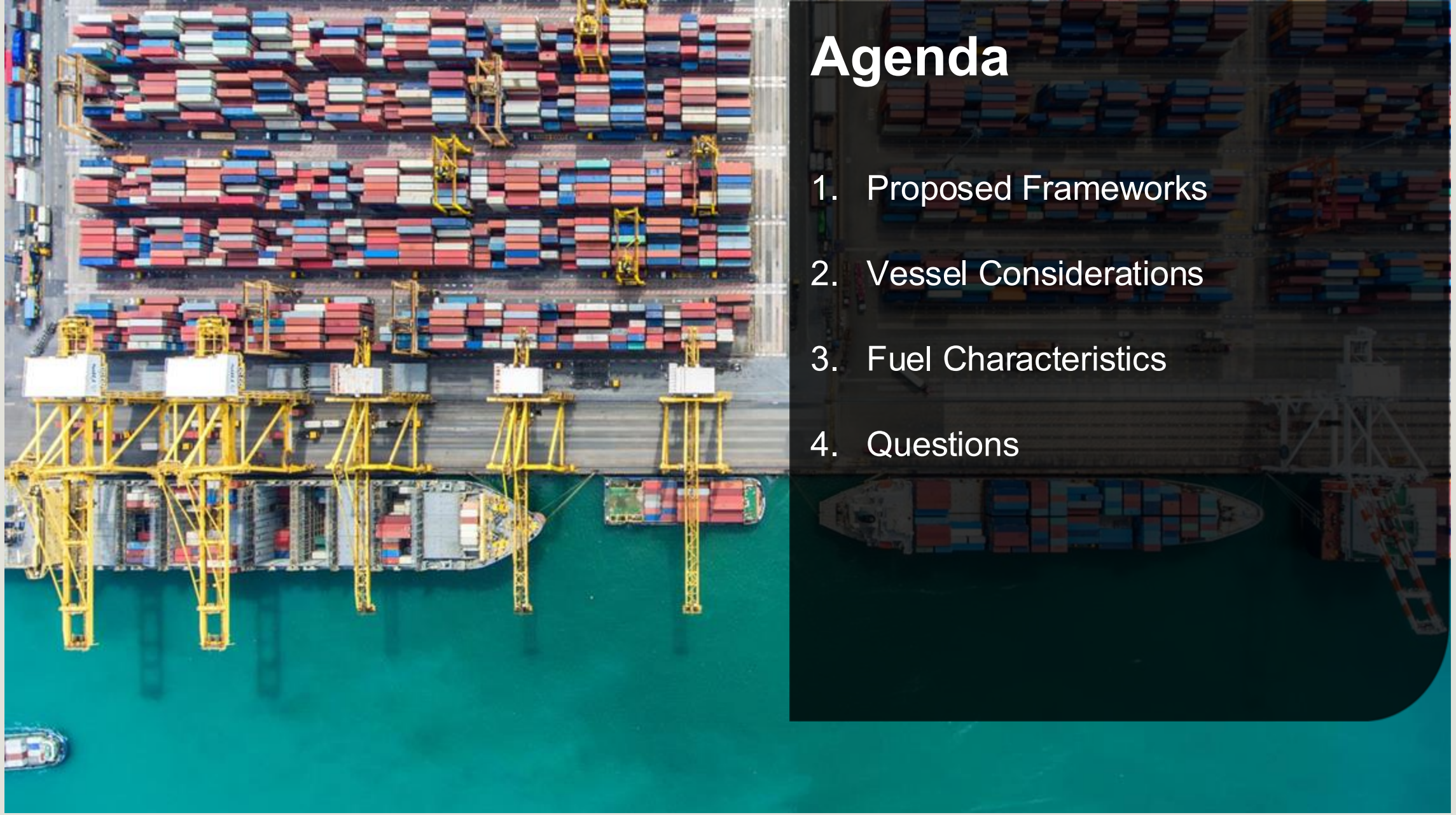
Senior Consultant

35+ years of industry experience

- Environmental Expert
- Specializes in emergency response
- Areas of Expertise:
  - Oil and Chemical Response
  - Remediation
  - Natural Resource Damage Assessment
  - Endangered Species
  - Habitat Restoration

NBA&F

CTEH®

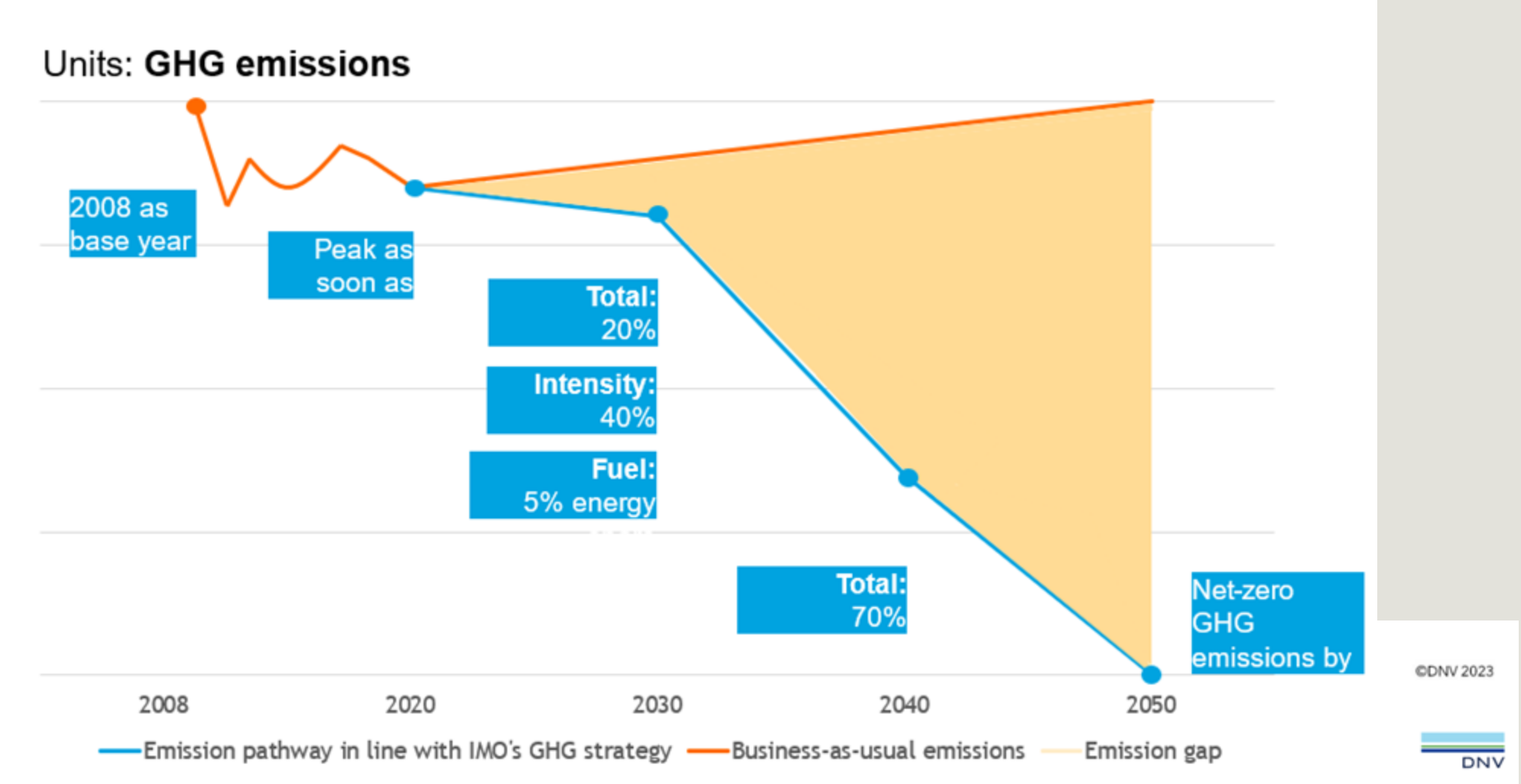


Agenda

1. Proposed Frameworks
2. Vessel Considerations
3. Fuel Characteristics
4. Questions

Proposed Frameworks

Strengthened IMO strategy on GHG reductions



Total: Well-to-wake GHG emissions; **Intensity:** CO2 emitted per transport work; **Fuel:** Uptake of zero or near-zero GHG technologies, fuels and/or energy sources

IMO – NET-ZERO/CARBON FEE APRIL 11, 2025, REGULATION

MEPC 83 / October 2025 Adoption / Spring 2026 Detailed Implementation / 2027 Entry Into Force

- **IMO Approval**: Mandatory marine fuel standards and GHG emissions pricing for shipping on April 11, 2025. Vessels will be required to progressively reduce their annual GFI (emissions per unit of energy used)
- **Implementation Timeline**:
  - Formal adoption expected in October 2025.
  - Measures to enter into force by late 2027.
- **Impact on Vessels**:
  - Applies to large ocean-going vessels over 5,000 gross tonnage
  - (approx. 85% of CO_2 emissions from international shipping).
- **New Regulations**:
  - The IMO Net-Zero Framework will be added as a new Chapter 5 to Annex VI
  - Introduces emissions limits and a carbon pricing mechanism.
  - Fees range from $100 to $380 per ton of CO_2 emitted above the thresholds.
- **Options for Compliance**: Ships exceeding emissions caps can:
  - Purchase unused allowances from lower-emitting vessels.
  - Contribute to the IMO Net-Zero Fund, which supports low-carbon fuel development and climate resilience for vulnerable small island nations.
- **Revenue Generation**: The initiative could generate $10 to $13 billion annually
- **Full Enforcement**: Expected by 2028.

