A case for EU ship operational CO2 standards

And why blending fuel mandates is a bad idea

April 2020

Summary

Shipping's decarbonisation requires sustainable zero-carbon energy/fuels. These fuels are considerably more expensive than fossil fuels and require new port bunkering infrastructure. Without a well-designed and stringent regulation, ships will unlikely adopt them on their own.

Operational CO_2 standards (a.k.a. goal-based mechanisms) present an effective regulatory tool to drive the tech/fuel uptake at the EU level. Such standards can be implemented using EU MRV and enforced via port-state control. This would, on the one hand, allow each ship flexibility to improve its energy efficiency (e.g. slow steaming, wind-assist), and choose the most appropriate technology (e.g. battery for ferries, while liquid hydrogen for small/mid-size vessels, ammonia for the largest) to fit its operational profile. On the other hand, this would send a demand signal to potential tech/fuels suppliers. A sub-target could also be considered, with enough lead-time, to be achieved specifically by the uptake of sustainable zero-carbon e-fuels/energy. The standard should be expressed in CO_2 equivalent terms and include methane. To ensure environmental sustainability, crop-based biofuels and alternative fossil fuels must not count towards carbon intensity improvements. The contribution of advanced biofuels could be excluded too or be capped at X% (e.g. 1%) of fuel consumption/carbon intensity improvement.

Prescriptive fuel blending mandates present high risks for environmental sustainability and technology lock-in. Such mandates would drive in biofuels, which due to limited bio-feedstock cannot be scaled up. Most biofuels are more damaging than fossil fuels. Furthermore, given that sustainable and unsustainable biofuels would have similar physical properties, and that ships can easily bunker outside the EU, it would be virtually impossible to enforce sustainable compliance with blending mandates. Most importantly, blending mandates would disadvantage sustainable alternatives such as green hydrogen and ammonia as they cannot be physically blended into current marine fuels, hence undermining the deployment of the EU's Hydrogen Strategy in shipping. We recommend against EU fuel blending mandates.

1. Marine fuel blending mandates

Fuel blending mandate is a regulatory mechanism to gradually increase the prevalence of the new fuel types in the targeted fuel market. For such policy mechanism to be successful, several key conditions need to be in place:

- Physical/chemical compatibility of blended fuels,
- Sustainability and scalability of blended alternative fuels,
- Robust accounting and enforcement mechanism to lock out unsustainable alternatives,
- Existence of a captive fuel market - i.e. inability of the fuel users to refuel cheaper/less sustainable fuel elsewhere and avoid the system.

Europe has in the past experimented with fuel blending mandates under the Renewable Energy Directive (RED) for road transport; however, given the lack of proper sustainability criteria and limited availability of sustainable advanced biofuels, RED largely became a regulatory failure in climate action (fig 1).

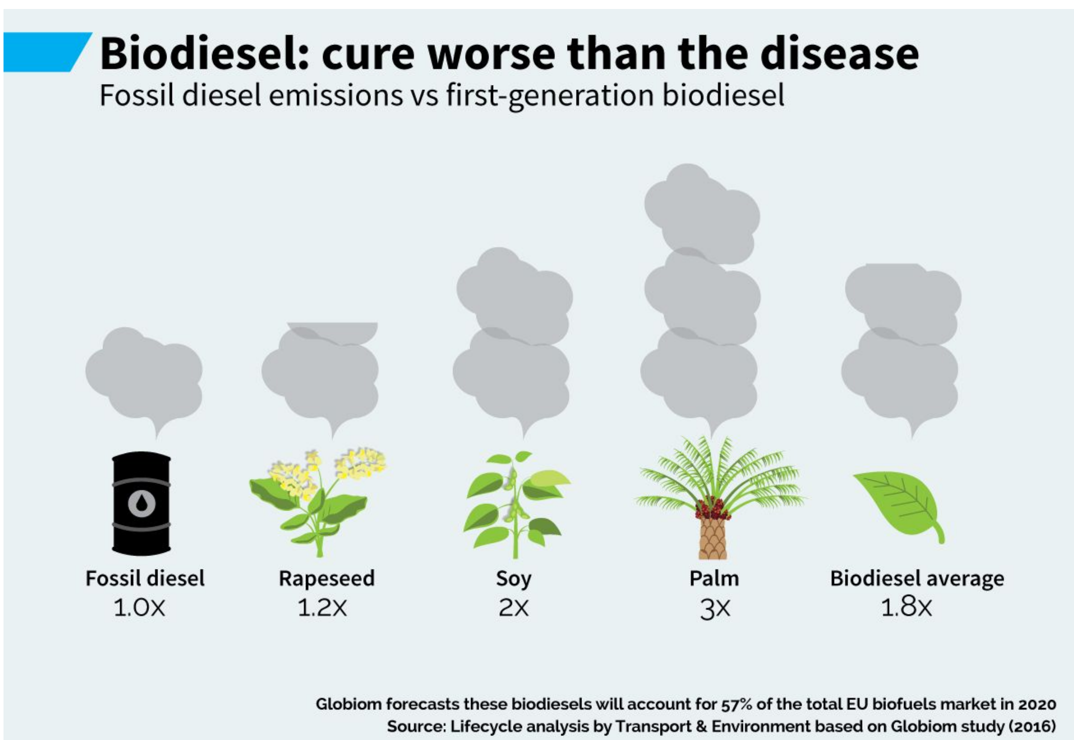

Figure 1: Fuel blending mandates would drive unsustainable biofuels causing huge environment damage

