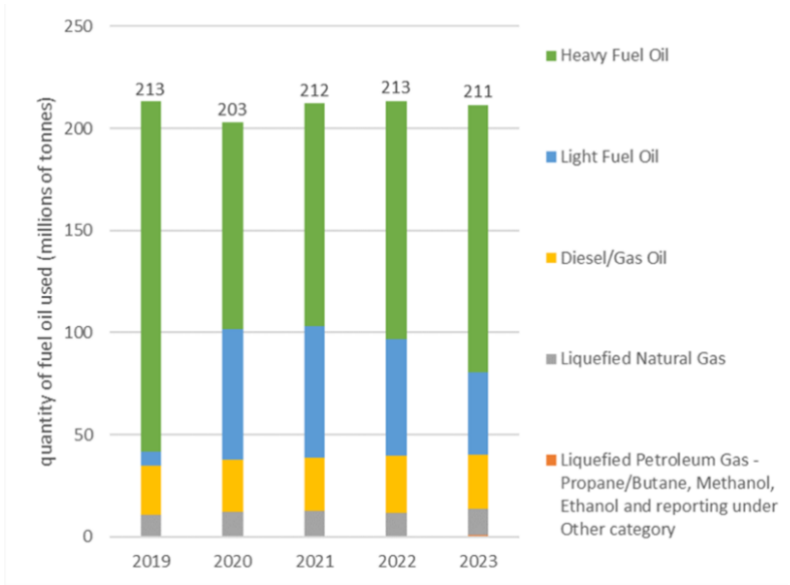
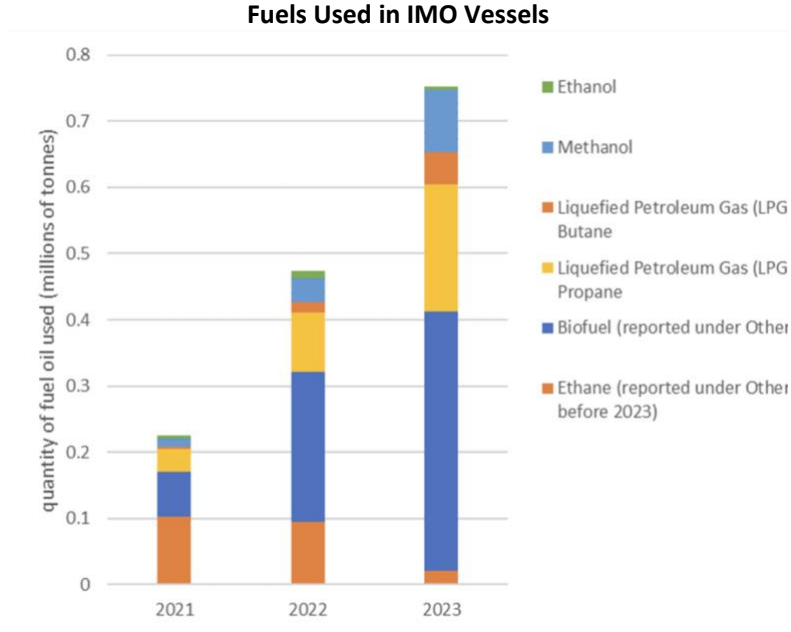
Ethanol in Maritime

Fuel ethanol is the lowest cost low-carbon fuel available at scale in port regions worldwide and so should be a primary beneficiary of the IMO's Net-Zero Framework

Challenges and Opportunities



Source: IMO



Source: IMO

Shipping accounts for 2–3% of global greenhouse gas (GHG) emissions, with almost no use of low carbon fuels. The maritime industry consumes approximately 300 million tonnes of fossil fuels annually, over 200 million tonnes of which are used in the larger vessels (>5,000 tonnes) subject to the jurisdiction of the International Maritime Organisation (IMO), the UN agency responsible for the safety and security of international shipping.

Ethanol, despite being the most widely used biofuel in global transport, has been ignored in discussions about maritime decarbonization.

