Why an e-fuel mandate for ships?

Questions & Answers (FuelEU Maritime Regulation)

January 2023

Introduction

How to speed up the adoption of green e-fuels? Despite rising prices of fossil fuels, they are still highly expensive and not available yet for ships to bunker. Under the EU's draft FuelEU Maritime (FEUM) regulation, the European Parliament proposed in October 2022 to mandate shipping to use at least 2% Renewable Fuels of Non-Biological Origin (RFNBOs) by 2030.
As EU policy-makers are expected to make a final decision in trilogues in early 2023, this policy briefing aims to answer frequently asked questions on the introduction of a RFNBO sub-quota in the FEUM Regulation.

I) Is a RFNBO sub-quota needed at all?

1. Why did Parliament propose a RFNBO sub-quota, while FuelEU Maritime already sets GHG intensity reduction targets?

The policy framework proposed by the Commission relies on a GHG intensity reduction target, which, while setting a long-term pathway to reduce progressively the carbon content of ships' energy use, has a few major flaws. Firstly, the proposed draft regulation sets a common overall GHG reduction targets in a supposedly technology-neutral way but applies sustainability criteria to RFNBOs, while giving a free pass to fossil natural gas. In specific terms, this means that any RFNBO will need to demonstrate at least 70% GHG reduction on a well-to-wake basis to be eligible under the FEUM, while no such requirement is imposed on LNG. Secondly, given the decade-long EU subsidies towards LNG and biofuels, these fuels have lower production costs than RFNBOs. As a result, the proposed system makes investments in short-term solutions such as fossil LNG and biofuels more attractive than in truly sustainable and scalable solutions.[1] In this context, despite rising prices of fossil fuels, green hydrogen-based fuels remain considerably more expensive than alternatives, which means any e-fuel uptake during the entire duration of the proposed FEUM Regulation would

[1] Transport & Environment. (2022). *FuelEU Maritime: T&E analysis and recommendations. How to drive the uptake of sustainable fuels in shipping*

be at best marginal under the Commission's proposal, which is recognised in the EC's own impact assessment, too.[2]

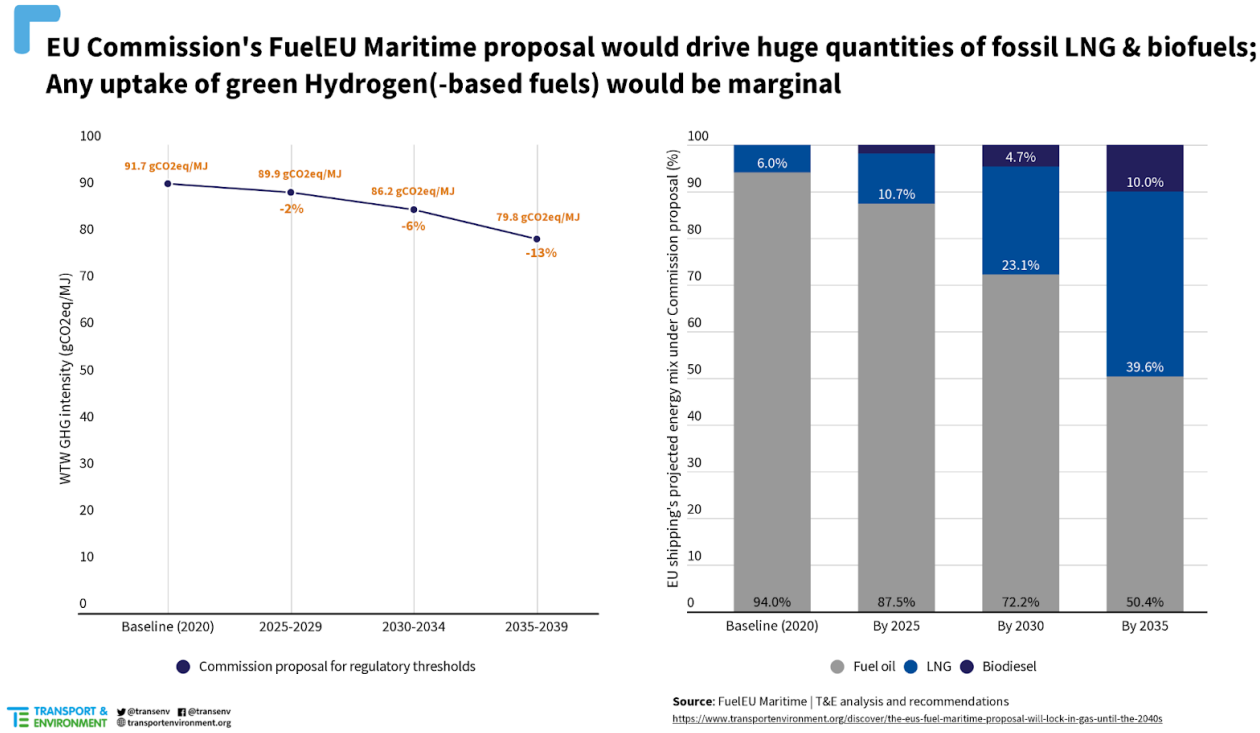


Figure 1: Projection of EU shipping fuel mix based on Commission proposed GHG intensity reduction targets and fuel costs

In order to correct the level playing field and guarantee a minimum uptake of green hydrogen-based fuels in this decade, the European Parliament has proposed to introduce a sub-quota in the FuelEU Maritime Regulation, which mandates a minimum 2% share of RFNBOs to be used in EU shipping by 2030. This follows on a similar logic as in the EU's Renewable Energy Directive and the draft RefuelEU Aviation, both of which included sub-quota for RFNBOs given their higher prices but big potentials. Adopting such a sub-quota under the FEUM will help to correct the above-mentioned imbalance in the Commission's original proposal.