The same mistake shouldn't be repeated in the shipping sector. The challenges in this sector are much larger and fuel blending mandate on European bunker suppliers or ships calling at EU ports would create a number of insurmountable regulatory challenges and environmental risks:

1. **Sustainability** - European fuel supply market is about 50 million tonnes per year. Assuming that the demand will grow by 50% in the next three decades, the market in a BAU scenario could reach 75 million tonnes/year by 2050. That would be similar to growth in demand for aviation fuels. A recent analysis estimated that if **all** of Europe's sustainable feedstocks for advanced biofuels for the transport sector were used in aviation alone, this would cover only 11.4% of airlines' fuel demand in 2050.[1] Aviation unlike shipping doesn't have many other alternatives, hence, using all sustainable advanced biofuels in aviation is a more cost-effective climate policy. This also means shipping's fuel transition cannot rely on biofuels (blending). Therefore, designing an EU policy mechanism, while knowing that it will be a dead-end due to lack of sustainable bio-supply (whether liquid or gaseous), would be a "bad regulation".

2. **Technical** - potential alternative fuels for shipping are numerous. Drop-in fuels like biofuels and synthetic hydrocarbons (e-LNG, e-gasoil) can be physically blended with existing fossil marine fuels (i.e. fossil LNG and fossil MGO). These fuels are not environmentally sustainable, nor energy efficient (figure 2) or economically affordable. More sustainable alternative fuels, such as liquid hydrogen (L_H2) and liquid ammonia (L_NH3), on the other hand, cannot be physically blended with existing marine fuels. Therefore, an EU blending mandate on fuel suppliers or users would disconnect shipping from Europe's Hydrogen strategy and lock the industry on an expensive and unsustainable pathway (see Annex I, A.4.).

3. **Evasion** - European shipping fuel supply market is a non-captive market. That is to say, ships, having large fuel tanks, can afford bunkering outside the EU if European marine fuel supplies become more expensive due to blending. Such an evasive behaviour is known as "tankering". For example, the Netherlands, Malta, Spain, Greece and Belgium have large marine fuel suppliers, hence are large bunkering destinations. If fuel sales in these EU countries become expensive due to blending, ships could simply bunker in neighbouring ports in Egypt, Turkey, Morocco, Russia, etc. For that reason, a fuel blending obligation that regulates only European fuel suppliers without providing a corresponding demand obligation on ships would create a disastrous carbon leakage. The same would not be the case for ETS as it covers emissions from the journey independent of where the fuel was bunkered.

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[1] T&E, Roadmap to decarbonising European aviation, 2018, https://www.transportenvironment.org/publications/roadmap-decarbonising-european-aviation

4. **Enforcement** - Sustainable and unsustainable biofuels would have similar apparent physical properties. The same will also be true about synthetic hydrocarbons, such as e-methane, e-methanol and e-gasoil. Under blending mandates, it would create an insurmountable task for a port-state control to enforce sustainability as it would be difficult to differentiate good and bad fuels. This is because what defines their sustainability is not the fuel quality per se, but indirect land-use change emissions (or source of CO_2 in the case of synthetic hydrocarbons) that aren't visible in chemical testing of the fuel. Because of these and given that ships can easily bunker outside the EU, it would be virtually impossible to enforce sustainable compliance with blending mandates.