U.S. RESPONSE TO THE IMO's NET-ZERO/CARBON FEE APRIL 11, 2025 - August 12, 2025

- *"President Trump has made it clear that the United States will not accept any international environmental agreement that unduly or unfairly burdens the United States or harms the interests of the American people. This October, members of the International Maritime Organization (IMO) are poised to consider the adoption of a so-called "Net-Zero Framework," aimed at reducing global greenhouse gas emissions from the international shipping sector.*
- *Whatever its stated goals, the proposed framework is effectively a global carbon tax on Americans levied by an unaccountable UN organization. These fuel standards would conveniently benefit China by requiring the use of expensive fuels unavailable at global scale. These standards would also preclude the use of proven technologies that fuel global shipping fleets, including lower emissions options where U.S. industry leads such as liquified natural gas (LNG) and biofuels. Under this framework, ships will have to pay fees for failing to meet unattainable fuel standards and emissions targets. These fees will drive up energy and transportation and leisure cruise costs. Even small vessels would incur millions of dollars in fees, directly driving up costs for American consumers.*
- *The Trump Administration unequivocally rejects this proposal before the IMO and will not tolerate any action that increases costs for our citizens, energy providers, shipping companies and their customers, or tourists. We will fight hard to protect the American people and their economic interests. Our fellow IMO members should be on notice that we will look for their support against this action and not hesitate to retaliate or explore remedies for our citizens should this endeavour fail."*

https://www.state.gov/releases/office-of-the-spokesperson/2025/08/joint-statement-on-protecting-american-consumers-and-shipping-industries-by-defeating-the-international-maritime-organizations-net-zero-framework-aka-global-carbon-tax

NBA&F

CTEH®

IMO Fails to Adopt and Adjourns for One Year the Net-Zero Framework

IMO at the end of a contentious week adjourned the vote on the Net-Zero Framework for one year (IMO)

PUBLISHED OCT 17, 2025 4:34 PM BY **THE MARITIME EXECUTIVE**

IMO safety regulatory framework to support the reduction of GHG emissions from ships using new technologies and alternative fuels

Safety codes and interim guidelines for new alternative fuels	
LNG (the IGF Code)	2017 entered into force
Methyl/ethyl alcohol	2020 approved Interim Guidelines
Fuel cells	2022 approved Interim Guidelines
LPG	2023 approved Interim Guidelines
Ammonia	2024 approved Interim Guidelines *Note also: use of ammonia cargo as fuel on gas carriers to be allowed as from 1 July 2026*
Hydrogen	2026 expected to be approved
Low-flashpoint oil fuels	2026 estimated finalization

The current IMO legislative framework

LNG - Code of Safety for Ships using Gases or Other Low Flashpoint Fuels (“IGF Code”)

- A comprehensive regulatory framework to facilitate the safe use of LNG as fuel, which aims to provide an international standard for ships, other than vessels (gas carriers), operating with different fuels.

Draft Interim guidelines for the safety of ships using hydrogen as fuel

- Currently developed by the IMO
- Goal-based and provide provisions for the arrangement, installation, control and monitoring of machinery, equipment and emergency systems using hydrogen as fuel in order to minimize the risk
- Will focus on both compressed and liquefied hydrogen forms

Draft Interim guidelines for ships using ammonia as fuel

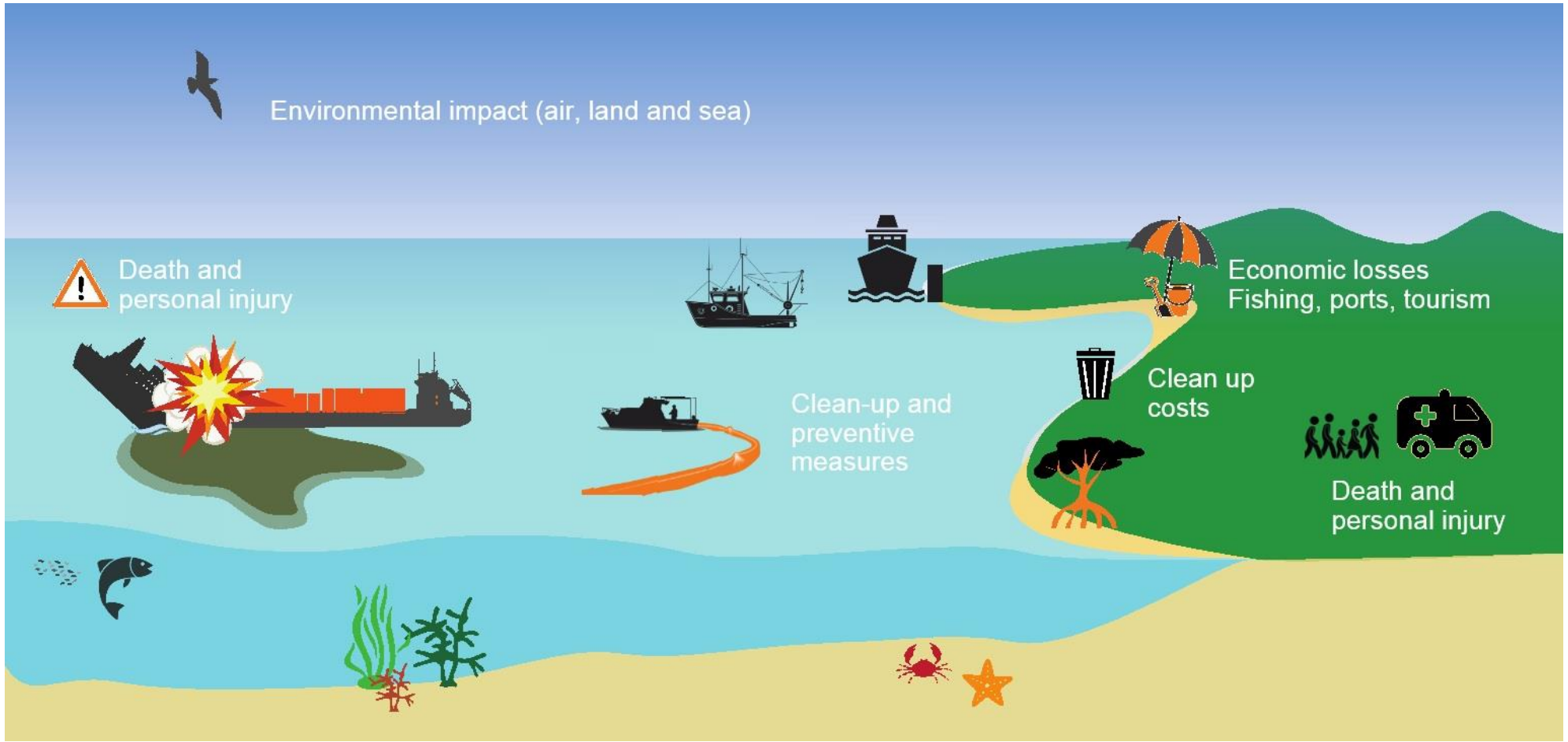
- In December 2024, the Maritime Safety Committee at the IMO approved interim guidelines for the safe use of ammonia as a marine fuel.
- A core focus of the guidelines is the application of inherently safer design principles to minimize ammonia release risks.

Biofuels - MARPOL Annex VI Regulation 13

- On June 10, 2022, the Marine Environment Protection Committee approved Unified Interpretations (UIs) of Regulation 18.3 of MARPOL Annex VI, simplifying the use of biofuels on board ships.

IMO Hazardous & Noxious Substances Convention

- Not Entered Into Force / Adopted 2010



https://www.leadership-indonesia.com/public/training/2_HNS%20Training

OPA

- The Oil Pollution Act's key provisions apply to discharges of "oil," as defined by statute. 33 U.S.C. § 2701(23) defines **"oil"** broadly as:

"oil of any kind or in any form, including petroleum, fuel oil, sludge, oil refuse, and oil mixed with wastes".

- Crucially, this definition **excludes** any substance **specifically listed** as a hazardous substance under CERCLA (§ 101(14)(A)–(F)), even if it is petroleum-based:
  - **Ammonia**: Ammonia is **not petroleum based** and is instead classified as a hazardous substance under CERCLA § 101(14)(B), making it **explicitly excluded** from OPA's coverage. Thus, discharges of ammonia are **not covered** by OPA liability.
  - Neither **LNG** nor **Hydrogen** are solely petroleum-derived and therefore cannot meet the definition of oil under OPA.
  - **Biofuels**: Biofuels that are derived from petroleum or petroleum mixed with wastes are included in OPA's definition. Under OPA 90, biofuels like fatty acid methyl esters (FAME) are regulated as "oil." However, purely **biogenic fuels** (like ethanol or biodiesel produced from biomass) may **not fall within** OPA's scope unless they meet the petroleum-based criteria. The analysis depends on whether the fuel qualifies as "oil mixed with wastes" under § 2701(23).

CERCLA (Comprehensive Environmental Response, Compensation, and Liability Act)

- CERCLA hazardous substances are listed in 40 C.F.R. § 302.4 (including various pollutants and waste streams), or designated by EPA under CERCLA § 102(a):
  - FAME and *similar biodiesel components* are not currently deemed hazardous substances: FAME—derived from vegetable or animal oils—is not on the CERCLA list, nor has EPA designated it as a hazardous substance under § 102(a).
  - Safety data sheets for B99 biodiesel explicitly state that the fuel "does not contain any substances regulated as hazardous substances under … CERCLA".
  - EPA's "petroleum exclusion" under CERCLA § 101(14) excludes crude oil and its fractions (including indigenous hazardous compounds); however, additives added after refining are not excluded by the EPA. Since FAME/similar biofuels are synthesized after refining and not listed as a designated hazardous substance, it remains outside CERCLA's purview.

CERCLA (Comprehensive Environmental Response, Compensation, and Liability Act) cont.

- The definition of a hazardous substance in CERCLA excludes LNG/LPG products. CERCLA includes an express exclusion for LNG, as well as the so-called petroleum exclusion, which covers LPG.
- Hydrogen is not currently listed as a CERCLA hazardous substance.
- Ammonia is considered a hazardous substance under CERCLA. Specifically, it's listed with a reportable quantity (RQ) of 100 pounds under CERCLA. This means that if a facility releases 100 pounds or more of ammonia, it must be reported to the National Response Center. Additionally, ammonium hydroxide, a solution of ammonia in water, is also listed under CERCLA, but with a higher RQ of 1,000 pounds.

That said, EPA has recently begun designating new substances—e.g., PFOA and PFOS—as hazardous under CERCLA, demonstrating that future expansions are plausible. But as of now, FAME, Hydrogen, and LNG are not regulated as a hazardous substance under CERCLA.

Migratory Bird Treaty Act (1918) (16 U.S.C. 703-712)

Migratory Bird Treaty Act (MBTA)

- The Migratory Bird Treaty Act (MBTA) of 1918 prohibits the unauthorized "take" (which includes killing, harming, or capturing) of protected migratory bird species listed by the US Fish and Wildlife Service. The MBTA applies regardless of intent, meaning even accidental or incidental harm—such as bird deaths caused by pollution, oil spills, alternative fuels or industrial operations—can trigger liability.

- It does not matter how the bird was killed; whether from oil, alternative fuels, or any other cause, if a company's actions result in the death of a protected bird, it can be held liable. The law has historically imposed strict liability.

- Under this strict liability framework, companies or individuals may face criminal penalties if their actions—or even failures to act—result in the death of a protected migratory bird. Penalties can include misdemeanor fines of up to $15,000 per bird killed and up to six months in prison per offense. For more egregious, intentional violations, felony charges can carry fines up to $250,000 for individuals or $500,000 for organizations under 16 U.S.C. § 707.

Migratory Bird Treaty Act (MBTA) – Cont.

