



How (not) to quit fossil fuels

by Ewa Kochańska

Transport & Environment (T&E) has released a report assessing the effects of the FuelEU Maritime (FEUM) Regulation on the European maritime sector. While the study recognises the significance of political consensus on this first global legislation pushing the shipping industry to shift to low-carbon fuel technologies, it has also found that FEUM will keep the maritime sector reliant on fossil fuels even after 2050. “The ambition and scope of the Regulation still leave huge room for improvement, and more needs to be done to put shipping on a Paris-compliant trajectory,” states the publication.

FuelEU Maritime, which aims to reduce greenhouse gas (GHG) emissions in shipping, is part of the Fit for 55 package, legislation representing the EU’s attempt to reduce its overall negative environmental footprint and transition to a more sustainable and low-carbon economy.

As it is now, the maritime sector still heavily relies on traditional fuels, which greatly damage the environment and contribute to air pollution and climate change. The main goal of FEUM is to promote the switch to sustainable fuels in shipping.

The T&E report examines the impact of the transition by modelling how shipping companies are likely to respond to increasing restrictions and fuel costs.

Needed alterations

The publication stresses that certain improvements must be made to the legislation by 2027 to correct the trajectory. Right now, the main specifications of FEUM include a progressive reduction in GHG intensity of shipping fuels in five-year increments from 2025 to 2050; a requirement for ships to use shore-side electricity (SSE) or an alternative zero-emission technology while moored in EU TEN-T ports; a sub-target **mandating ships to use at least 2% renewable fuels of non-biological-origin** (RFNBO) from 2034 if a minimum of 1% uptake of RFNBOs has not taken place by 2031 (so-called ‘sunrise’ clause); a multiplier of two for RFNBO – until the sub-target comes in – permitting a lower volume of RFNBO to comply, which reduces the costs associated with its use; a pooling mechanism which allows combining emissions and RFNBO consumption within and between operators allowing for fleet-wide target fulfilment instead of only individually; allowing companies to shift their compliance balance from year to year – the ‘banking and borrowing’ mechanism – instead of having to fully comply each year.

The T&E study found that several corrections in FEUM could help propel EU shipping

in the right direction. Firstly, too many types of vessels remain unregulated, such as ships under the gross tonnage (GT) of 5,000, offshore vessels or fishing and non-cargo ships (those added up to 20% of all emissions in the EU in 2021). Next, the targets in the legislation are too weak, according to the report, requiring only a 14.5% reduction in emissions in the late 2030s without requiring a transition into truly sustainable fuels (the ‘banking and borrowing’ clause adds to this problem). Thirdly, the RFNBO target is too limited even compared to existing industry targets, and fourthly, penalties for non-compliance are much too low, possibly allowing for a ‘pay-to-comply’ scheme instead of encouraging a sustainable shift.

The base(s)

By analysing several scenarios in the container shipping sector, with varying fuel pricing and feasibility, the research study allows for comparing several options that could produce better outcomes (Tab. 1).

The first scenario – 1A – uses ‘base case’ pricing assumptions, FEUM emission intensity reduction for every five years, RFNBO sub-target (assuming that the ‘sunrise’ clause comes into place from 2034), RFNBO multiplier (until the introduction of the sub-target), and the SSE mandate.

The results underscored that the agreement stimulates the uptake of liquefied natural gas (LNG) dual-fuel (DF) high-pressure two-stroke engines in the 2030s, after which, in the 2040s, ammonia DF becomes the “technology of choice.” In such a scenario, vessels using fuel oil and LNG DF would make up 72% of the container vessels in the EU in terms of fuel consumption in 2040 and 37% in 2050. “Given that methanol-fuelled ships are available today, and ammonia-fuelled vessels are likely to become feasible within the next few years, FuelEU Maritime is unnecessarily slow in pushing the shipping industry to shift to more advanced propulsion technologies,” points out the report.

Scenario 1A clearly illustrates that fossil LNG will see an increase in demand from 10% in 2025-2029 to 39% by 2035-39; even in 2050, it will tot up to 22% of total consumption. This is because the FEUM agreement actually encourages its use at the beginning because of its low costs and lacklustre emissions intensity targets. Therefore, although LNG is marketed as a “transitional fuel” under the current agreement, it will still be used in the 2050s.