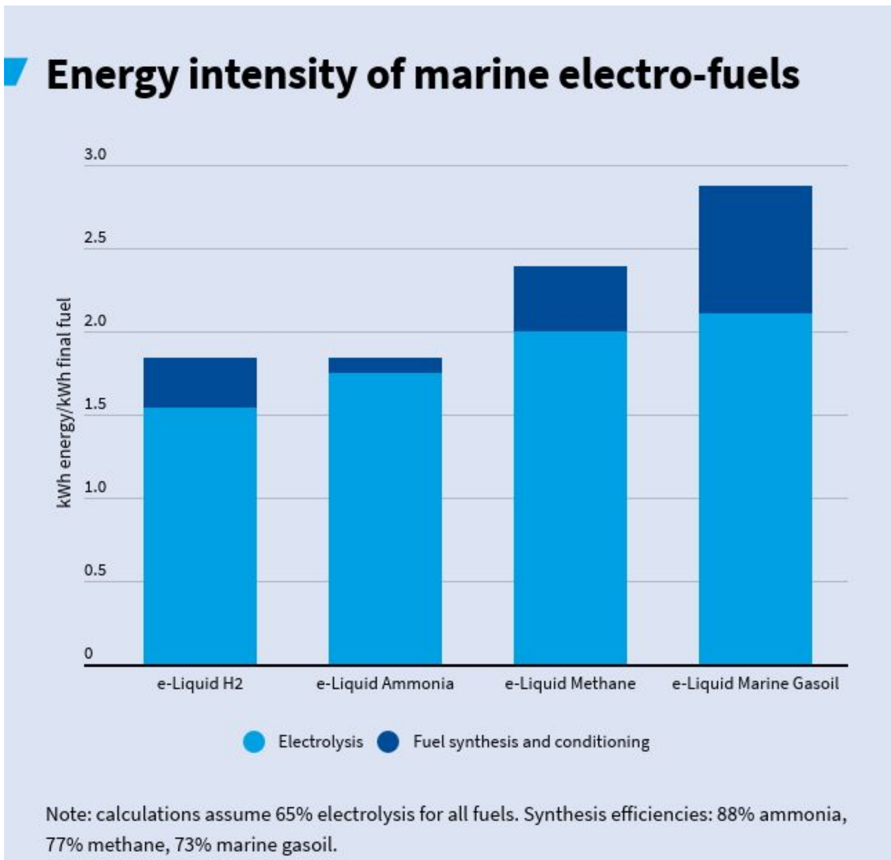

Figure 2: Synthetic methane and gasoil are 30-60% energy demanding than synthetic hydrogen and ammonia (2018)[2]

[2] This graph only includes upstream carbon intensities. There are some differences in on-board energy efficiencies of different drive trains (ICE vs. FC), which would also increase the intensity gaps between hydrocarbon and non-hydrocarbon e-fuels.

Do not adopt marine fuel blending mandates

Due to sustainability, technical incompatibility, carbon leakage reasons, enforcement challenges, an EU fuel blending mandate on European marine fuel suppliers or users would be a practically ineffective and potentially environmentally damaging policy choice. We recommend the EU not to mandate fuel blending on marine fuel suppliers.

2. European operational ship CO2 standard

Mandating operational CO_2 standards (a.k.a. operational goal-based carbon intensity targets) present a more practical, environmentally sustainable and economically cost-effective method to drive the technology uptake in European shipping. For ships operating on regular schedules (e.g. containerships, cruise vessels and ferries) such a standard could be mandated on an annual basis. For ships operating in the charter market, such a mandate could be applied for the duration of the charter-party contract, as opposed to a calendar year.

Operational CO_2 standards refer to the regulator setting a **carbon intensity objective** for individual ships or fleet of ships per operating company to achieve in the near future and leave it to the shipowner/operator to choose the means of achieving the set goal. To comply with stringent enough carbon intensity objectives, ships could reduce their operational speed, increase load-factor, install wind-assist technologies and gradually switch to renewable and sustainable zero-carbon fuels/energy sources (i.e. green hydrogen, ammonia or electricity). For the latter, the EU will need to develop sustainability criteria and stringent accounting systems for marine fuels under the EU MRV regulation, explicitly excluding crop based biofuels and fossil-based alternatives from the scope. Over time this would force existing ships to retrofit to run on sustainable carbon-free fuels and incentivise news ship designs that are optimised for new carbon-free propulsion options. A sub-target could also be considered, with enough lead-time, to be achieved specifically by the uptake of sustainable zero-carbon e-fuels/energy. To avoid any loopholes, the standard should be expressed in CO_2 equivalent terms and include all GHG emissions, including methane.

Operational CO_2 standards would have several key climate/environmental and economic benefits in line with Europe's climate efforts and economic transition:

- *Environmental*: European operational CO_2 standards would reduce ship GHG, SO_x, NO_x and PM and enable economic growth decoupled from impact on climate change. It will also incentivise the market to gradually phase in zero emissions technologies/fuels, such as batteries and green-hydrogen and ammonia. In the short/mid-term this would transform ships into hybrids, while in the mid and long-term, fully zero-emission ships can be mandated under the operational CO_2 standard. Due to their disproportionate impact on the environment[3], mandating zero emission standards for cruise ships could also be prioritised, which can be phased in within the framework of operational CO_2 standards. **To ensure environmental sustainability, the contribution of advanced biofuels to achieving carbon intensity reduction could be excluded or be capped at X% (e.g. 1%) of annual fuel consumption/carbon intensity improvement. Crop-based biofuels and alternative fossil fuels must not count towards carbon intensity improvements.**

- *Economic*: Operational CO_2 standards would also improve the energy efficiency of European shipping, while reducing energy/fuel bills for ship and cargo owners by encouraging efficient maritime operation and uptake of wind assist technologies. This would make European exports more competitive while contributing to improved international trade. Improving ship operational energy efficiency will also be important for shipowners to absorb the extra costs of using sustainable e-fuels as an end goal.

- *Industrial*: The major technology providers for ship efficiency are European (e.g. Siemens, Alstom, ABB, MAN Energy, Wärtsilä, CMB Technologies, ABC, BEVI, etc.), with European shipyards (e.g. Fincantieri, Saint Nazaire/STX, Damen, Meyer Werft, Meyer Turku, Stocznia Gdańsk, etc.) offering the most advanced ship designs and technologies compared to Asian competitors. In addition, there are more than 100 European companies promoting hydrogen technology, while the EU is in the process of developing a strategy to deploy clean H2 at mass scale, of which shipping can be the primary user in transport.[4] European operational CO_2 standards would create demand for services of European companies and help revive the EU (ship) manufacturing sector contributing to jobs creation and sustainable economic transition.