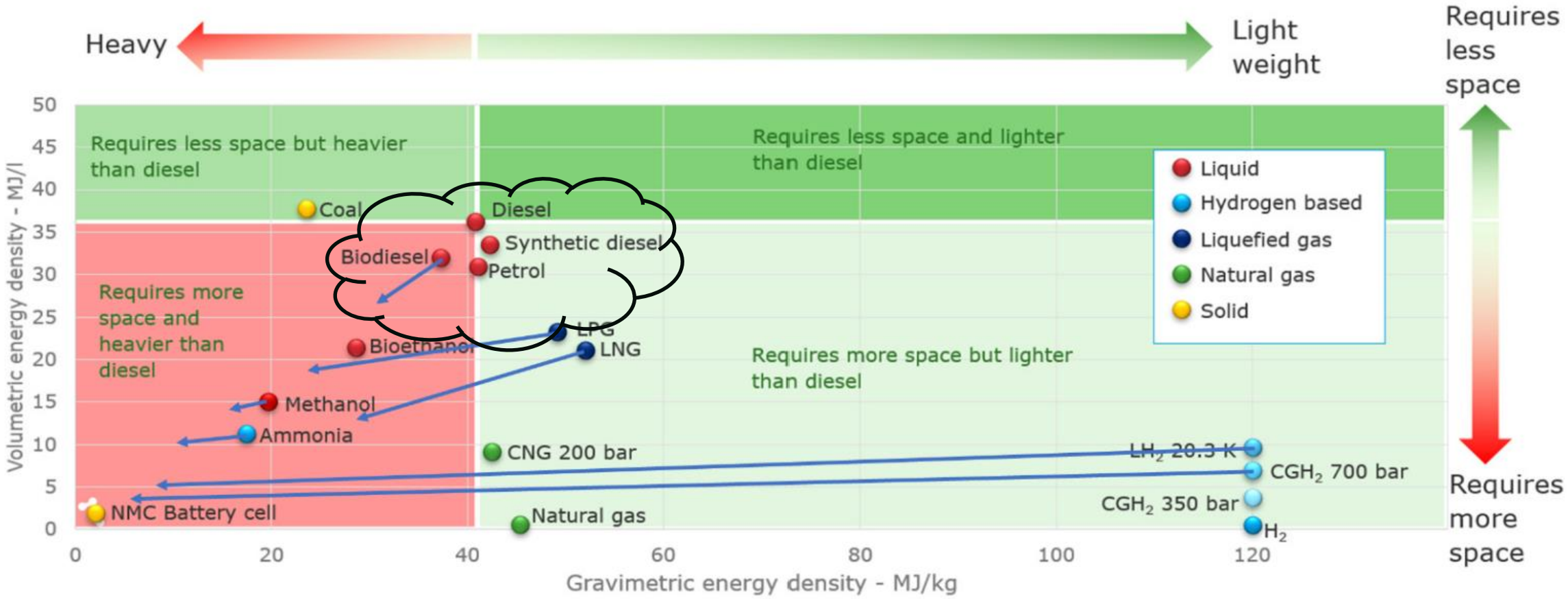
- **Federal-Level:**
- 2021 (Biden Administration): Reinstated interpretation that MBTA covers incidental take.
- April 11, 2025 (Trump Administration): DOI M-Opinion repeals prior guidance and restores position that MBTA applies only to intentional take.
  - Shift driven by Unleashing American Energy Executive Order directing agencies to rescind “unduly burdensome” regulations, with a one-page, April 11, 2025, legal opinion (M-37085) reversing to only prohibit intentional take.
- Reinforced by Zero-Based Regulatory Budgeting to Unleash American Energy:
  - Requires agencies to offset new regulations by eliminating existing ones
  - Imposes sunset provisions—many regulations must expire unless affirmatively renewed
  - Encourages periodic reassessment of regulatory necessity and cost
- **State-Level Overlay (California):**
- California Migratory Bird Protection Act establishes independent state liability, prohibiting take or possession of migratory birds (including incidental take), effectively preserving broader protections regardless of federal rollback. Assembly Bill (AB) 454.

Vessel Considerations

Vessel Design Impacts

- Weight Impacts - stability/vessel size & arrangements
- Fuel Storage Volume
- Cargo capacity impacts
- Operational Costs
- Personnel/Environmental Risk
- Availability of Fuels

Alternative Fuels For Existing Vessels

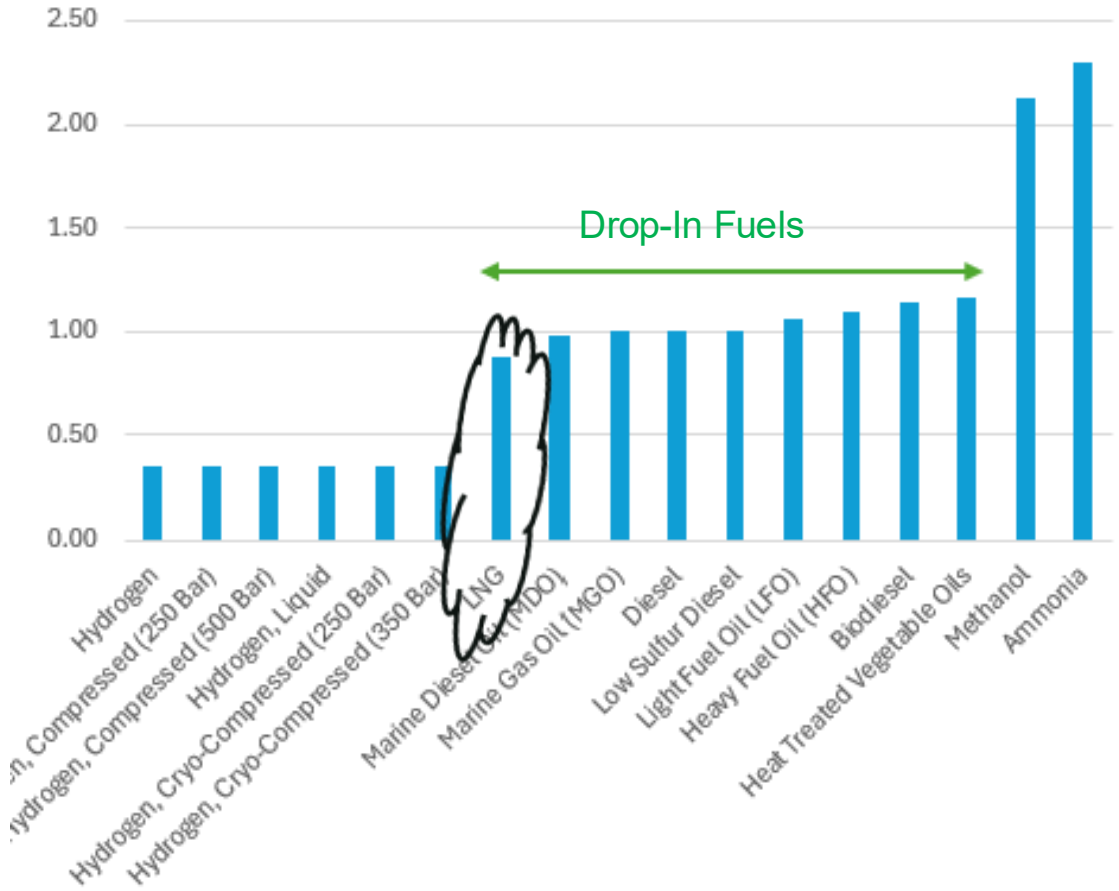


Ref: DNV Report 2019-0567, Rev 3, Comparison of Alternative Marine Fuels, p. 5

NBA&F Thornton Tomasetti CTEH

Fuel Weight Comparison

For Identical Energy Content



For the same range, fuel weight:

- LNG = 0.9 x diesel
- Methanol = 2.1 x diesel
- Ammonia = 2.3 x diesel
- Hydrogen = 0.4 x diesel

Not including additional space required for toxic, cryogenic, corrosive, flammable or explosive fuel.

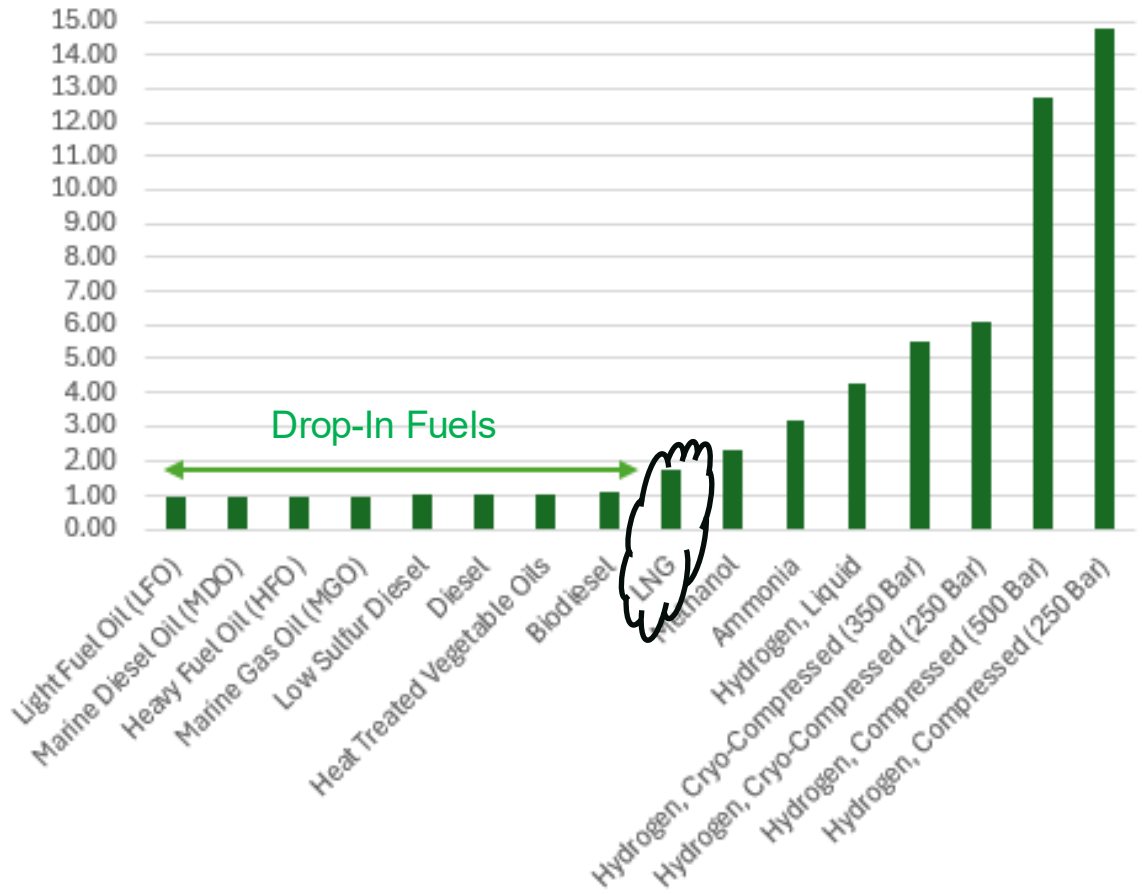
NBA&F

Thornton Tomasetti

CTEH

Fuel Volume Comparison

For Identical Energy Content



For the same range, fuel volume:

- LNG = 1.7 x diesel
- Methanol = 2.2 x diesel
- Ammonia = 3.1 x diesel
- Hydrogen = 4.2 x diesel (or more)

Not including additional space required for toxic, cryogenic, corrosive, flammable or explosive fuel.