Stricter GHG targets in 2030 would also have contributed to creating the much needed space for e-fuels to flourish; T&E had recommended to raise the 6% GHG intensity target to 13% in 2030. Unfortunately this option was not retained by either EU institution. It thus appears that adopting an RFNBO sub-quota in 2030 is the only way to guarantee a minimum switch to sustainable and scalable marine fuels in this decade.

[2] European Commission (2021), COMMISSION STAFF WORKING DOCUMENT IMPACT ASSESSMENT Accompanying the Proposal for a Regulation of the European Parliament and of the Council on the use of renewable and low-carbon fuels in maritime transport. See Table 2 Share of renewable and low carbon fuels in maritime energy use in navigation and at berth. Link: https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A52021SC0635&qid=1666798933492

2. Can a RFNBO sub-quota be compatible with the principle of technology neutrality?

During the negotiations, some voiced concerns that a specific target for RFNBOs uptake might challenge the goal-based approach of the FuelEU Maritime. However, it was clarified in the proposal that the sub-quota should not exclude any propulsion technology: any fuel complying with the sustainability and GHG criteria for RFNBOs defined under RED III should be allowed. This means many fuel pathways are available for ships to comply with the sub-quota: from direct use of renewable hydrogen to its derivatives such as e-ammonia, e-methanol, e-methane and e-diesel. And all these fuels can be used in internal-combustion engines, fuel-cells or even gas turbines. An RFNBO sub-quota can thus be considered as a technology neutral policy tool, since it does not favor one type of e-fuel against the other.

Introducing specific RFNBO targets in end use sectors is not a new idea. It was proposed by the European Commission in the ReFuelEU Aviation Regulation, as a key policy measure to kick-start the use of synthetic kerosene in planes taking off in EU airports. An RFNBO sub-quota in shipping would fulfill the same goal, while taking into account the diversity of propulsion technologies in the sector.

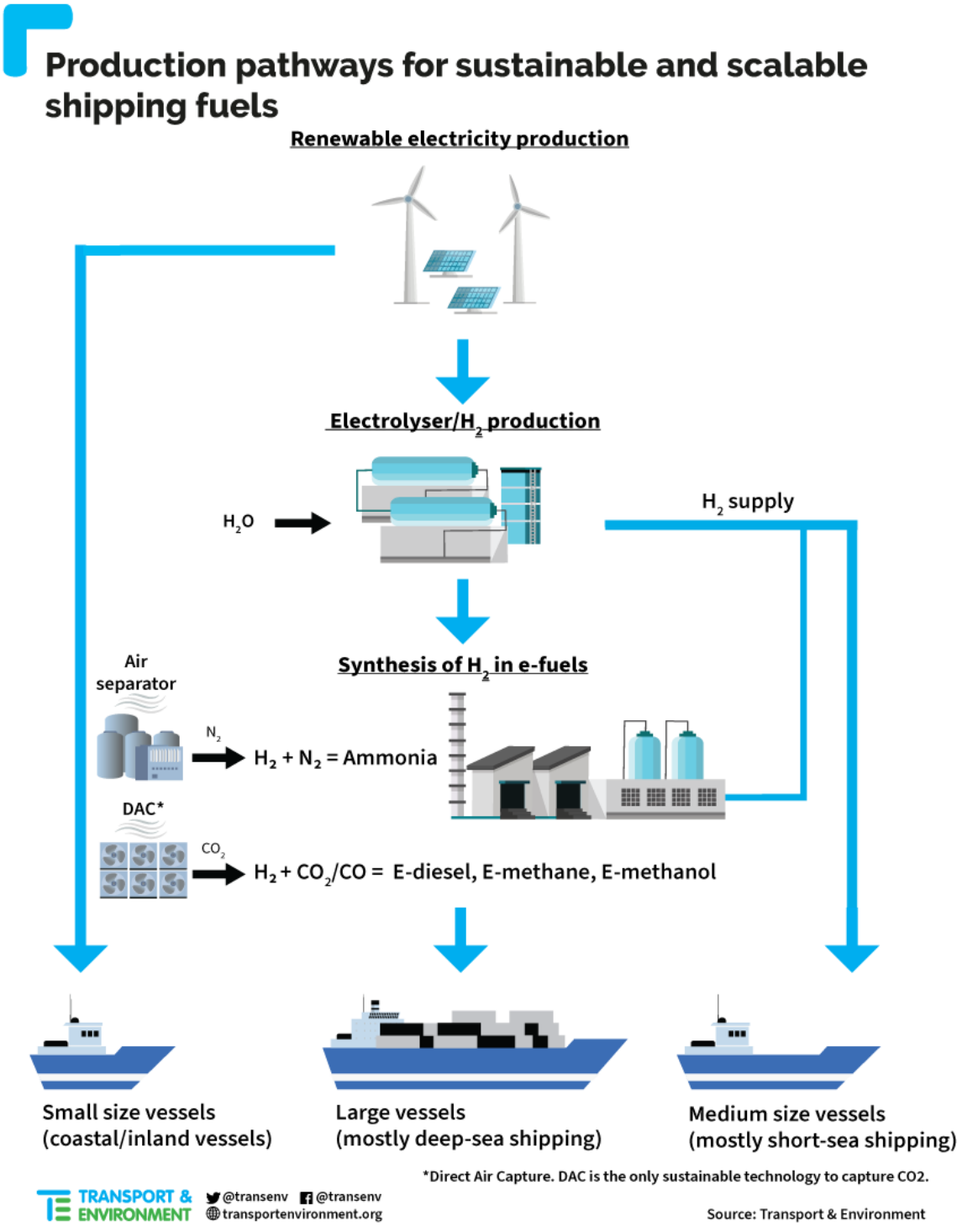


Figure 2: Production pathways of renewable electricity and Renewable Fuels of Non-Biological Origin suitable for different ship types

II) What does the EP proposal of sub-quota mean for green hydrogen uptake in shipping?