This scenario also finds that e-ammonia will become the primary fuel in shipping from 2040 and beyond, if technically possible, due to its comparatively low cost. Additionally, e-LNG in this scenario “is not economically feasible” until the final period (because of lack of investment in e-LNG plants); therefore, e-LNG should not be considered a solution to emission problems in shipping because that will simply extend the use of fossil LNG into the 2050s.

In regards to RFNBO, these fuels are discontinued in the 2025-35 period (despite the multiplier); the RFNBO sub-target doesn’t move the needle during this time since e-ammonia (at 6% of fuel mix) becomes a better option for operators. However, other scenarios in the report illustrate that the sub-target is vital to increasing sustainable fuel use if the e-ammonia price point does not become competitive in achieving emission intensity goals.

The report advises that since e-methanol and e-ammonia engines are supposed to be widely available beginning in the late 2020s, FEUM should be revised to increase the use of these fuels instead of waiting until the 2040s.

Regarding emissions, under scenario 1A, the total well-to-wake CO_{2e} emissions of container ships in the EU will either stay the same or even increase; only after 2040-44 do they have the potential to decline. The report states that in the first 10-15 years of FEUM implementation, the emission reductions will not be high enough to offset the possible rise in demand in the container ship sector.

Tab. 1. Summary of scenarios generated for The Impact of FuelEU Maritime on EU Shipping report using T&E's container ship optimisation model

Code	Scenario Description	FuelEU Emissions Intensity Reduction						RFNBO sub-target	RFNBO Multiplier	Demand growth & efficiency	Fuel prices	Carbon prices
1A	FuelEU final agreement, base case pricing	2%	6%	14.5%	31%	62%	80%	2% from start-2034 onwards (assume 'sunset' clause activated)	2025-33: 2x 2034-2054: none (assume 'sunset' clause activated)	IMO 4 th GHG study, demand scenario: SSP2_RCP2.6_G; efficiency: OECD_RCP2.6_G	'Base case' pricing assumptions	IEA 'Net Zero Pledges' scenario
1B	FuelEU final agreement, low e-fuels pricing	As in 1A									As in 1A for fossil/biofuels. E-fuels take min. value of base case sources	As in 1A
1C	FuelEU final agreement, low biofuels pricing										As in 1A for fossil/e-fuels. Biofuels take minimum value of base case sources	
1D	FuelEU final agreement, late ammonia feasibility										As in 1A, except for e-methanol which takes minimum value of base case sources	
1E	FuelEU final agreement, high ETS prices											
2A	'Business as usual,' base case pricing	0%						None		As in 1A		2030: €150/t 2040: €275/t 2050: €400/t
2B	'ETS-only,' base case pricing											
3A	FuelEU EU Commission proposal, base case pricing	2%	6%	13%	26%	59%	75%					
4A	Denmark & Germany EU Council proposal, base case pricing	3%	10%	20%	40%	75%	100%	2030: 2% 2045: 29% 2035: 5% 2050: 70% 2040: 12%	2025-2034: 4x 2035-2039: 3x 2040-2054: none		As in 1A	As in 1A
5A	SBTi 1.5°C-compliant emissions, base case pricing	25.5%	60.4%	88.7%	97.8%	99.6%	100%	None				
5B	SBTi 1.5°C-compliant emissions, base case pricing, low demand + high efficiency									Demand basis IMO 4 th GHG study: SSP3_RCP2.6_G; efficiency: T&E Roadmap (2021) 'optimistic' scenario		

Source: T&E's The Impact of FuelEU Maritime on EU Shipping

In scenarios where the fuel demand remains the same or grows, FEUM provisions fail to ensure that emissions cuts in shipping comply with the trajectory demanded by the Paris Agreement. Further, regardless of demand, the scenarios show that fossil fuels will not be completely phased out by mid-century, with emissions still projected to remain at 27% of the current level.

On costs of decarbonisation, the report also examines the potential fuel and newbuild pricing under FEUM and the EU Emissions Trading System (minus other fees such as port fees or container handling and maintenance). In Scenario 1A, total costs increase from €9.7 billion/year in 2025-29 to €15.7b/y in 2050-54. Fuel costs will be most important to shippers, as they account for 53% of

total expenses across the whole period. In the business-as-usual scenario (2A), prices stay flat for the most part, but they do not include effects from the International Maritime Organization's or other regulations.