NBA&F

Thornton Tomasetti

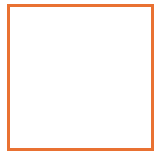
CTEH®

How do volume differences affect the design of the vessel?

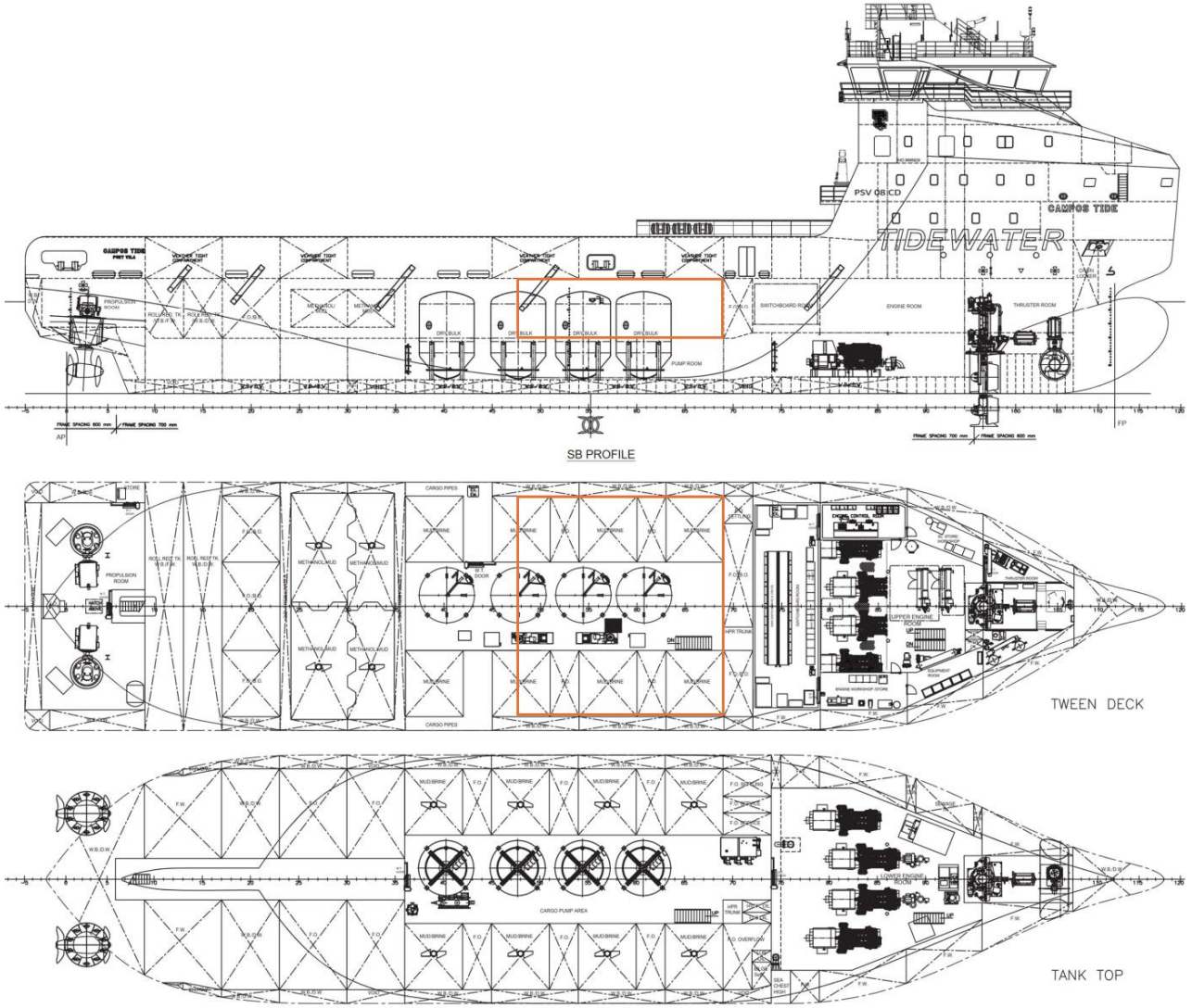
Platform Supply Vessel (PSV)

Diesel Volume in Single Tank

Fuel Tanks



Ref: Tidewater STX PSV 08

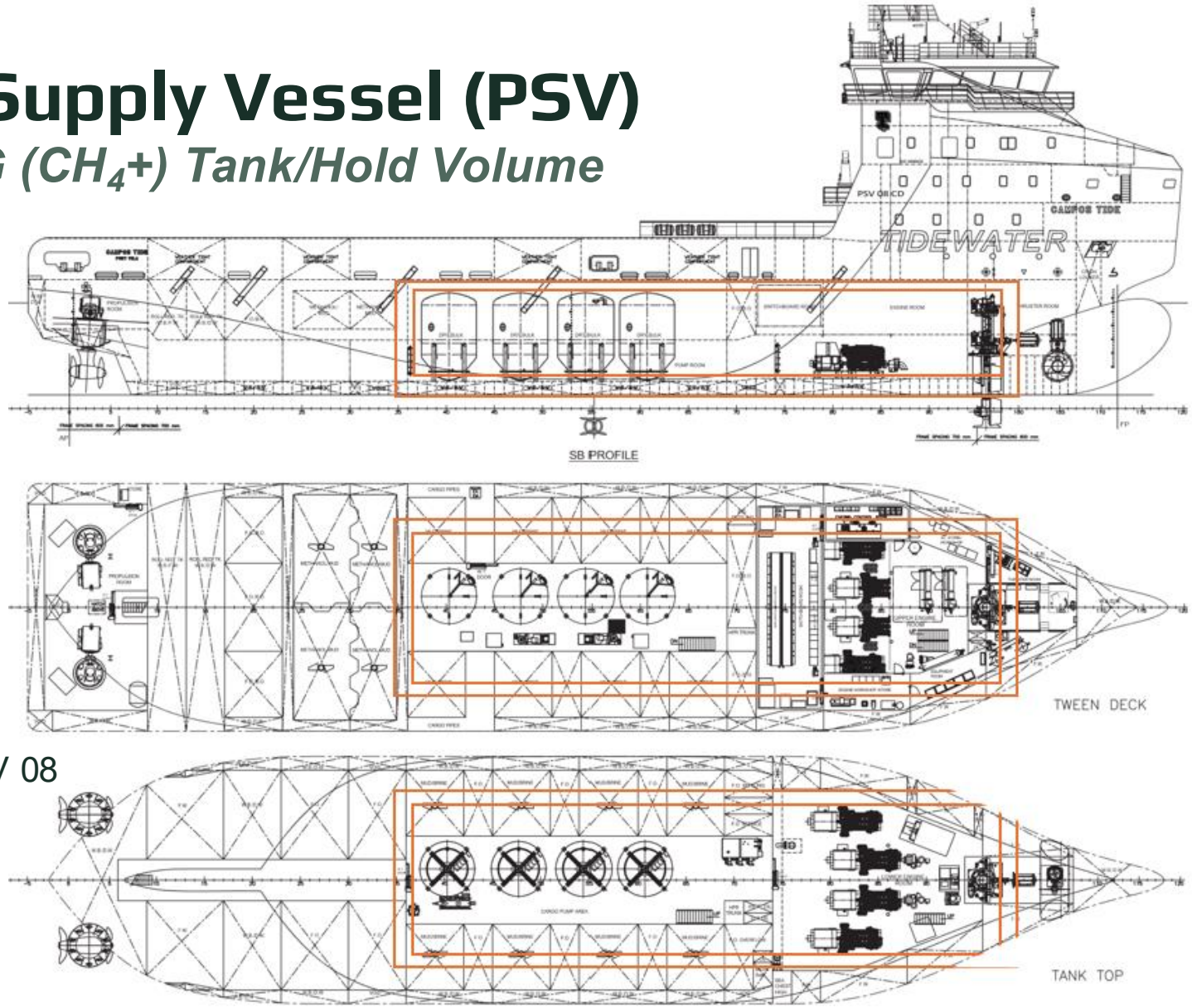


Platform Supply Vessel (PSV)

Equivalent LNG (CH_4+) Tank/Hold Volume

Fuel Tanks

Engine Room



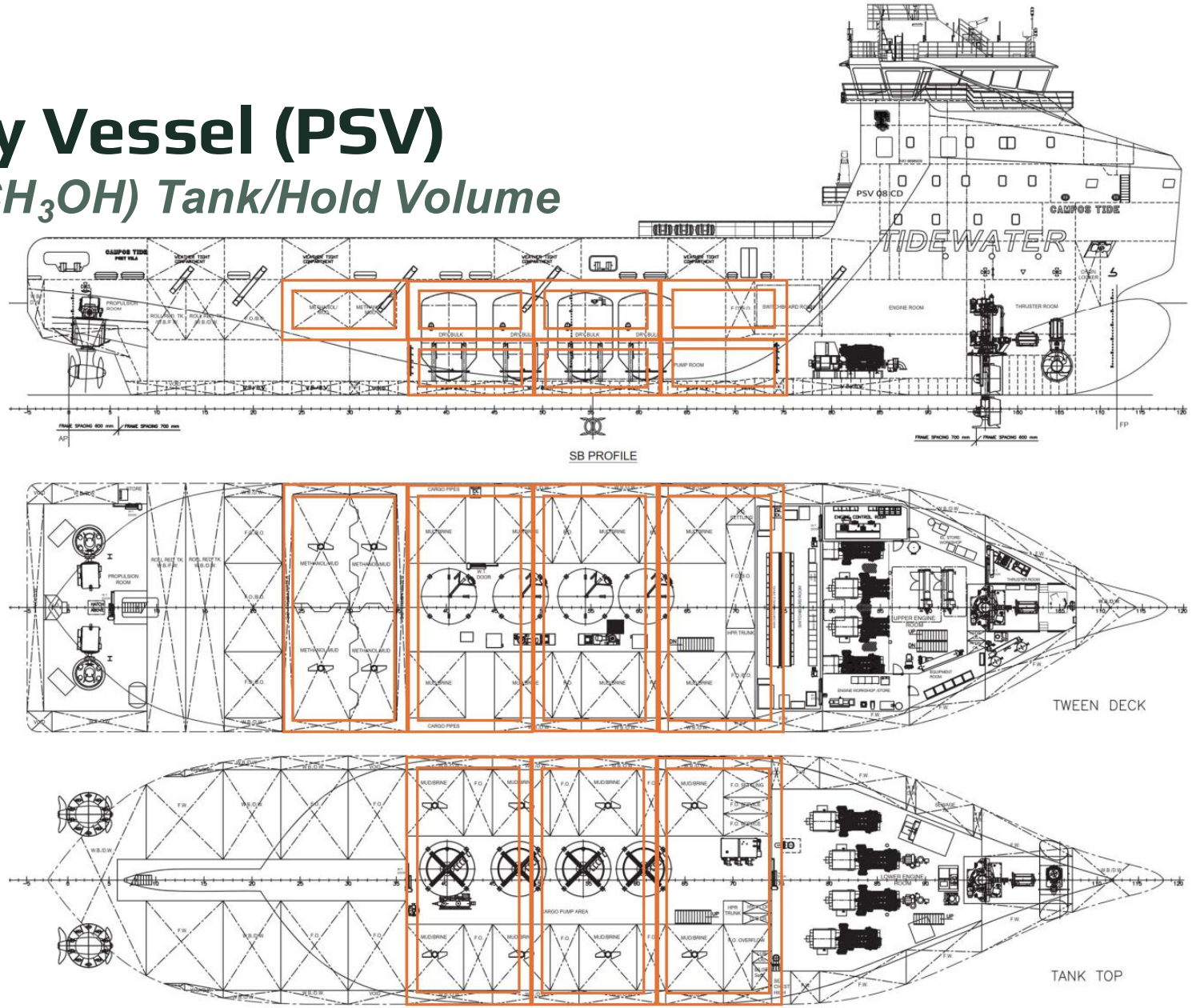
Ref: Tidewater STX PSV 08

Platform Supply Vessel (PSV)