1) The European Parliament's proposal in figures

A 2% sub-quota would create a demand for about 21.5 PJ[3] of RFNBOs for European shipping, which would guarantee a market demand of about 205 000 tonnes of green hydrogen by 2030. We estimate the electrolyser capacity required to be ~2.2 GW to produce that volume. In terms of costs, the production of either e-ammonia or e-methanol in Europe to fulfil the 2% would range from ~0.8 to 1.4 bn EUR in 2030.[4] This will create a guaranteed market and business certainty for H_2 investments, acting as a regulatory-driven business guarantee of announcements already made by some shipping companies. Moreover, it would directly contribute to reducing Europe's dependence on imported oil and gas, as shipping currently relies 99% on fossil fuels, as part of the efforts undertaken via the RePowerEU Plan. We estimate a 2% sub-quota to replace about 514 ktoe of fossil fuels with renewables annually.

2) Scope and exemption for small companies

The sub-quota applies to each individual ship, but in practice, companies may balance their compliance within the fleet via a pooling system, as opposed to using small amounts of RFNBOs in every ship. **Yet, the Parliament has proposed the sub-quota applies only to shipping companies that own more than three ships, effectively exempting over half of shipping companies, equivalent to about 15% of energy use in European shipping**[5]. This temporary exemption, applying from 2030 to 2035, was intended by Parliament as a means to protect small companies from administrative burden.

In general, T&E recommends removing this exemption, which is unnecessary. This is because the pooling system already allows companies to share surplus between themselves, so that both small and large companies can optimise their investments. At the very least, EU policy-makers should empower the Commission to monitor closely the use of such exemption, so that any suspected evasion behaviour of a shipping company is investigated (article 4.7.). This would limit the risks of companies restructuring into smaller entities to avoid compliance, especially in the case of ship management companies where legal structures are more flexible than for owners or operators of

[3] These figures assume an exemption for small companies that own three ships or fewer (EP proposal). Should it be removed, 2% RFNBOs in the form of e-ammonia or e-methanol would require about 237 500 tonnes of green hydrogen, instead of 205 000 tonnes.
[4] T&E calculation based on costs from CONCAWE 2022 study (Figure 28, Costs of e-fuels produced inside Europe by zone in 2030). On average, 21.5 PJ of e-ammonia would require 0.9bn EUR investments in 2030 to cover production costs, and about 1.4bn EUR if the 21.5 PJ were met by e-methanol.
[5] T&E estimations based on IHS Markit 2022 data and EU MRV emissions reporting.

vessels. In addition, the pooling system at article 18 could be simplified to ensure all companies, big or small, can easily make use of pooling. For example, the FuelEU compliance database defined in article 16 could be used as an electronic platform for the storage and exchange of compliance surplus between companies.

III) Supply vs. demand: is 2% RFNBOs for shipping feasible by 2030?

1) Where will the production effort come from?

Based on the current bunker sales distribution in Europe, quantities of renewable hydrogen required to supply enough RFNBOs locally for ships to meet the 2% RFNBO sub-quota differ a lot from country to country. Quantities range from 30-50 kt green hydrogen in the Netherlands, Belgium and Spain, to 3kt or less in Denmark, Poland or Croatia (see the distribution on the map below).
But as the supply of e-fuels will be dependent on domestic production capacity and/or imports capacity in ports, the market equilibrium might shift in favour of countries that decide to invest in e-fuels in this decade.

Figure 3: Potential renewable hydrogen supply needs, EU-EEA distribution of 2% RFNBOs by 2030 based on current bunker fuel sales

2) How does the EP ambition compare to existing industry plans?

The European Commission has proposed as part of the RePowerEU plan to target the supply of 40 million tonnes of renewable hydrogen by 2030, half of which is to be produced in Europe. In comparison, under the EP proposal, European shipping would need between 205 000 and 237 000 tons (~0,2 million) of green hydrogen for the production of enough RFNBOs to meet the 2% sub-quota. If the FuelEU Maritime Regulation targeted a higher share, for example of 6% as recommended by Transport & Environment in previous studies[6] shipping could consume about 800 000 tons of renewable hydrogen, still a very modest amount compared to the 2030 goals set for the European economy in RePowerEU.

EP proposal of 2% RFNBO sub-quota vs 1 industry supply plan and T&E recommendations			
	EU Parliament proposal	**Maersk investment in e-methanol production in Spain**	**T&E 2022 study - recommendations for FuelEU Maritime**
RFNBO sub-quota (% EU shipping demand)	2% by 2030, excluding companies operating three ships or fewer	3% in 2030	6% by 2030
RFNBOs demand	21.5 PJ, eq to 1,1 Mt e-ammonia or e-methanol	2 Mt e-methanol, eq to 40 PJ	85 PJ, equivalent to 4,6 Mt e-ammonia
Green hydrogen demand	0.2 Mt	0.39 Mt	0.8 Mt

When it comes to industry supply plans, among the many investments announced in green hydrogen production, some projects already target shipping as an end-use sector. For example:

- Orsted and Liquid Wind aim to produce in Sweden 50 000 tons of e-methanol annually for maritime transport, starting in 2024;
- HOST PtX Esbjerg is a large 1 GW level green ammonia plant project in the port of Esbjerg, Denmark, eying to supply shipping and other uses;
- Maersk announced in November 2022 investments of 10 billion euros in new production facilities in Spain, to supply ships with e-methanol starting from 2025 with 200 000 tonnes, with possible ramp up to 1 million tonnes by 2028 and 2 million tonnes by 2030. If confirmed, the investment could supply enough e-fuels to meet 3% of the EU shipping demand in 2030[7],

[6] Transport & Environment. (2022). *FuelEU Maritime: T&E analysis and recommendations. How to drive the uptake of sustainable fuels in shipping*

[7] Analysis of the 2030 EU shipping demand assumes no regulatory-driven energy efficiency gains by the sector until 2050 and full shore-side electricity use by all vessels at berth, within the geographical scope proposed in

and thus overachieve the 2% RFNBO sub-quota proposed by the European Parliament for the entire European fleet.