Additionally, to estimate fuel volumes needed in Europe under FEUM, the study scaled the scenario 1A results to include the whole EU shipping sector, showing that the sector's fuel demand in Europe will be growing slower than just for container ships because of weaker demand across other segments.

Editing the pathways

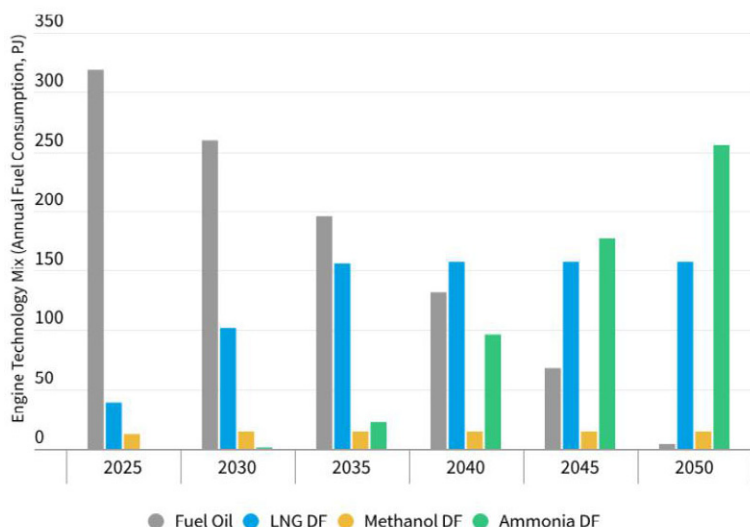
The report also modelled scenarios with alternative fuel and carbon price points to examine how they could influence the full impact of FEUM. Scenario 1B, for example,

has the same regulatory constraints and pricing for fossil and bio-fuels as scenario 1A, but for all four e-fuels, the minimum value from the same sources is used instead of averages from selected sources.

Results show that scenario 1B sees a higher uptake of RFNBO than scenario 1A: from 6% to 10% in 2035-39 and 24% to 26% in 2040-44. These outcomes depend on lower e-ammonia prices, making it competitive with other fuels (other e-fuels in this scenario are too expensive to increase RFNBO uptake).

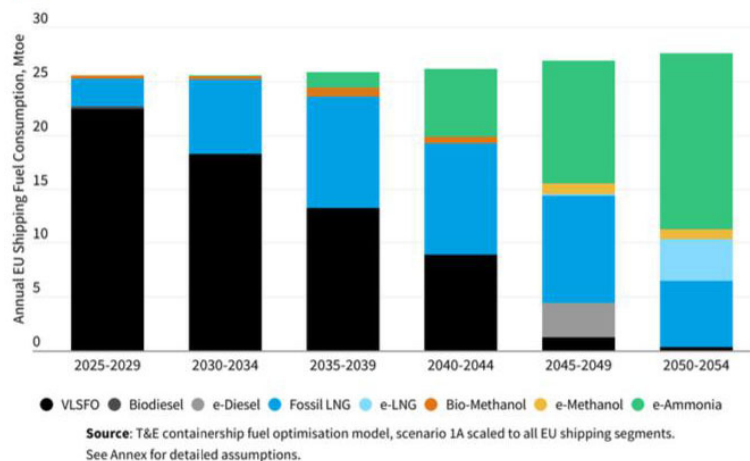
The report also points out that even at the lower price point, the RFNBO sub-target is responsible for the uptake of e-fuels before 2035 – for one year under the 'sunrise' clause. "Increasing the sub-target from 2030 would provide more certainty to producers

FuelEU Maritime will take too long to deliver the technology shift that shipping needs to make



Source: T&E containership fuel optimisation model (scenario 1A), based on FuelEU Maritime final agreement with 'base case' pricing assumptions.

EU shipping could require 16 Mtoe of e-ammonia per year by 2050



Source: T&E containership fuel optimisation model, scenario 1A scaled to all EU shipping segments. See Annex for detailed assumptions.

and should encourage scaling up of production and technological learning, which are likely to lead to lower costs coming down sooner," the report's authors say.