Equivalent Methanol (CH_3OH) Tank/Hold Volume

Ref: Tidewater STX PSV 08

Fuel Tanks

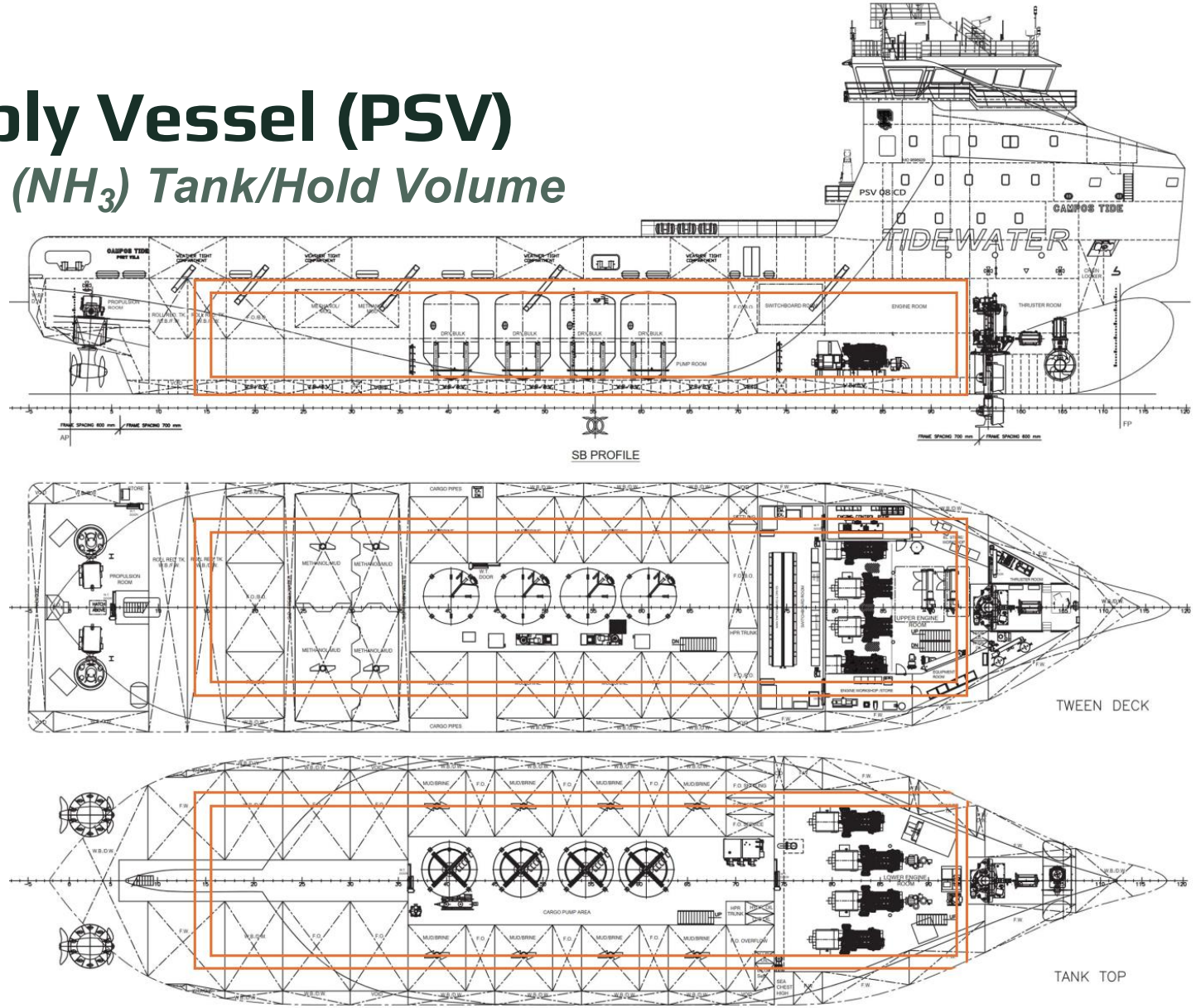


Platform Supply Vessel (PSV)

Equivalent Ammonia (NH_3) Tank/Hold Volume

Fuel Tanks

Ref: Tidewater STX PSV 08

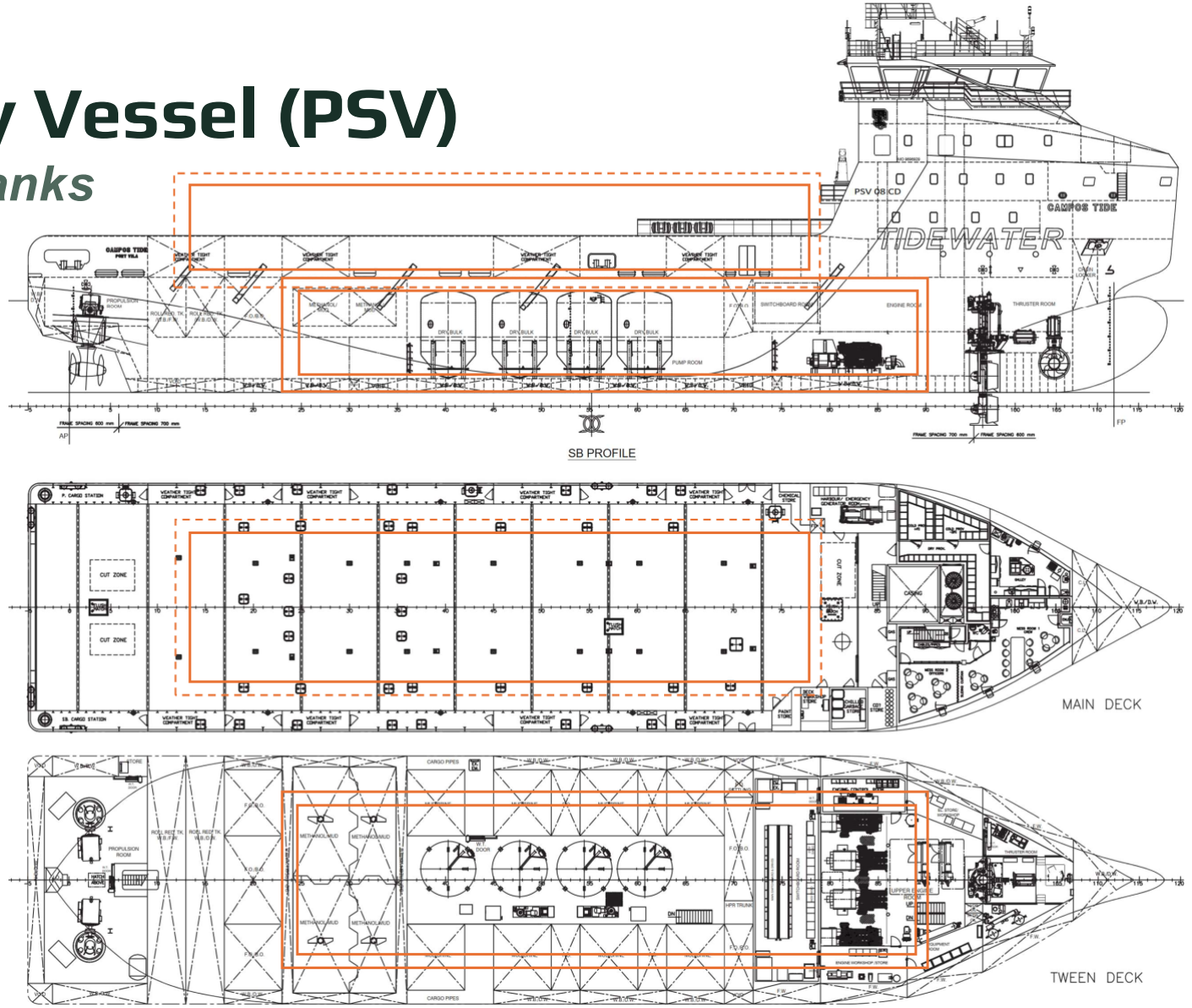


Platform Supply Vessel (PSV)

Liquid Hydrogen (H_2) Tanks

Fuel Tanks

Ref: Tidewater STX PSV 08



New Vessels – Characteristics of Alt fuels – risk identification & physical/operational changes to address

- Confined spaces…increased toxic / asphyxiation and explosion risks.