Emerging regulatory landscape

IMO's ability to force changes in shipping is evidenced in SOx reduction rules, which have been global and successful.

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IMO maritime decarbonisation discussions began a decade ago. In April 2025, IMO's Maritime Environmental Protection Committee (MEPC 83) approved the so-called IMO Net-Zero Framework, which would require binding GHG reductions starting in 2028. The draft regulation's measures include a credit trading scheme, a new two tiered fuel standard for ships, and an emission pricing mechanism. Additionally, fines for non-compliance will fund a reward mechanism for zero- and near-zero-emission fuels (NZN fuels). The agreement is scheduled for final approval in October 2025. Detailed implementation guidelines are expected to be finalized in Spring 2026, with the regulation entering into force in 2027.

With carbon pricing on the horizon, the shipping sector may become the first industry with internationally mandated emission reduction targets. The IMO's Net Zero Framework is expected to provide clear signals to steer the shipping industry toward low-carbon solutions. The two-tiered system of GHG Fuel Intensity (GFI) targets are set out below (base and direct compliance targets), with the base carbon intensity set at 93.3 gCO2eq/MJ.

	Base line	2028	2029	2030	2031	2032	2033	2034	2035	2040
Base target		4%	6%	8%	12.4%	16.8%	21.2%	25.6%	30%	65%
gCO2/MJ	93.3	89.6	87.7	85.8	81.7	77.6	73.5	69.4	65.3	32.7
Direct compliance target		17%	19%	21%	25.4%	29.8%	34.2%	38.6%	43%	TBD
gCO2/MJ	93.3	77.4	75.6	73.7	69.6	65.5	61.4	57.3	53.2	

Competing marine fuels

In maritime industry discussions, current conventional wisdom is that **LNG** (and in part **BioLNG**) will dominate in the near term, while **methanol** and **ammonia** may lead the energy transition in the 2030s. **Biodiesel** (including HVO and UCOME) is also mentioned, primarily in the context of use in existing vessels. **Ethanol**, however, has been overlooked because the global ethanol industry, until very recently, has been generally absent from the discussions.

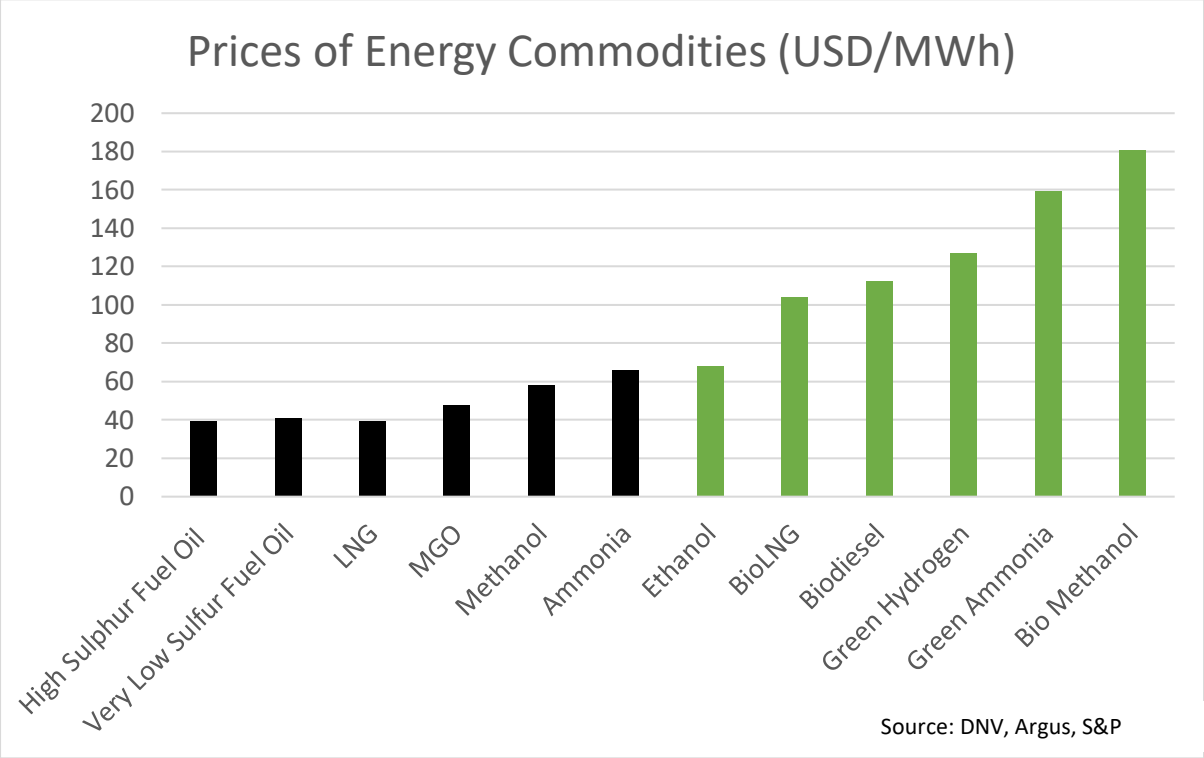
The IMO Net-Zero Framework will require inexpensive, available, large volume, low-carbon fuels. To be viable for shipping, non-fossil marine fuels must meet four critical criteria. **Affordability** is important because shipping is a low margin industry, and fuel comprises a large portion of the industry's variable costs. **Availability** means that fuel and its bunkering infrastructure must be present in large volumes across major ports worldwide. **Volume** means volumes in the millions of tonnes. **Low carbon** means a carbon intensity well under 93.3 gCO2/MJ (which is the fossil fuel baseline). Today, only LNG, biodiesel/HVO and ethanol meet these criteria, and it is unlikely that this will change much in coming years.