Scenario 1C examines the effects of the final FuelEU agreement with lower biofuel price points (fuel prices here represent the minimum values from the same sources as in scenario 1B). In such a case, ship operators still try to lower their emissions in the 2030s by replacing fuel oil ships with LNG DF vessels and using fossil LNG.

Having said that, the report points out that the replacement of ships would not happen as uniformly as it does in the model – some operators may not replace their fleets in 2030-34. Those operators might switch to biodiesel instead of building new LNG DF ships to meet the FuelEU emission intensity targets. From 2040, bio-methanol becomes

the favoured fuel for new ships because of the low price point, which translates to an increased share of methanol DF engine technology compared to other scenarios.

By contrast, scenarios 1A and 1B see an uptake of e-ammonia; in scenario 1C, e-ammonia uptake is no more than the 2% required by the RFNBO sub-target. "Given the sustainability and scalability issues around biofuels, this highlights the need for a stronger RFNBO target to provide certainty to e-fuel suppliers," underscores T&E.

One of the most significant issues for maritime decarbonisation is the feasibility of ammonia – one of the most promising marine future fuels. These translate into methanol's more substantial role. Methanol engines are gaining interest because the technology is relatively developed; however, in scenario 1A, methanol ships fall out of

favour due to predicted higher e-methanol costs than e-ammonia's. On the other hand, the report notes that a situation in which safety risks associated with e-ammonia are never overcome is not included in the studied model, and such a scenario would be advantageous for methanol-fuelled ships.

Scenario 1D deals with an alternative pathway for keeping the interest in methanol DF ships; the scenario keeps minimum e-methanol prices and slows e-ammonia uptake until 2040. It also assumes that ammonia's safety and operational problems will not be resolved in the near term. In this situation, the methanol DF fleet would be three times bigger than what is currently on order, but methanol still loses its place as a primary e-fuel in shipping beginning in 2040. The peak for bio-methanol and e-methanol in this scenario is 8% of total fuel consumption (compared to 3% in 1A) as it is used as a bridging e-fuel until e-ammonia becomes available.

"Given the potential competitiveness of methanol in the 2030s if ammonia is unavailable, a strengthening of EU or global regulation in the short term could also encourage a greater role for methanol as a marine fuel," notes the report. If ammonia's feasibility is delayed, the RFNBO sub-target will create demand for renewable fuels – by guaranteeing demand.

More alternatives

Scenario 3A illustrates the situation under the European Commission's (COM) initial FEUM agreement, which had weaker emission intensity targets and no RFNBO target or multiplier. Under this proposal, fossil fuels would be used longer due to softer targets and slower RFNBO uptake. Even without RFNBO targets, operators in this scenario would still have to increase RFNBO production as quickly as in the 1A pathway. "In any scenario, we believe a well-calibrated RFNBO sub-target should increase the likelihood that fuel suppliers can rapidly scale up production as demand for these sustainable fuels rises in later periods," underlines the report.

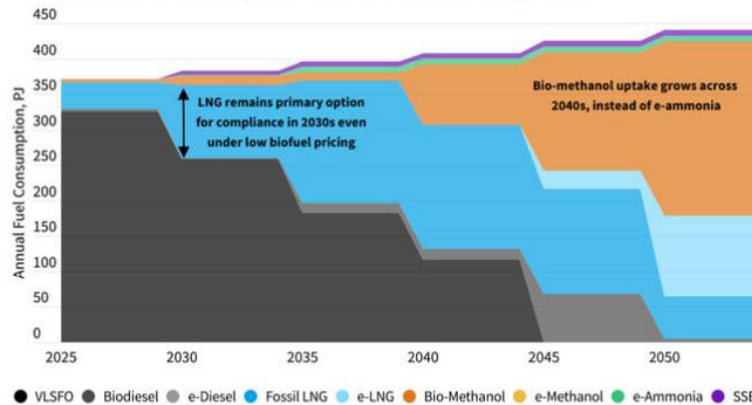
Another alternative pathway – 4A – is based on Denmark and Germany's proposal during FEUM negotiations with stronger emission intensity targets, RFNBO sub-target and multiplier. Under this scenario, more ambitious GHG intensity and RFNBO targets translate to lesser demand for fossil LNG – highest at 23% of fuel demand in 2035-39 compared to 39% in scenario 1A. Similarly, RFNBO use goes up faster – reaching 2.2% of fuel demand in 2030-34 and later, with the multipliers driving up

RFNBOs have take-off potential, but low sub-target means they will have a slow start



Source: T&E containership fuel optimisation model, scenarios 1A & 1B. RFNBO sub-quota in 2030-34 is averaged across period (0.4%/year), assuming implementation of 'sunset' clause in 2034.