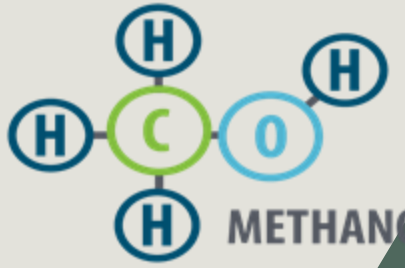
Fuel	Features	Toxic / Asphyx. Risk	Fire Risk	Explosion Risk
Liquid Hydrogen	Cryogenic liquid, low ignition energy, detonation potential, asphyxiation, invisible flame,	M	H	VH
LNG	Cryogenic liquid, flammable, explosion potential, asphyxiation	M	H	H
Methanol	Volatile liquid, flammable, highly toxic, explosion potential, invisible flame	H	H	M
Ammonia	Low volatility liquid, highly toxic, flammable	VH	L	L
Biodiesel	Low volatility liquid, flammable	L	M	L

Fuel Characteristics

Alternative fuels and their associated risks

Fuel & associated risks from the four different fuels

Ammonia Hydrogen LNG Biofuels Methanol

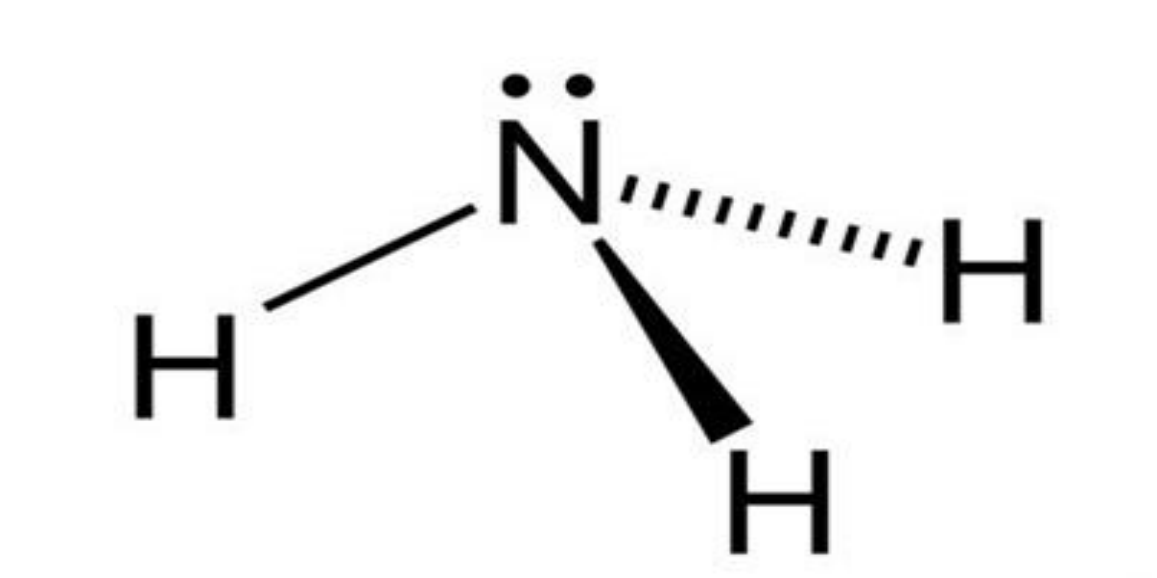


https://www.shimadzu.com/an/industries/new-energy/fuel-cells/index.html
https://www.energyintel.com/0000017f-1b41-d1ad-afff-bf77b78b0000
https://mykn.kuehne-nagel.com/news/article/cma-cgm-reports-exceptional-financial-year-de-06-Mar-2023
https://www.marinebusinessworld.com/news/248708/New-class-of-hydrogen-ship-design

NBA&F

CTEH®

Ammonia



Public Health Considerations:

- Very irritating gas: coughing, throat irritation, skin and eye irritation
  - Although it is colorless, its pungent odor provides early warning of its presence
- High concentrations can be fatal (pulmonary edema) and limit one's ability to escape a spill area
- Acute exposure 5,000–10,000 ppm is rapidly fatal in humans and exposure to 2,500–4,500 ppm is fatal in about 30 minutes (HEALTH EFFECTS - Toxicological Profile for Ammonia - NCBI Bookshelf (nih.gov))
- Flammable: gas presents an explosive hazard in confined spaces

Environmental Considerations:

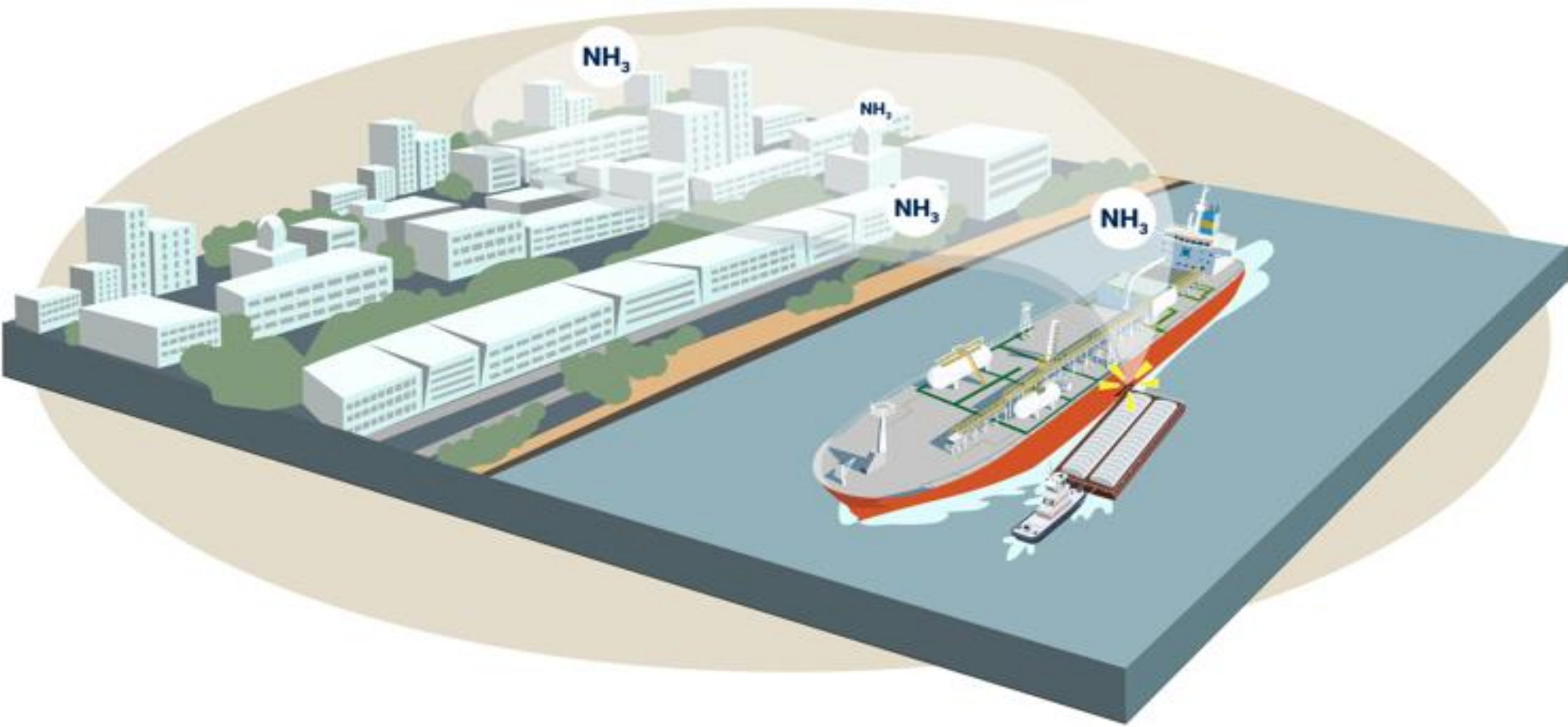
- Highly soluble in water (70% of a surface spill volume will go into solution with water)
  - Liquid ammonia that does not contact water will rapidly volatilize
- Toxic to aquatic life (formation of ammonium hydroxide generates heat, increases water pH)
- Fish kills have been reported even in smaller spills
- Can contaminate drinking water sources

https://www.pngegg.com/en/png-tmyis
https://www.offshore-energy.biz/japan-to-launch-first-ammonia-fueled-ammonia-gas-carrier-in-2026/

NBA&F

CTEH®

U.S. East Coast green ammonia bunkering plan in the works - Marine Log

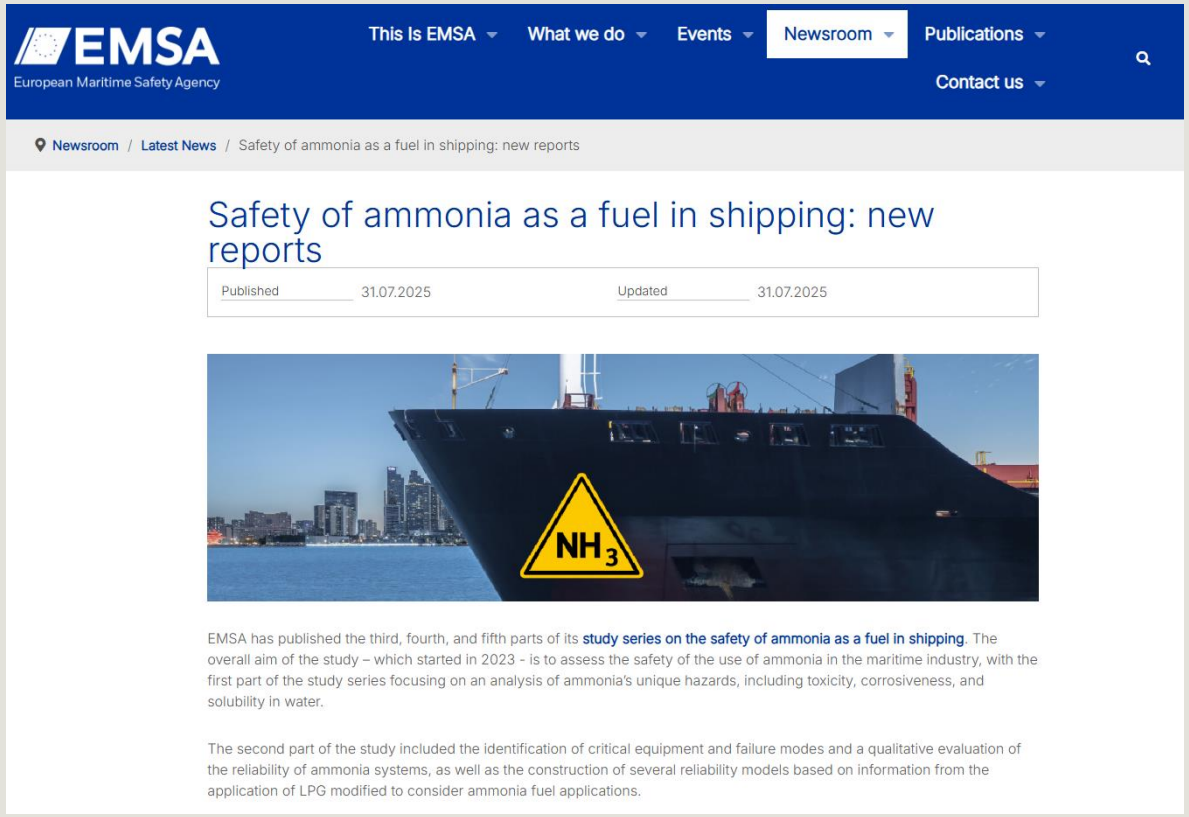

NH_3
NH_3
NH_3
NH_3

Ammonia Tugboats

https://www.offshore-energy.biz/nyk-to-convert-lng-fueled-tugboat-to-ammonia/ (Japan)

https://go.amogy.co/en/amogys-ammonia-powered-tugboat (NY - Inland Waterways)

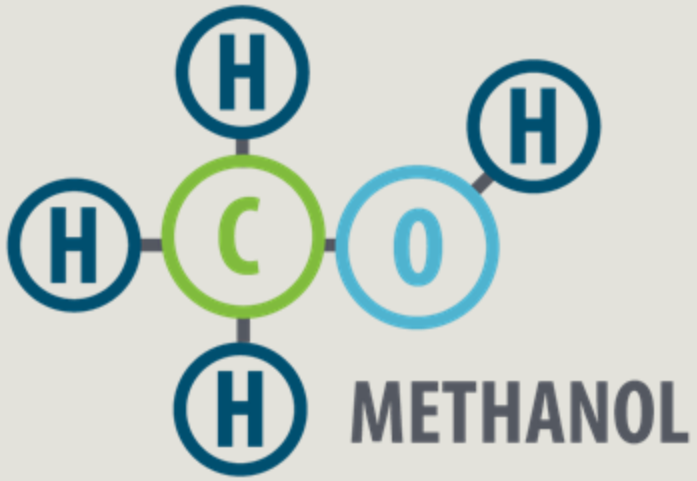
European Maritime Safety Agency



https://www.emsa.europa.eu/newsroom/latest-news/item/5532-safety-of-ammonia-as-a-fuel-in-shipping-new-reports.html

https://www.emsa.europa.eu/safety-of-alternative-fuels/ammonia.html

Methanol



Public Health Considerations:

- **Flammability (primary concern)** : highly flammable, denser than air (vapors accumulate close to the ground), and produces nearly invisible flames in daylight
- Acute effects: vapors can cause headache, dizziness, nausea, and central nervous system depression (hundreds of ppm)
- Methanol also metabolizes to formic acid - causes severe acidosis + organ/tissue damage
  - Ingesting as little as 10 mL can cause permanent blindness by destruction of the optic nerve (ingestion of 30 - 100 mL is potentially fatal).
  - Because of its toxic properties, methanol is frequently used as a denaturant additive for ethanol manufactured for industrial uses.