Adopt EU operational CO_2 standards

We recommend an EU-wide *operational ship CO_2 standard* – i.e. mandatory operational carbon intensity improvements under the EU MRV Regulation. Such a mandate should apply to all ships, regardless of flag, ownership or ship age, calling at European ports and be based on operational carbon intensity metrics under the MRV. To avoid any loopholes, the standard should be expressed in CO_2 equivalent terms and include all GHG emissions, including methane.

[3] T&E report One Corporation to Pollute Them All
[4] See: Moving hydrogen from hype to hope, 2020: https://www.transportenvironment.org/newsroom/blog/moving-hydrogen-hype-hope

ANNEX I: Operational CO2 standards

A.1. Technical design

Data needed to implement operational CO_2 standards is already available under the EU MRV regulation, including the two carbon intensity metrics that could be used for regulatory mandate: EEOI (Energy Efficiency Operational Index - gCO_2/tonne cargo-nautical mile) or AER (Annual Efficiency Ratio - gCO_2/cargo capacity-nautical mile). For passenger vessels gCO_2/passenger-nautical mile could be used.

The levels of the required carbon intensity targets could be determined by applying a percentage reduction over historical carbon intensity levels in a baseline year (e.g. 2018 see below) using the below formula, which can be differentiated across various ship types/sizes:

$$Required\ AER_{target\ year\ N} = baseline\ AER_{ship\ type,\ size} * (1 - reduction\ \%_{(ship\ type, size)})$$

To ensure environmental sustainability, the contribution of advanced biofuels to achieving carbon intensity reduction could be excluded or be capped at X% (e.g. 1%) of total annual fuel consumption. Crop-based biofuels must not count towards carbon intensity improvements.

The most effective tool to ensure compliance is dissuasive penalties (e.g. €100/tonne_CO_2 as defined by the EU ETS Directive). These penalties should be proportionate to the level of non-compliance and applied on the excess CO_2 emitted. The penalty for recurrent annual non-compliance should increase by the base amount, year on year, until compliance is ensured. Thereafter the penalty could be reset to the base amount. The following formula can be used to calculate the total excess CO_2 emitted due to non-compliance:

$$Excess\ CO2_{year\ N} = Total\ CO2_{year\ N} * (1 - \frac{Required\ AER_{year\ N}}{Attained\ AER_{year\ N}})$$

In addition, unachieved targets should be carried over to the following compliance year. <u>Only if such non-compliance is detected</u>, the following formula can be used for that purpose:

$$Required\ new\ AER_{year\ N} = Required\ AER_{year\ N} - (Attained\ AER_{year\ N-1} - Required\ AER_{year\ N-1})$$

A.2. Baseline and reduction levels

Baselines are one of the most important elements of a carbon intensity measure. In general baselines should reflect the real-world historical performance of the fleet using data from a period of time that is relevant to the regulation in question. IMO’s initial GHG strategy currently relies on the 2008 baseline, the year in which emissions were the highest and operational ship efficiency was the lowest in the recent recorded history. If the EU chooses the 2008 baseline, a period when ships were significantly less efficient than they are today, a completely false impression will be given of the progress to be made in the next decade. Improvements that occurred before the potential EU regulation came into existence would be “booked” as if they are the result of the EU regulation. This is wrong and misleading to any outside observer.

In addition, a 2008 baseline would also suffer from a lack of data. EU MRV came into existence only in 2018. We do not have real-world measured CO_2 and carbon intensity data for the EU let alone global shipping for 2008. This has already proven to be a huge problem to design regulatory measures at the IMO. Being aware of this almost insurmountable challenge, the EU should not make the same mistake.

Contrary to certain claims, using 2018 as a baseline will not punish first-movers, those shipping companies that have invested in improving the efficiency of their ships during the past decade. This is because the recommended operational CO_2 standards would be mandated on individual ships/companies but the required improvements would be compared to the fleet average (per type/size) in 2018, as opposed to every ship’s own past performance in 2018. Table 1 demonstrates this using an example of three ships. The result is that under such operational CO_2 standards, first-movers would still maintain their competitive advantage, having to reduce their carbon intensity much less than average or laggard ships.

Table 1: An example of the impact of 2018 baseline on the first movers.

	2018 real-world performance individual ships (example)	2018 Baseline carbon intensity in absolute terms *	2030 required target carbon intensity in absolute terms**	Extra reduction in carbon intensity reduction that each ship would need to deliver to meet the 2030 target (taking into account its original efficiency)	
	Unit (gCO2/t-nm)				
Efficient ship (first-mover)	10			-1	small extra effort
Moderate ship (average performer)	15	15	9	-6	moderate effort
Inefficient ship (laggard)	20			-11	big effort

The required carbon intensity reduction targets could be derived from the linear decarbonisation trajectory to achieve zero-carbon 2050 EU target. Assuming half the average historical annual growth in maritime transport demand, a (close to) linear carbon intensity improvement of above 40% by 2030 compared to 2018 levels would be required in order to be inline with this trajectory (figure 3).[5] If the future travel demand exceeds the assumptions here (i.e. half the average historical annual growth), then a more stringent than -40% carbon intensity reduction would be necessary.