Costs of Marine Fuels

In the long run, fuel cost will drive market adoption. While fuel prices are often presented on a volumetric basis, the chart below compares them by energy content for fair comparison.

Among renewable fuels, **ethanol is the winner** on cost. The fuels discussed the most recently - electricity based fues like e-methanol and e-ammonia are the most expensive options. Predictions that these costs will decrease dramatically are not credible. Any shipping company that does place bets of these e-fuels will be putting its competitiveness as risk.

Fuel prices on an apples-to-apples energy basis (May 2025)

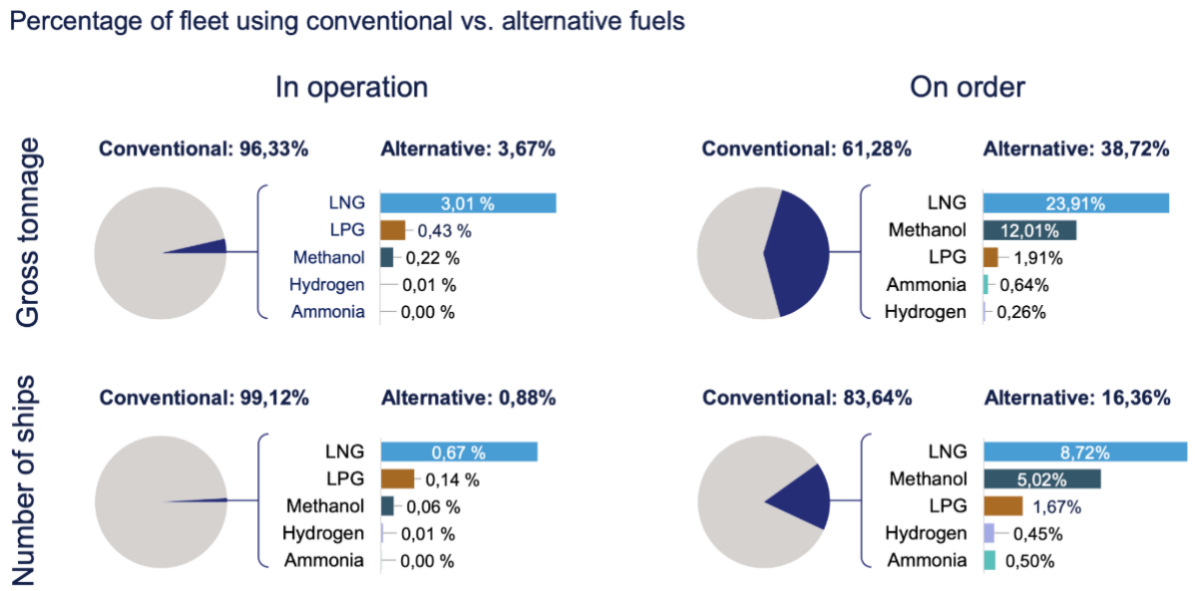


Investment cycle

Achieving the IMO targets is expected to require significant investment by the shipping industry in fuel production technologies, new vessels, and port infrastructure, particularly if synthetic fuels are prioritized. In contrast, LNG and bioLNG do not necessitate shipping companies to invest in fuel production or port infrastructure. Similarly, biodiesel/HVO and ethanol require no investment in fuel production by shipping companies and only small upgrades to port infrastructure. Notably, ethanol is already globally traded, with tens of millions of tonnes passing through ports across Asia, Europe, North America, and South America.

Nearly 200 liner ships capable of using renewable fuels are already in operation, with 700 more expected by 2030. Dual-fuel engines are gaining attention. In 2024, about 50 dual-fuel

vessels were in operation, with over 500 more on order. Methanol engines can be slightly recalibrated to accommodate ethanol, presenting a pathway for fuel flexibility.



Source: DNV (May 2025)

Although ethanol is already widely available at scale in major ports regions worldwide, it is not yet certified for marine use at bunkering ports, but only modest effort is needed for that process. Ethanol can be used as a maritime fuel under the IGF Code for alcohols, which includes both methanol and ethanol. However, further work is needed to define and standardize ethanol blends.

Perceptions and reality

Widespread "food vs. fuel" rhetoric, along with concerns about Indirect Land Use Change (ILUC), has contributed to a perception in some maritime circles that crop-based ethanol offers limited GHG savings. International organizations such as the IEA, OECD have largely overlooked ethanol in the context of maritime decarbonization.