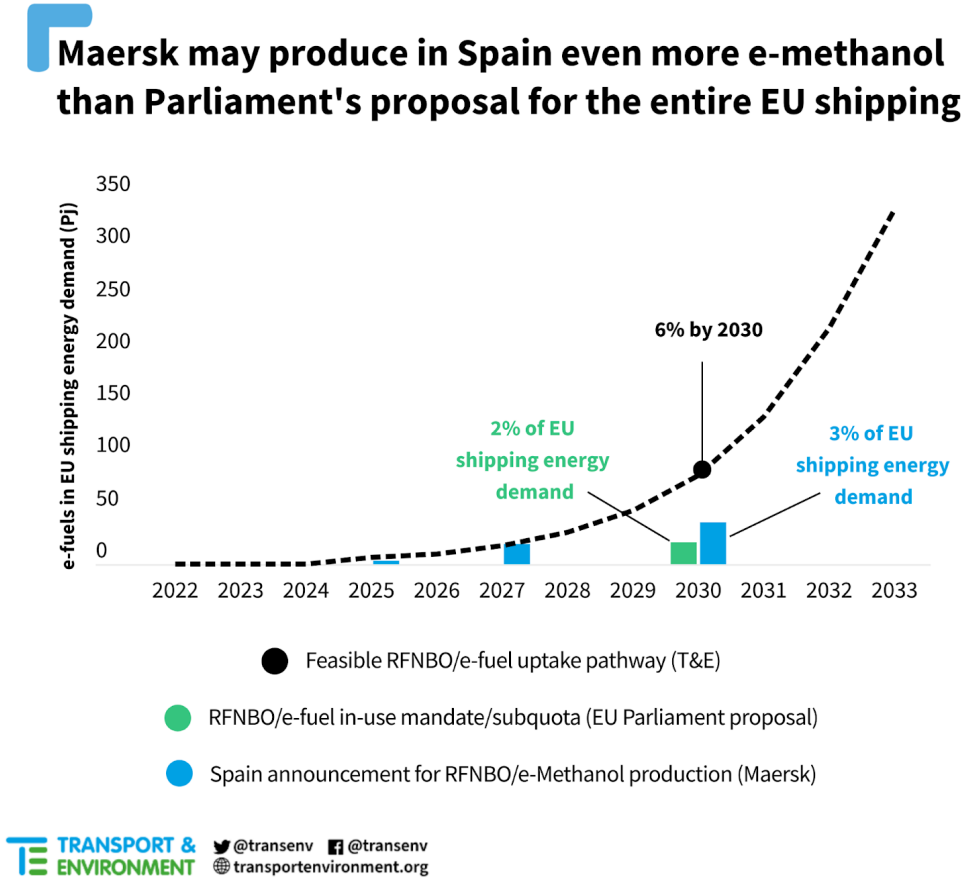


Figure 4: Comparison of Maersk's announced production plans of e-methanol in Spain with the EU Parliament's proposal of 2% RFNBO sub-quota (in % of EU shipping demand)

3) Are ships ready to use RFNBOs?

In Europe, around 23 ships are already sailing on methanol - of fossil origin - according to the Methanol Institute. Another 42 ships capable of running on methanol are on order according to Clarksons order book 2022.

When it comes to ammonia, according to Clarksons' data, 130 "ammonia-ready" ships were already on order in October 2022 globally, which signals a high interest of the shipping industry for this fuel. While these ships will need to be retrofitted to run on ammonia, major engines manufacturers have already announced plans to sell ammonia engines from 2024 (2 stroke engines, suitable for long

the FuelEU Maritime (EU MRV, 50% of international voyages). Source: *Decarbonising European Shipping Technological, operational, and legislative roadmap, T&E, 2021.*

distances) and by 2025 for 4-stroke engines (auxiliary engines, suitable for passenger ships and in ports).[8] These innovations are taking place in the absence of IMO standards, by using alternative rules for safety certification, which are burdensome for early-movers. But class rules already exist, developed by classification societies such as DNV-GL or Lloyd's Register. Enshrining an e-fuel mandate in law could boost the adoption of such rules, indispensable for mass-market development.

Examples of European companies already planning to use of RFNBOs in shipping:

- Maersk has ordered up to now 19 very large containerships able to run on e-methanol, all to be delivered by 2025. About half of these ships are forecast to run on e-methanol, according to the company's current supply plans;
- CMB Tech has developed and already operates a range of hydrogen fuel cell ships in Belgium, very well suited to the short-sea shipping segment. The company also aims to operate large ammonia ships from 2024, and has invested in a green ammonia plant in Africa to supply their fleet;
- Ferry companies like DFDS are also collaborating with fuel suppliers to produce green ammonia, methanol and hydrogen for their ships with new facilities planned in Denmark.
- Hydrogen fuel cells are available on the market for small ships, and are being scaled up to power larger ships by manufacturers such as ABB and Ballard Europe. Innovations are also scaling up in the cruise ship segment, notably with zero-emission designs announced in Norway;
- CMA-CGM recently joined a pilot project in France to develop synthetic methane production for their LNG containerships, and has ordered in 2022 6 methanol ships;
- Many other companies, including SMEs (e.g. Future Proof Shipping, Blue Water Shipping, Energy Observer, etc), are developing ships to be powered by green e-fuels.