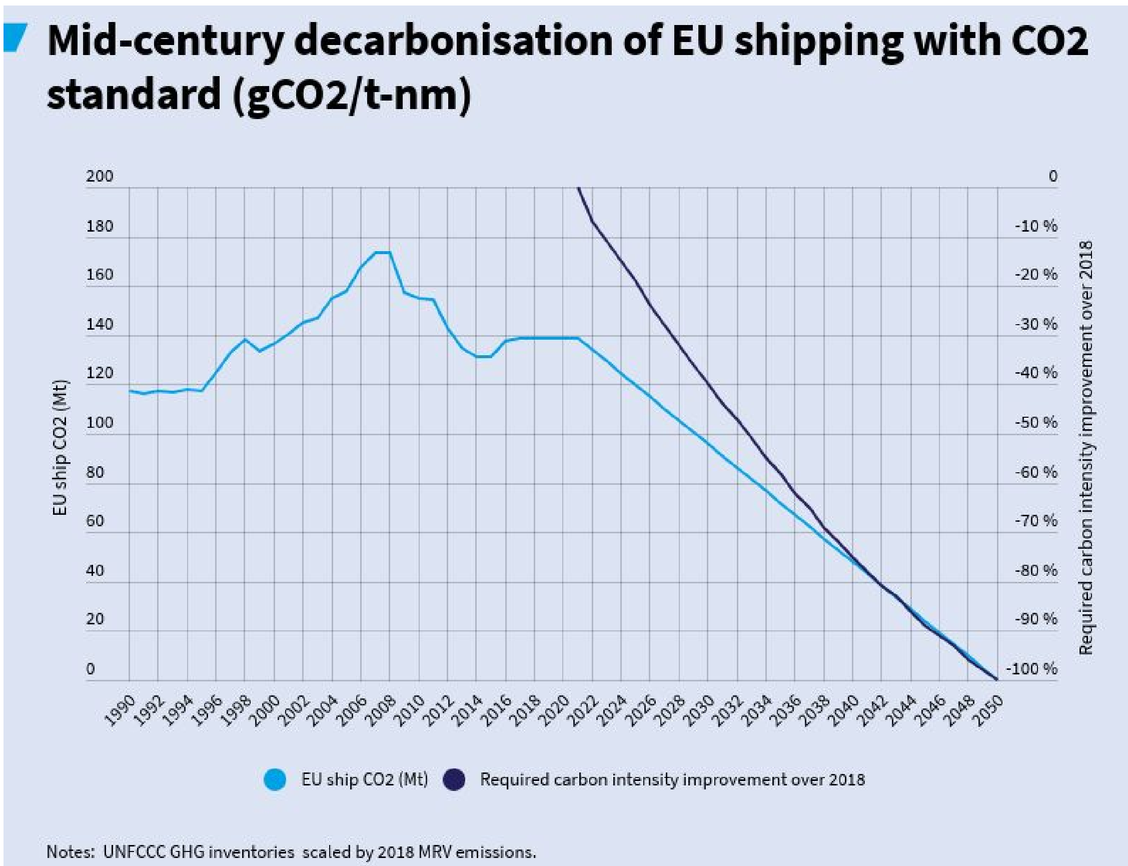

Figure 3: Above 40% (close to) linear carbon intensity improvement by 2030 compared to 2018 levels is needed to achieve carbon-free shipping by 2050.

[5] T&E, How European Transport Can Contribute to an EU -55% GHG Emissions Target in 2030, 2020; https://www.transportenvironment.org/sites/te/files/publications/2020_02_TE_EGD_vision_How_EU_transport_can_contribute_minus_55.pdf.

A.3. Operational vs. design CO2 standards

It is important to differentiate operational CO_2 standards from design CO_2 standards, such as IMO EEDI regulations or car CO_2 standards applicable in the EU. As such, there are three main practical differences between operational and design CO_2 standards (EEDI) for ships :

1. Firstly, under the EEDI design standard, the legal obligation of the shipowner is to purchase a ship that is certified by the manufacturer to theoretically achieve certain improvements. Such a system does not place any legal requirement on the shipowner to actually achieve those promised improvements in the real world. A recent analysis based on the EU MRV data showed that there is a huge performance gap between ship design scores and their operations in the real world (figure 4).[6] Conversely, under the operational CO_2 standard the legal obligation of a shipowner/operator would be to prove to have achieved required improvements in real-world operations.
2. Secondly, EEDI design standard applies to new ships only. With an average ship lifetime of 25-35 years, it would take EEDI a significantly longer time horizon to renew the global fleet and drive in new technologies and fuels to decarbonise the sector. In contrast, EEOI operational CO_2 standard would apply to all ships, existing fleet and new builds alike, and ensure a level playing field in reducing emissions and the adoption of new technologies. In practice, an operational CO2 standard would require existing ships to constantly uptake new technologies through retrofitting or to improve their logistics to achieve the mandated targets.
3. Lastly, the majority of new ships are built and sold in East Asia.[7] For this reason, a European regulation setting design CO_2 standard for new ships built in Europe, would likely exempt 98% of ships calling at European ports and have no real impact on emissions reductions. Conversely, operational CO_2 standards would not face such a constraint as it would apply to all ships calling at EU ports, new and old alike, regardless of the place construction, flag and nationality of the ship owner or operator.