Bio-methanol could make up over half of EU shipping fuel demand if prices are sufficiently low



Source: T&E containership fuel optimisation model, scenario 1C. See Annex for detailed assumptions.

demand above the sub-target level, peaking at 25% in 2040-44 and 76% in 2045-49 – compared to 24% and 58% in scenario 1A.

Because of this jump, the necessary technological advancement in the 2040s is very intense in this scenario – the report underscores that a more realistic shift could be introduced by increasing targets already in the 2030s. Correspondingly, the most meaningful impact of the sub-target proposals from Denmark and Germany would be the early RFNBO adoption – even just 2% from 2030 would encourage fuel suppliers to begin dedicated production of RFNBO with shipping in mind. “Moreover, the analysis shows that a stronger sub-target would mean that RFNBO uptake is not stalled if ammonia feasibility is delayed; instead, this process begins to happen regardless,” says the report.

Paris-compliant shipping

Finally, the report examines – using research by the Science Based Targets Initiative (SBTi) – in scenario 5A how FEUM intensity targets could be altered to align the sector with the Paris Agreement goals and how that affects fuel demand.

In 5A, a ‘rapid switch’ of fuels is required in each period – from biofuels in 2025-34, a mix of e-fuels in the 2040s, to e-ammonia uptake by 2050 (as e-ammonia is the only zero-emission option in this model). Results show costs for EU container shipping as 37% higher than in 1A because of this radical transformation. Also, very high volumes of biofuels would be necessary in this scenario: in 2030-34, biodiesel is 50% of total fuel demand, and biofuels as a whole make up 69% of total fuel demand. When scaled

up to include all of the EU shipping sector, this would amount to 114% of current bio-fuel consumption by all European transport.

An alternative, more realistic scenario was also tested – 5B – with lower fuel demand but still with the GHG intensity targets set to meet the 1.5°C emission compliance. In 5B, the fuel demand is reduced by 19-27%, and the volume of biofuels is lower than in 5A and doesn’t increase as rapidly. Additionally, the required volume of e-fuels for EU container shipping increases in more achievable increments: e-fuels demand in 2035-39 is 51petajoules/year – compared to 22PJ in 1A – and increases more sharply in the 2040s (compared to 208PJ in the same period in 5A).

Misaligned trajectories

Based on the analysis of the data gathered in the study, the T&E report makes several recommendations for the Fit for 55 package regarding shipping.

First, COM must align FEUM GHG targets with the SBTi emissions trajectory consistent with the Paris Agreement environmental goals. Second, setting higher and additional RFNBO sub-targets is vital to ensure clarity for fuel suppliers and fuel prices. Third, harsher penalties for non-compliance with GHG limits and RFNBO sub-targets could discourage the ‘pay-to-comply’ “solution” that some operators might find more financially convenient than switching to sustainable fuels. Fourth, cargo and passenger vessels under GT 5,000, along with offshore and other non-cargo vessels, should be included in FEUM. Fifth, the Alternative Fuels Infrastructure Regulation in the Fit for 55 package should remove the LNG bunkering infrastructure mandate and replace it with mandates for more sustainable fuels such as ammonia or methanol. Sixth, the RFNBO supply target in RED III must be mandatory – to ensure the supply of sustainable fuels in European ports. Lastly, introducing energy efficiency requirements in shipping would lower total fuel demand and ease the transition.

Summing up, FuelEU Maritime certainly aspires to represent a multifaceted approach to addressing environmental and economic challenges in the maritime sector while contributing to broader EU and global sustainability objectives. However, in its current form, the legislation falls short of ensuring that Europe becomes independent of fossil fuels beyond 2050, according to T&E. As a matter of fact, the NGO stresses that FEUM, as it is, encourages the uptake of fossil LNG, fails to guarantee demand for RFNBOs, and does not set the sector on a Paris Agreement-compatible trajectory. □