There are multiple projects, but also multiple market barriers that prevent mass adoption: high fuel costs compared to existing fossil fuels and biofuels, lack of fuel availability in the immediate future, lack of bunkering infrastructure, etc. Today, shipping companies investing in e-fuel capable ships often have to invest themselves in e-fuel production capacity to secure enough supply. A sub-quota would have the advantage to guarantee a minimum uptake of green hydrogen-based fuels in the maritime sector, providing legal certainty for investments undertaken by fuel suppliers, shipowners and ports. In the long term, it should also help to achieve much needed economies of scale across the green e-fuel supply chain.

[8] https://man-es.com/discover/two-stroke-ammonia-engine;
https://www.wartsila.com/media/news/05-04-2022-wartsila-coordinates-eu-funded-project-to-accelerate-ammonia-engine-development-3079950;
https://www.ammoniaenergy.org/articles/wingd-to-develop-ammonia-maritime-engines-by-2025/

4) How much would it cost?

RFNBOs are about four times more expensive than current marine fuels, which means increased operating costs. However, consumers are not directly exposed to price increases, contrary to the automotive or heating sectors. This is especially true in the container shipping segment. A recent study by Transport & Environment assessed that the price increase for shipping a single standard container (TEU) from China to Belgium would have negligible costs both for companies and for consumers, in the order of less than 8 cents of euro on the price of a pair of sneakers if it were to be shipped on a container powered by 100% RFNBOs.[9]

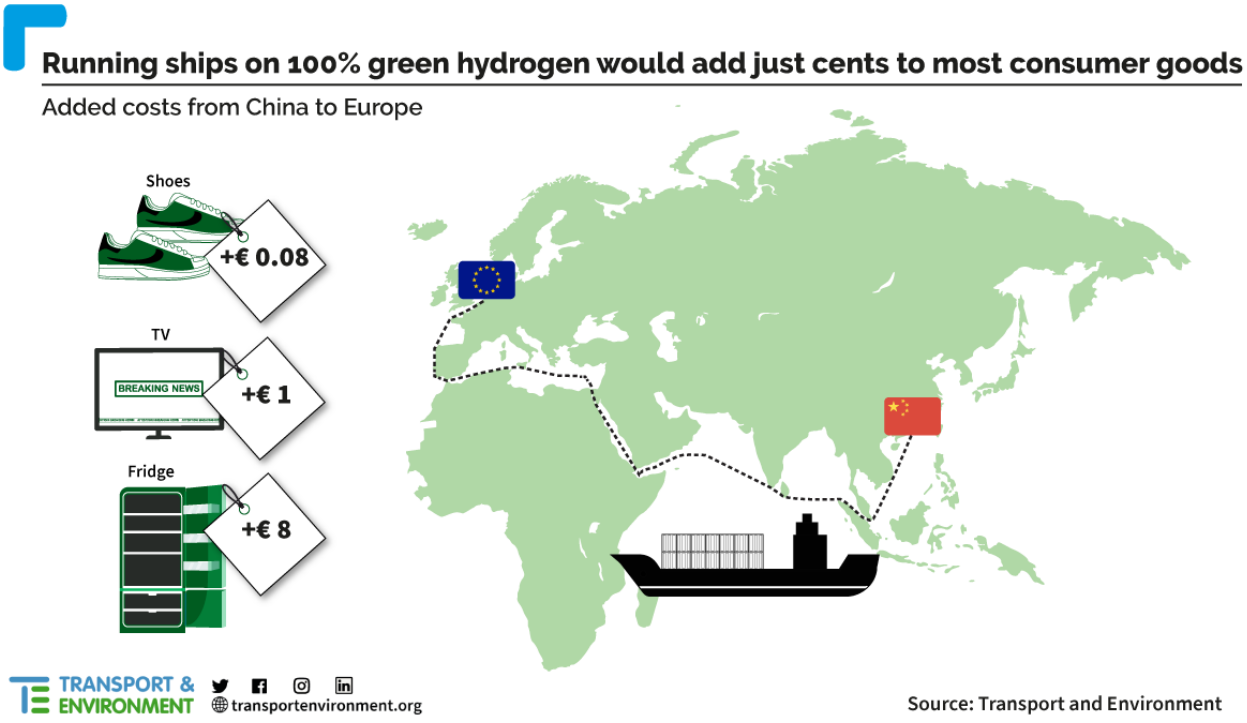


Figure 5: Extra cost of fully e-fuel powered shipping on products imported from China

5) Would an RFNBO sub-quota increase NO_x emissions from ships?

Some have claimed that Introducing an obligation to use a minimum share of RFNBOs might increase NO_x emissions. Notably, concerns have been raised in relation to the use of e-ammonia and e-diesel by ships to comply with the RFNBO sub-quota. The below facts and figures aim to clarify the debate:

- **IMO's NOX standards and new (and substantially modified) vessels**: All new vessels built after 2011 must meet global NO_x Tier II, and vessels built after 2016 and 2021 (and travelling to the US/Canada and Northern Europe respectively) must meet NO_x Tier III standard. Given that e-ammonia (and e-methanol) will likely be used by the new vessels built after these dates, they

[9] https://www.transportenvironment.org/discover/the-small-price-to-pay-to-clean-up-shipping/

will need to comply with these NO_X standards. It is expected that Tier III standard will be met by using selective catalytic reduction systems (SCR). Consequently, new ships using e-ammonia to comply with an RFNBO sub-quota would at worst emit no more NO_X than existing diesel vessels, or and at best emit less NO_X than existing diesel ships when they travel to the nitrogen emissions control areas (NECAs) thanks to the SCR systems. e-Methanol, on the other hand, already emits lower NO_X than diesel fuels.