Therefore, operational CO_2 standard is a more equitable, practical and effective regulatory tool to drive in new technologies/fuels and reduce emissions.

[6] T&E, European shipping's climate record, 2019, https://www.transportenvironment.org/publications/european-shippings-climate-record.

[7] BRS Group, *Shipping and Shipbuilding Markets,* Annual Review 2019, p.7.

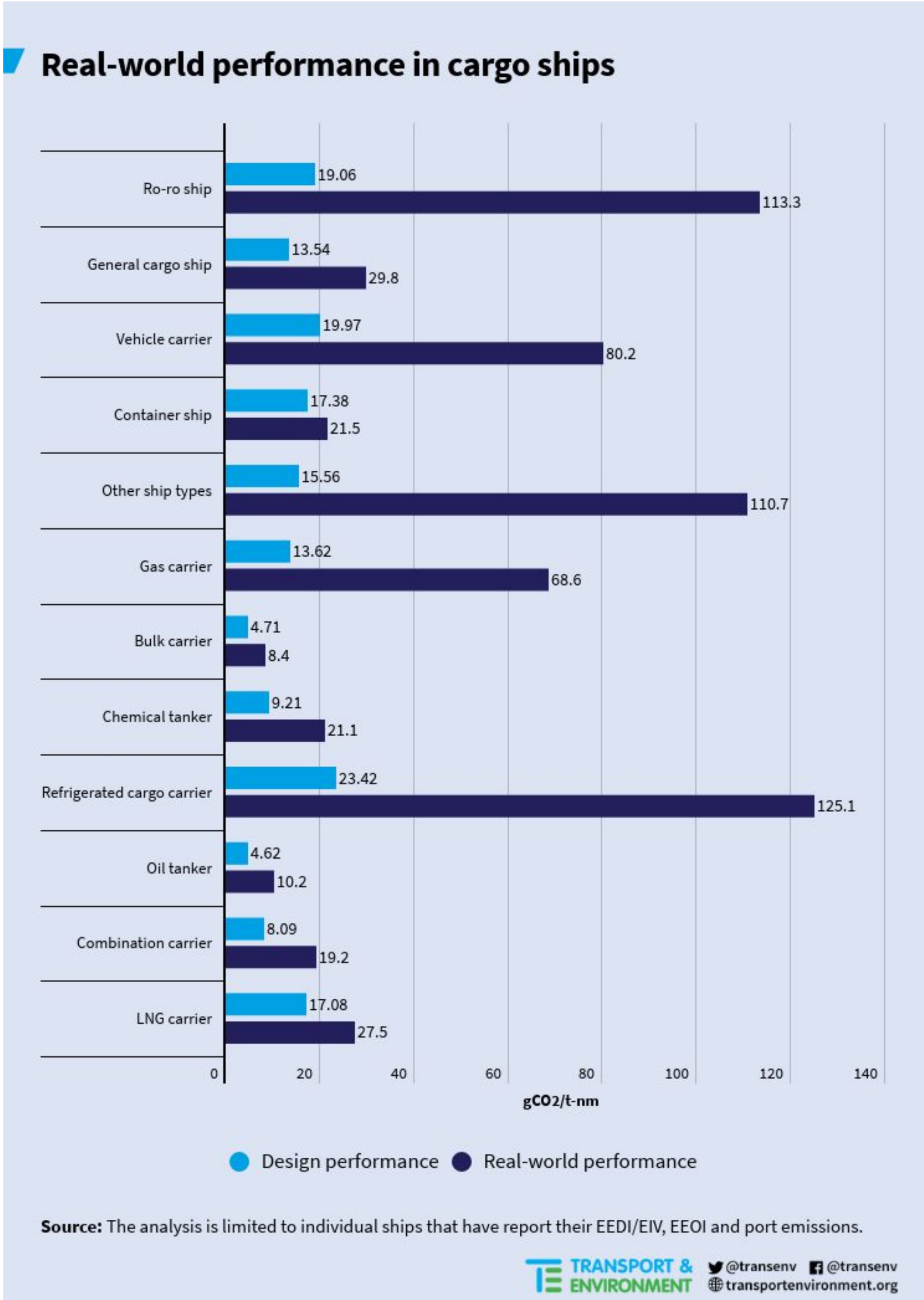

Figure 4: Large performance gap between ship design scores and operations in the real world

A.4. Implications of alternative fuels on ship onboard storage space

Volumetric energy densities of alternative marine fuels, especially of liquid hydrogen and ammonia, are generally inferior to that of conventional diesel (e.g. MGO). At the face of it, this could create potential storage problems for the largest ships engaged in deep-sea shipping. However, looking closely more into details one could realise that the challenges that lower density fuels present are not insurmountable. It is important to consider the following factors:

1. **Oversized bunker fuel tanks** - The current fuel tanks of vessels are oversized. That is to say, the modern vessels are designed to carry more fuel than it is technically necessary between two longest port calls. From that perspective lower density of liquid hydrogen and ammonia can be compensated by bunkering more often or losing a small share of cargo space. ICCT has recently analysed, using global satellite data, that on the China-US trans-pacific container corridor, one of the busiest in the world, ***99% of the voyages can be powered by liquid hydrogen with only minor changes to fuel capacity or operations—i.e., by replacing only 5% of cargo space with more hydrogen fuel or by adding one additional port of call to refuel.*** Also, 43% of the voyages can be made without any such changes.[8]
2. **Limited cargo space utilisation** - Some shipowners would be quick to argue that even 5% of cargo space would be unacceptable due to commercial reasons. However, the analysis of the EU MRV data shows that hardly any ship type ever reaches above 70% annual average capacity utilisation (figure 6). In that regard, given that almost ⅓ of the capacity is already underused a 5% loss of the total capacity would hardly create commercial constraints on the operators.[9]
3. **Total cost of operations** - In some ship types it is possible that the use of less dense zero-emission alternative fuels could compromise actual cargo space (unless the maximum range of a ship cannot be reduced) incurring opportunity costs on ships, i.e. forgone revenue. Therefore, analysis of cost-effectiveness of zero-carbon alternative marine fuels needs to take into account the total cost of operations, weighing, among other factors, the cost of machinery and fuel/energy, as well as opportunity costs. Recent analysis by Lloyd's Register and UMAS/UCL has concluded that the economies of scale to be achieved by the mass scale deployment of e-H2 and e-NH3 could still make them a cheaper alternative to denser

[8] Mao, Xiaoli et al., Refueling assessment of a zero-emission container corridor between China and the United States: Could hydrogen replace fossil fuels? ICCT, 2020; https://theicct.org/publications/zero-emission-container-corridor-hydrogen-2020

[9] For some ship types, it is possible that capacity utilisation on the laden voyages could be higher than the annual average, which comprises both laden and ballast voyages.

synthetic and biological hydrocarbons (figure 5).[10] That is despite the inferior energy density and associated potential monetary costs of on-board space loss of e-H2 and e-NH3. Hence, from the total costs of operation viewpoint, having a denser but more expensive fuel might not necessarily be a cost-effect solution to decarbonise a ship.