Environmental Considerations:

- Relatively lower risk of environmental impact vs. other fuels
- Fully miscible with seawater and biodegradable; it spreads briefly on surface then dissolves into water column.
- Dissolved oxygen depletion from biodegradation is the main concern for fish / invertebrates
  - Microbes break it down to CO_2 and H_2O, which consumes oxygen.
  - Controlled dilution/dispersion + aeration to protect dissolved oxygen
- Vapor clouds can pool near the water surface and flash back. Manage ignition sources!
- Can contaminate drinking water sources

https://www.pngegg.com/en/png-tmyis
https://www.offshore-energy.biz/japan-to-launch-first-ammonia-fueled-ammonia-gas-carrier-in-2026/

CMA CGM adds another methanol-powered vessel to its fleet as it continues to work towards the goal of reaching around 150 low-carbon vessels by 2029. Pictured: The naming ceremony of the *CMA CGM Antigone*, a 15,000-teu methanol-fueled container vessel, in China on 11 December.

Monday, March 31, 2025

CMA CGM Signs Green Methanol Agreement

GENERAL INFORMATION

- **CMA CGM, SIPG Energy, and Shanghai Electric Group join forces to create a sustainable green methanol supply chain.**
- **This collaboration will play a crucial role in realizing CMA CGM's decarbonization goals.**
- **CMA CGM takes a partnership approach and aims to work with partners in shaping a greener future in shipping and logistics!**

On March 20, 2025, CMA CGM, a global leader in sea, land, air, and logistics solutions, formally signed a landmark Green Methanol Long Term Supply Cooperation Agreement to develop a fully integrated green methanol value chain. This collaboration underscores CMA CGM's leadership in maritime decarbonization and strengthens our partnership with major Chinese partners.

Pioneering a Net-Zero Future in Global Shipping

Under this agreement, Shanghai Electric Group will provide mid-to-long-term green methanol fuel supply for CMA CGM. In partnership with SIPG, green methanol will be transported via land-sea combined logistics from production base in Taonan to Shanghai Yangshan Port, the world's largest container port.

Firmly committed to the energy transition in shipping and a pioneer in its use of alternative fuels, the CMA CGM Group has set a Net Zero-Carbon target for 2050. Last month, CMA CGM IRON, the Group's first dual-fuel methanol vessel just set sails. With a container capacity of 13,000 TEUs, it is the first of 12 new dual-fuel methanol vessels planned by CMA CGM.

https://www.cma-cgm.com/local/china/news/148/cma-cgm-signs-green-methanol-agreement

CMA CGM ANTIGONE is the lead ship of CSSC Jiangnan Shipyard's independently designed "Kun" series of 15,000 TEU-class methanol dual-fuel container ships. With an overall length of 366 meters, the vessel represents a new generation of large container ships that combine high operational efficiency with significantly reduced environmental impact. Powered by methanol dual-fuel propulsion, the vessel achieves substantial reductions in nitrogen oxide (NOx) emissions and near elimination of sulfur oxide (SOx) emissions, enabling early compliance with the International Maritime Organization's (IMO) 2030 emissions reduction targets.

Ahead of the project launch, BV assembled a dedicated team of gas-carrier and alternative-fuel experts to provide specialized training for BV surveyors and the client's project team and assessed forthcoming international regulations to facilitate early and future compliance. During design review, BV worked closely with Jiangnan Shipyard to optimize structural arrangements and fuel system integration, using advanced simulation tools to meet safety requirements while controlling lightship weight.

In accordance with BV's Rules for Methanol & Ethanol Fueled Ships, BV provided technical review and risk assessment for key areas including ship design and fuel system safety. During construction, BV surveyors applied refined process control and data-driven monitoring and conducted targeted inspections of fire safety, ventilation, and explosion-proof systems, reinforcing the vessel's inherent safety.

https://marine-offshore.bureauveritas.com/newsroom/bureau-veritas-classes-its-first-methanol-dual-fueled-container-ship-cma-cgm-antigone

LNG

Public Health Considerations:

- Liquefied natural gas (LNG) is natural gas that has been cooled to a liquid state (liquefied), to about -260° Fahrenheit, for shipping and storage
  - Liquid volume is 600 times smaller than gas volume, making it viable as a transportation fuel
- Direct contact with spilled LNG can cause frostbite/burns
- Inhalation of high concentrations of LNG vapors may cause CNS depression (nausea, headache, dizziness)
- As LNG evaporates, it can rapidly displace oxygen in low-lying areas or confined spaces (asphyxiation hazard!)
- Methane in LNG vapors can ignite

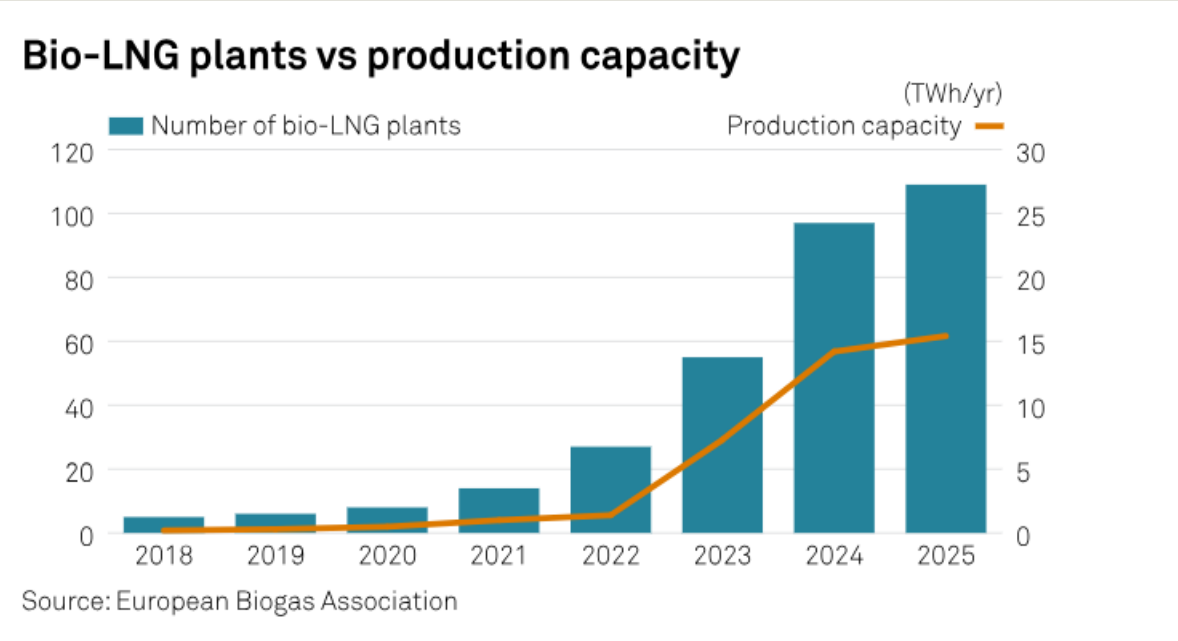
Environmental Considerations:

- Highly volatile (less persistent); visible dense vapor cloud forms on water
- When accidentally spilled to water, it is known to sometimes undergo a localized vapor explosion known as rapid phase transition (RFT).
- LNG is not particularly toxic, but its rapid volatilization from water could deplete oxygen and harm marine life.

https://www.compliancesigns.com/pd/lng-reflective-label-for-liquified-natural-gas-nhe-50737-blu
https://www.technologyreview.com/2024/02/06/1087728/we-are-having-the-wrong-debate-about-bidens-decision-on-liquefied-natural-gas/

Bio-LNG & Methane – E.U. Developments

- Growing EU regulatory and statutory frameworks — including **FuelEU Maritime** and the expanded **EU Emissions Trading System (EU ETS)** — are increasing in relative importance following developments in the IMO Net Zero Framework, prompting shipowners with LNG-capable vessels to seriously consider **bio-LNG** as a compliance and cost-management strategy.
- **Bio-LNG / Biomethane:** renewable, low-carbon fuels derived from organic waste (e.g., agricultural residues, manure, food waste) through anaerobic digestion and purification into biomethane, then liquefied into a drop-in alternative to fossil LNG. Compared with marine diesel and conventional LNG, bio-LNG offers significantly lower lifecycle greenhouse gas emissions — in some cases reducing emissions by up to ~80% — while requiring little to no engine modifications or new bunkering infrastructure.



EU ETS Augments Impact via Carbon Pricing

Parallel to FuelEU Maritime, the EU Emissions Trading System began phasing in maritime coverage in January 2024. Under the current schedule, shipping companies must surrender allowances covering 40% of their 2024 emissions, 70% of 2025 emissions, and 100% of emissions from 2026 onwards for voyages between EU ports and 50% of emissions for voyages departing from or arriving at EU ports from third countries.

With EU ETS allowance prices trading averaging €75/tonne CO_2 throughout 2025, the regulation imposes material operating costs on conventional fossil fuel consumption. Bio-LNG receives a zero-emissions factor under the ETS provided it meets the EU's Renewable Energy Directive sustainability criteria, creating immediate cost avoidance compared to fossil LNG.