- **E-Diesel and existing vessels**. It is possible that the existing/old fleet relies on e-diesel (a by-product of the aviation e-kerosene production) to comply with the RFNBO sub-quota. In doing so, they would replace 2% of MGO (or VLSFO) with 2% e-diesel. Given similar chemical properties, both fuels are expected to emit similar amounts of NO_X, which means that e-diesel would not increase NO_X emissions compared to a business-as-usual scenario.
- **e-Diesel vs LNG**. It is sometimes argued using e-diesel as opposed to LNG would increase NO_X emissions. In reality, using LNG instead of (or in addition to) 2% RFNBO with e-diesel would bring no additional NO_X benefits. This is because dual-fuel LNG engines still need diesel as a pilot fuel to start the combustion process, which generally accounts for as much as 8% of total ship fuel consumption. Moreover, as current LNG vessels use fossil diesel as pilot fuel, a 2% RFNBO sub-quota could technically replace the fossil pilot fuel to reduce the well-to-wake GHG emissions of even LNG vessels.
- **RFNBOs vs. biofuels**. Without a RFNBO sub-quota more biodiesel would be needed for EU shipping to comply with the GHG intensity reduction targets under the FuelEU Maritime. The NO_X emissions of biodiesel are comparable to NOX emissions of RFNBOs, including the e-diesel. Consequently, using more biodiesel as opposed to RFNBOs would not reduce NO_X emissions.

Ultimately, shipping's air pollution problem will not be solved by the FuelEU Maritime: other regulations are needed. T&E strongly supports the development of a dedicated EU Directive to reduce NO_X from maritime transport.

IV) How would the RFNBO sub-quota work in practice?

1. Will all ships be required to use 2% RFNBOs?

Although the FuelEU Maritime Regulation applies in principle at a ship level, in practice, it is very likely that compliance will be achieved at a company level, or even at a larger fleet level. This is possible thanks to the pooling system at article 18 of the proposal, which will enable companies to balance compliance within their fleet, and even to exchange compliance surplus between themselves. This flexibility option was designed by the European Commission precisely to avoid situations where every ship complies with the GHG intensity targets by blending minimum amounts of alternative fuels, and incentivise instead compliance with new, fully renewable ships. The Parliament proposed to create a similar pooling system to facilitate compliance with the RFNBO sub-quota.

2. What are the available compliance options for shipping companies subject to the sub-quota?

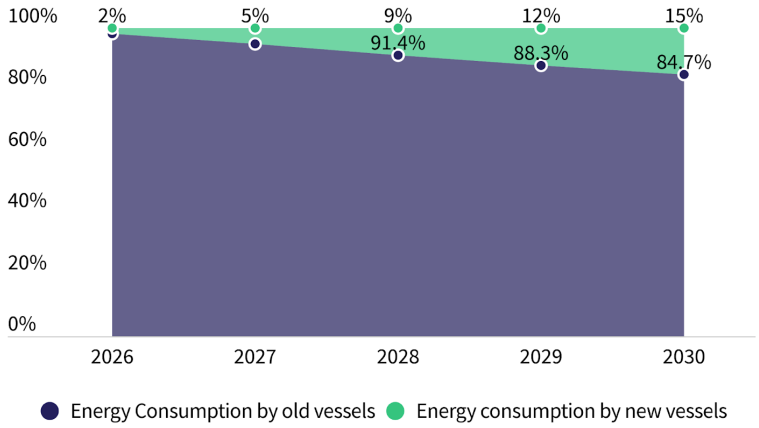
In general, four main options of compliance can be identified for shipping companies (non-exhaustive):

1. Purchase a new ship able to run on e-hydrogen, e-ammonia or e-methanol, run it fully or partially on RFNBOs, and bank or pool the compliance surplus. Any RFNBO use above 2% of the ship energy use can be pooled within the same company;
2. Blend in small shares of RFNBOs compatible with existing ships, such as synthetic methane in LNG ships, or synthetic diesel in diesel ships. However, these fuels are expected to be more expensive than e-hydrogen and e-ammonia;
3. Retrofit the auxiliary engine of an existing ship to run it on e-methanol, in order to meet at least 2% RFNBOs in the ship's total energy consumption;
4. Instead of using RFNBOs directly, enter in pooling with other companies to buy missing compliance units from companies willing to sell their surplus.

Should the company fail to comply, the Parliament proposed to impose penalties equivalent to about three times the price difference between the fuel used and the RFNBO type compatible with the given ship. Paying the penalty would allow companies to receive a FuelEU certificate of compliance.

In practice, and especially if the pooling system is made easily accessible to companies (see part II) 2)), **the 2% RFNBO sub-quota is likely to be met only with new ships**, able to run on RFNBOs. Using existing literature on the average lifetime of vessels, we estimate that by 2030, about 15% of EU shipping energy demand will come from vessels built after 2025. This date coincides with announced orders of vessels able to run on e-methanol.

By 2030, 15% of shipping energy will come from new vessels built after 2025



Source: T&E 2050 shipping decarbonisation roadmap (2021)

Figure 6: Estimated energy from ships built after 2025 (2025-2030)

Last but not least, the compliance of existing ships is technically possible by blending 2% of e-diesel. Although investments in new RFNBO production capacity for shipping generally focus on methanol and ammonia, certain amounts of synthetic diesel could be made available to the shipping sector as a result of the refining process of e-kerosene. E-kerosene will be indispensable to the decarbonisation of the aviation sector, and supply is to be mandated under the ReFuelEU Aviation Regulation. Under the Commission's proposal of 0.7% e-kerosene sub-target for aviation by 2030, about 7.7PJ of byproduct e-diesel could become available for shipping, which is equal to the sector's 0.6% energy demand. In other words, more than 1/4 of the EP's RFNBO sub-quota (i.e. 2%) can be met via the byproduct e-diesel in this scenario. If the ReFuelEU Aviation trilogue negotiations adopt the EP's proposed 2% e-kerosene target instead, **up to 22PJ of byproduct e-diesel could be available by 2030. This would be largely equivalent to shipping's supply needs to meet the EP's proposed 2% RFNBO sub-quota.** Rather than using e-diesel volumes in road transport, where consumers would pay the high price, a more appropriate use-case could indeed be the shipping sector, especially considering the need for diesel pilot-fuel in ammonia and methanol ships.