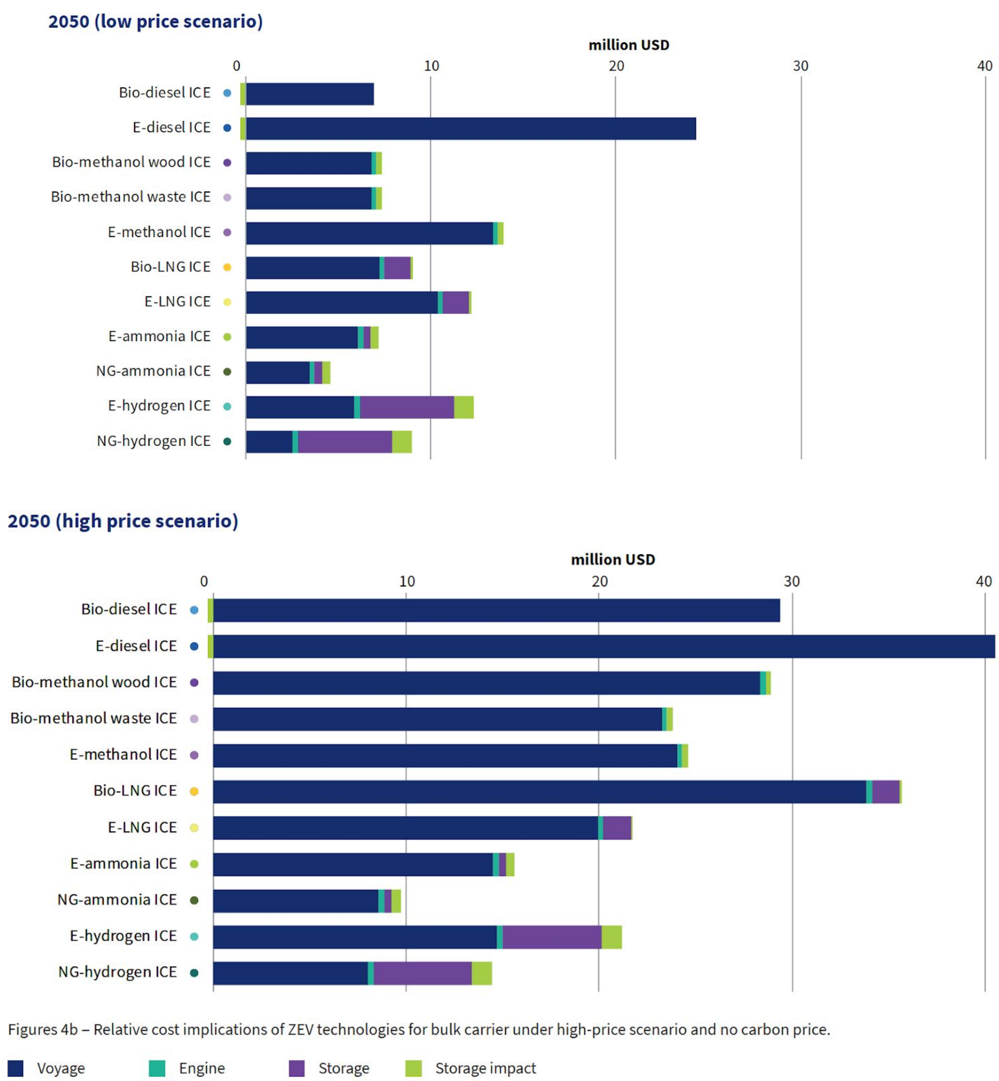

Figure 5: Relative cost implications of ZEV technologies for bulk carrier (UMAS & Lloyd's Register, 2020)

[10] *Techno-economic assessment of zero-carbon fuels*, Lloyd's Register and UMAS, 2020. https://www.lr.org/en/insights/global-marine-trends-2030/techno-economic-assessment-of-zero-carbon-fuels/

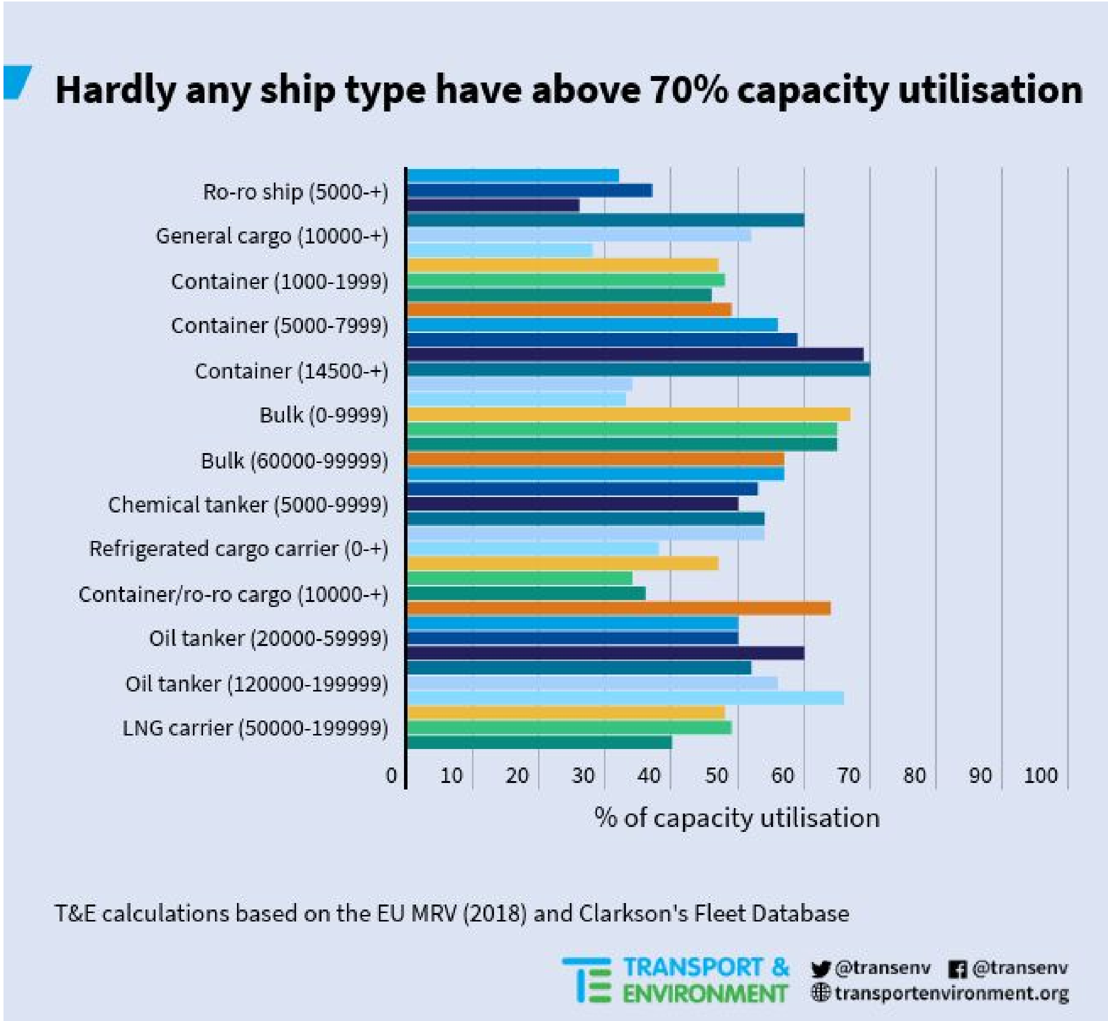

Figure 6: Capacity utilisation rates of ships calling at European ports

Further information

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