However, such rhetoric has been largely discredited, as its dire predictions have failed to materialize. It is now evident that ethanol has had minimal impact on food prices in real terms or deforestation, while contributing to increased agricultural resilience. Recent assessments of price impacts and ILUC indicate risks that are several orders of magnitude lower than previously suggested.

Just as importantly, the innovations in the ethanol industry over the last two decades are compelling.

GHG balance keeps improving

- Industry innovations have led to increased efficiency and higher crop yields.
- Most ethanol produced in the U.S., Brazil, EU, Canada, and India achieves 50% or more GHG savings compared to gasoline, with some global production exceeding 100% GHG savings.
- With Carbon Capture and Storage, crop-based ethanol is expected to become carbon neutral by 2030.

The big fight at the IMO currently centers around LNG. On the other end of the fuel spectrum, e-fuels, though heavily promoted, remain too costly to scale. Ethanol may emerge as the pragmatic winner.

Maritime stakeholders may express concerns that the use of ethanol in aviation could reduce its availability for maritime applications. However, it is more practical to prioritize ethanol use in the maritime sector. Standard fuel-grade ethanol can be directly utilized in ship engines, whereas converting ethanol into a kerosene equivalent involves costly processes. Consequently, the maritime industry is likely to have access to ethanol at a lower cost.

In conclusion, as the maritime industry faces mounting pressure to decarbonize, ethanol—long overlooked in shipping—now has a credible opportunity to emerge as a cost-effective, low-carbon marine fuel. Although it is the most widely used low-carbon transport fuel globally, ethanol's use in the maritime sector remains negligible. However, the upcoming IMO Net-Zero Framework, with its carbon pricing and fuel intensity targets, could position ethanol as a competitive alternative. Ethanol stands out for its affordability, global availability, scalability, and strong GHG reduction credentials. Its compatibility with dual-fuel marine engines and related methanol infrastructure further enhances its appeal as a near-term solution.

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