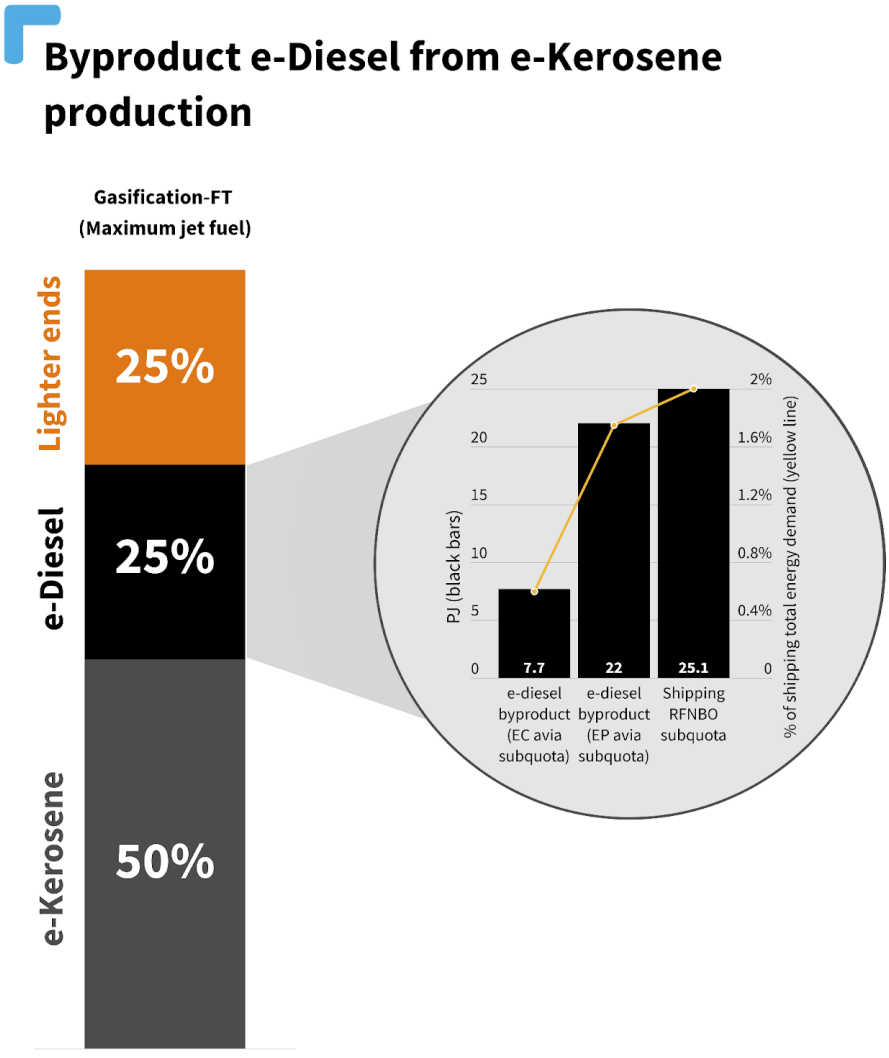
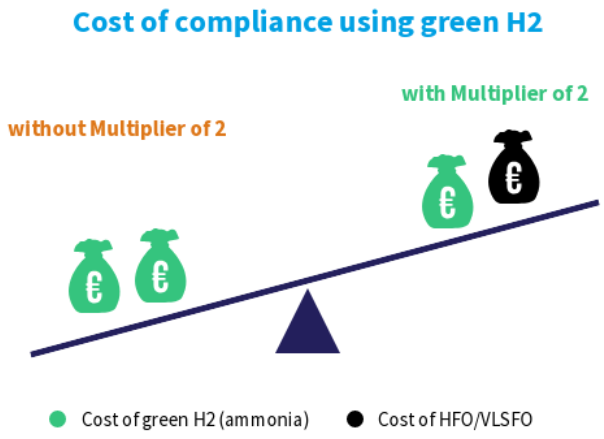


Figure 7: Potential e-diesel byproduct from e-kerosene production (PJ)

2) What is the role of a multiplier for RFNBOs? Can it work together with a sub-quota?

A multiplier is a well-proven mechanism to incentivise early-movers. It functions like a "discount" system allowing the use of each tonne of RFNBOs to count several times towards achieving the required GHG intensity reduction targets.[10] T&E had recommended a multiplier of 5 in order to bridge the cost-gap between green hydrogen-based fuels and other fuels. However, both the Parliament and the EU Council proposed only a multiplier of 2 under the FuelEU Maritime proposal, which alone would be insufficient to make RFNBOs cost-competitive vis-à-vis other alternatives.



However, if combined with a sub-quota, even a multiplier of 2 could deliver a powerful boost to investments in e-fuel ships. Before 2030, it would work as a pure incentive for early investments in e-fuels. When the sub-quota kicks-in, it would reward shipping companies going beyond minimum compliance, encouraging them to use more than the required 2% e-fuels in their fleet. What's more, the compliance surplus obtained would be multiplied by 2 until 2030 and by 1.5 after 2030 in the Parliament's proposal, generating revenues thanks to the pooling system. This means double benefits for companies choosing to think ahead rather than choosing unsustainable or unscalable fuels.

3) How to secure a green e-fuels supply chain if a RFNBO mandate only applies on the demand side, i.e. ships?