Exhibit 2: Estimated Compliance Costs, Large Containership

Year	FuelEU Reduction GHG Target**	EUA Price (€)	FuelEU Fine, in € Million	Annual Fossil* OpEx, in € M	Annual Bio-LNG OpEx, in € M
2025	-2%	75	.64	20.1	5% bio-LNG: 20.5
2030	-6%	120	1.78	27.5	10% bio-LNG: 27.2
2035	-14.5%	170	4.2	34.1	20% bio-LNG: 30.2
2040	-31%	215	8.9	42.9	40% bio-LNG: 31.5

Source: Rabobank, Capstone analysis
*Fossil baseline is VLSFO
**compared to a 2020 baseline of 91.16 gCO2e/MJ

Hydrogen

Public Health Considerations:

- Like LNG, direct contact with spilled liquid hydrogen can cause frostbite/burns
- Hydrogen gas is highly flammable and can ignite easily, even from small sparks or static electricity
  - Gas is colorless, odorless, tasteless
  - Readily forms an explosive mixture in air
- It can also rapidly displace oxygen in confined spaces (asphyxiation hazard!)

Environmental Considerations:

- Highly volatile (less persistent); visible dense vapor cloud forms on water
- Similar to LNG, when accidentally spilled to water, liquid hydrogen may undergo a localized vapor explosion (RFT).

https://www.power-eng.com/gas/mcdermott-shell-nasa-working-together-on-liquid-h2-storage-demonstration/
https://energy-oil-gas.com/news/why-shipping-is-sink-or-swim-for-scope-3-in-oil-and-gas-by-kris-fumberger/

NBA&F

CTEH®

Biofuels

Public Health Considerations:

- Human health hazards depend on the biofuel type
- e.g., Biodiesel is a paraffinic fuel with physical properties similar to petroleum distillates, but without the more toxic aromatic compounds.
- Pyrolysis oils (bio-oils) may have higher levels of PAHs (naphthalene, phenanthrene, anthracene) that present a long-term hazard.

Environmental Considerations:

- Less volatile – will remain in liquid form under ambient conditions and can be expected to persist relatively longer in environment
- Will form an oily slick on water surface, over time the slick can oxidize and sink.
  - Biodegradable (local dissolved oxygen depletion)
- Aquatic toxicity being studied, limited studies show low toxicity to marine organisms (bio-oils likely more toxic)

https://www.miadvancedbiofuels.com/2023/11/new-michigan-advanced-biofuels-coalition-stakeholders-represent-land-air-and-sea/

Lithium Batteries

- **Chemicals/mixtures of concern will depend on the battery type and state of charge**
- **General chemicals of concern for lithium-ion battery fires include:**
  - Hydrogen fluoride (HF)
  - Hydrogen chloride (HCl)
  - Hydrogen cyanide (HCN)
  - Metals (lithium, cobalt, manganese, nickel)
  - Smoke particulate matter
  - Combustion products (e.g., CO, NO_x)
  - Volatile organic compounds (VOCs)

NBA&F

CTEH®

Lithium Batteries

Source of these chemicals of concern?

- **Asphyxiant gases - CO, CO_2 – combustion, incomplete combustion**
- **Irritant gases:**
  - **HF** – electrolyte salt ($LiPF_6$) and binder (PVDF)
  - **NO_x** – N_2 and O_2 reacting during high temp combustion
  - **SO_2** – sulfur-based additive for solid electrolyte interphase
  - **HCl** – separator or flame-retardant additives in packaging

NBA&F

CTEH®

Future ahead?

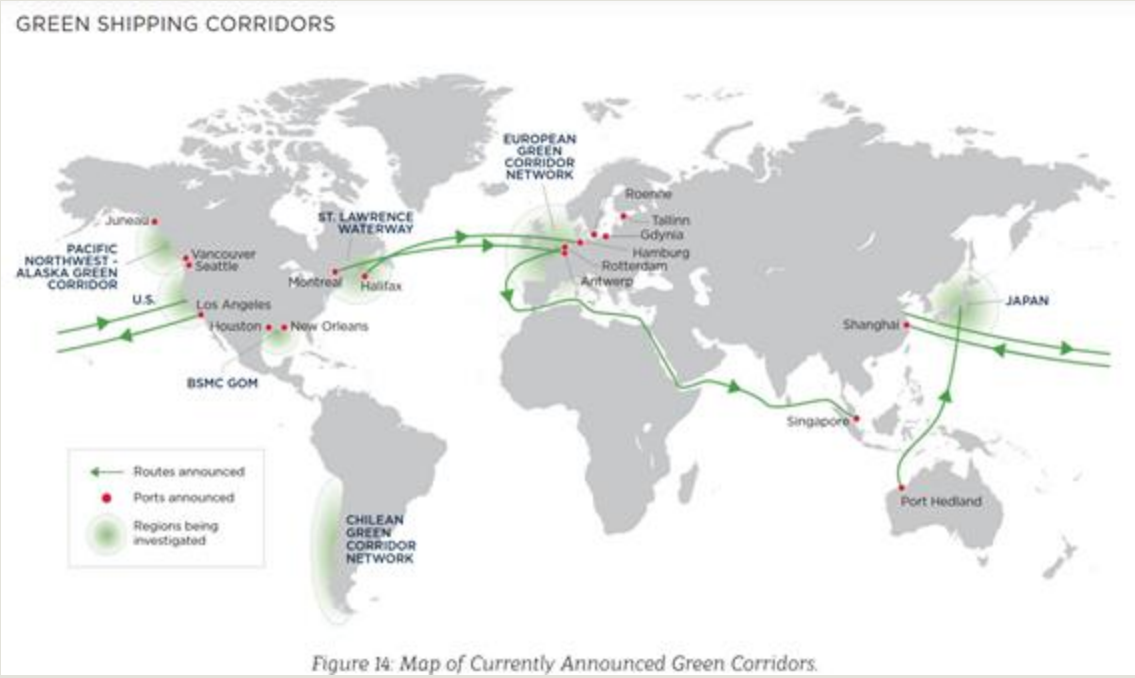


Figure 14: Map of Currently Announced Green Corridors.

ABS published the report “Green Shipping Corridors - Leveraging Synergies”, analyzing green corridors and how they can contribute to the landscape of maritime decarbonization.

In 2027, the world's first ammonia bunkering vessel is scheduled to be delivered to Itochu Corporation's Singapore-based subsidiary, Clean Ammonia Bunkering Shipping Pte. Ltd. The vessel, with a 5,000 m³ ammonia storage tank, will be used for ship-to-ship transfer of ammonia as a marine fuel, with trial bunkering operations planned to begin in Singapore after October 2027.

https://maritimemag.com/en/worlds-first-new-ammonia-bunkering-vessel-slated-for-2027/
https://www.marinelink.com/news/maritime/buckeye-partners
https://ammoniaenergy.org/articles/cop27-the-green-shipping-challenge/

Future ahead Ship Orders

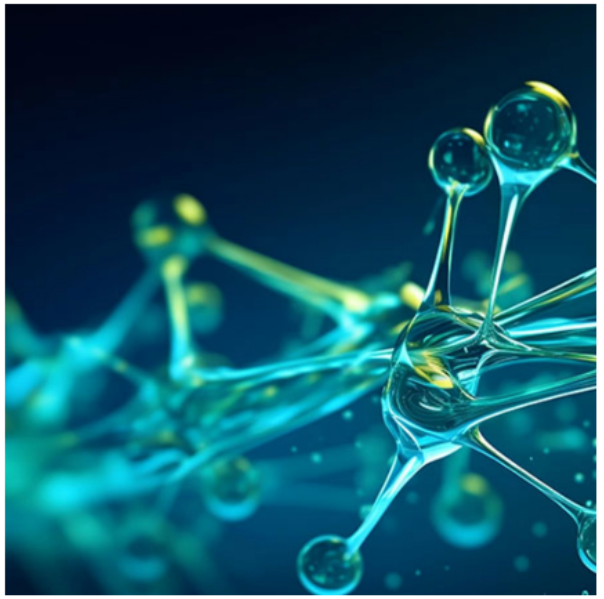
Expertise Services Knowledge Client login and support Search

Home / Knowledge Hub / Alternative-fuelled ship orders grow 50% in 2024

Insight article 02 January 2025

Alternative-fuelled ship orders grow 50% in 2024

Maritime energy transition | Innovative ship design | Fuel For Thought | Ammonia | Nuclear



Six hundred vessels ordered over the past year will help drive the maritime industry towards its decarbonisation targets.

- https://www.lr.org/en/knowledge/insights-articles/alternative-fuelled-ship-orders-grow-50-in-2024/

Future ahead Canadian Shipping

Français

Government of Canada | Gouvernement du Canada

Search NRC.Canada.ca | Search

Canada.ca › National Research Council Canada › Stories

From diesel to data: Decarbonizing Canada's ships

June 09, 2025 - St. John's, Newfoundland and Labrador

Canada, along with other countries in the international community, has committed to reaching net-zero emissions by 2050. But when it comes to being able to make this transition, not all sectors of the economy are created equal. Industries such as aviation, long-haul trucking and mining are considered hard to decarbonize. Another among them—one that is key for international trade and for the country with the longest coastline in the world—is shipping. According to the Council of Canadian Academies, a total of 20% of Canadian trade depends on ships, and approximately 90% globally.

- https://nrc.canada.ca/en/stories/diesel-data-decarbonizing-canadas-ships

Washington State Standard

POLITICS ENVIRONMENT HOUSING EDUCATION HEALTH CARE POLICE & COURTS ECONOMY

ENVIRONMENT TRANSPORTATION

Alternative ship fuels make waves in Pacific Northwest ports

The global shipping industry is a major emitter of greenhouse gases.

BY: **TOM BANSE** - DECEMBER 21, 2025 9:45 AM

The new LNG bunkering vessel Seaspan Garibaldi claimed a number of firsts in 2025, including the first cruise ship refueled with LNG in Vancouver and the first container ship. This bunker vessel and its sister ship have also topped off oil tankers and automobile carriers this year. (Photo courtesy of Seaspan ULC)

https://washingtonstatestandard.com/2025/12/21/altnerative-ship-fuels-make-waves-in-pacific-northwest-ports/

Mitigation strategies for vessel owners and their insurers

Quality control measures & robust testing protocols

- Singapore WA 2:2022 Fuel Standards / ISO 8217
- Implementing Fuel Sampling & Monitoring

Health impact assessments

- Human Health & Environmental Impact Assessments
- Air Monitoring & Detection Systems

Mitigation strategies for vessel owners and their insurers (cont.)

Engine Modifications

- Retrofitting Assessments
- Potential For Hybrid/Dual Fuel Engines

Training & Safety Measures

- Proper PPE, Medical Surveillance & Respirator Training
- Upgraded Fire Suppression Systems

Discussion Point: *Are there any attendees who own or work with alternative fuel vessels and have thoughts on spill prevention?*

Questions?

Speakers

Camille Zuber
Senior Associate
Nicoll Black Altenbrun & Feig
(213) 289 4149
czuber@nicollblack.com

Lawrence Malizzi
Senior Consultant
CTEH
(302) 598 7553
lawrencemalizzi@cteh.com