We recommend supporting the Parliament's proposals to guarantee RFNBO supply to shipping in this decade by aligning the Renewable Energy Directive (RED II) and Alternative Fuels Infrastructure Regulation (AFIR) on the FuelEU Maritime sub-quota. More specifically, we recommend:

- mandating EU fuel suppliers to deliver a minimum share of e-fuels to maritime transport under RED III;
- setting targets on ports to ensure sufficient roll-out of dedicated e-fuel bunkering infrastructure in the EU (AFIR).

[10] Transport & Environment. (2022). *FuelEU Maritime: T&E analysis and recommendations. How to drive the uptake of sustainable fuels in shipping*

Both pieces of legislation are currently under review. More specifically in RED, both the Council and Parliament agree on setting an overall transport RFNBO subtarget, and on the idea of a specific RFNBO subtarget for maritime transport. T&E strongly recommends binding subtargets, and especially for the maritime mode as proposed by the EP.[11] The EP text would mandate fuel suppliers to deliver at least 1.2% of all transport fuels in the form of RFNBOs to the maritime sector by 2030. This corresponds to almost 10% of EU 2030 shipping fuel demand, which is more than enough for ships to meet a 2% sub-quota by 2030. Matching targets on both the supply and demand side would close the chicken and egg problem of e-fuels uptake in maritime transport.

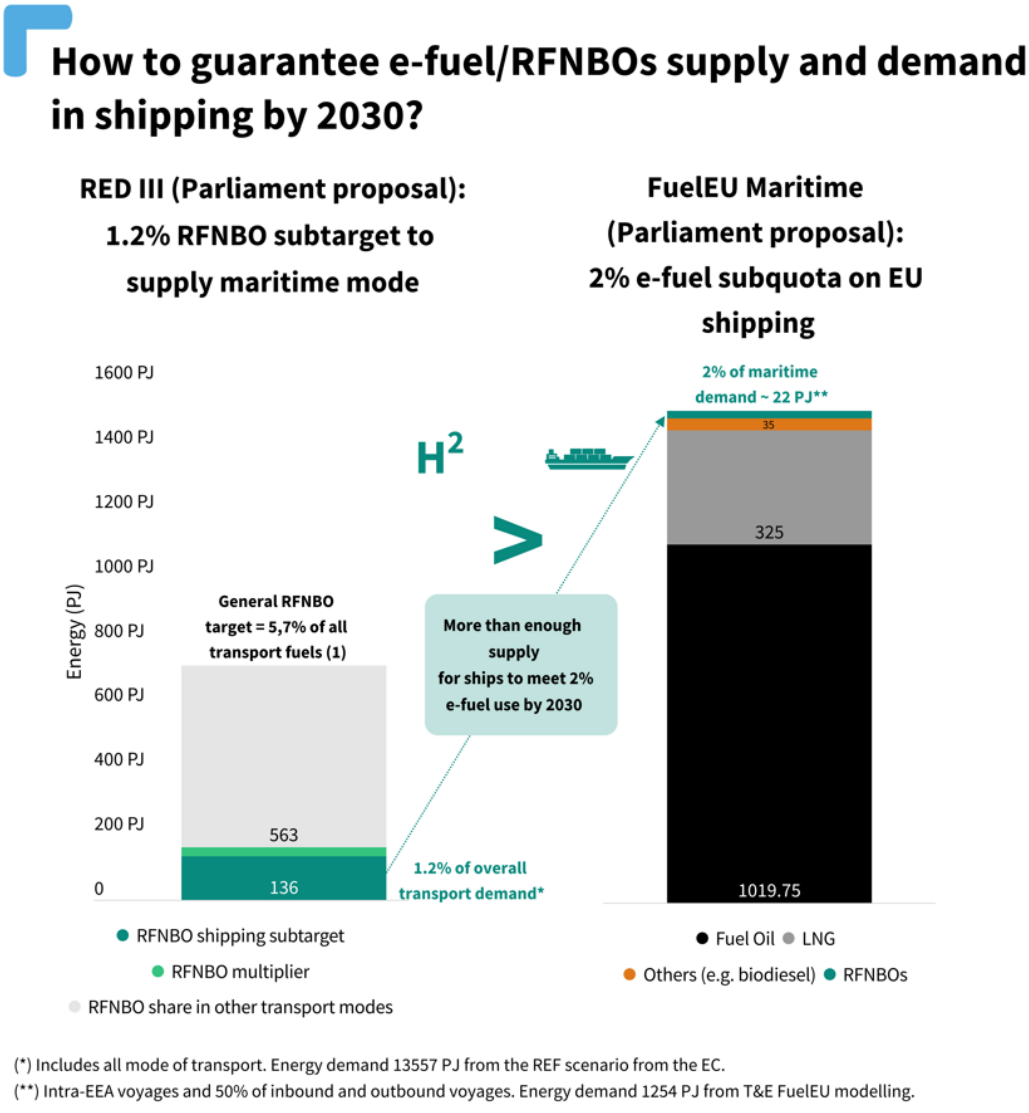


Figure 8: EU Parliament proposal of RFNBO mandates matching supply and demand in shipping under FuelEU Maritime and RED III

11 https://www.transportenvironment.org/wp-content/uploads/2022/10/TE-Briefing-RED-trilogue-TE_20221102.pdf

Conclusion

Finally, there is large support for an e-fuel mandate among NGOs and industry. 50+ energy suppliers, technology providers, shipping companies, ports and NGOs have called in June 2022 on the European Parliament, Member States and the European Commission to adopt a binding sub-quota in FuelEU Maritime by 2030. More and more maritime industry players are making their support public for a Regulation that scores higher ambition, with support mechanisms for RFNBOs and stricter GHG targets. EU policy-makers will have to make a final decision in trilogues in early 2023.

Further information

Delphine Gozillon
Shipping Policy Officer
Transport & Environment
delphine.gozillon@transportenvironment.org
Mobile: +41 (0) 78 259 02 31