Feasible on all counts

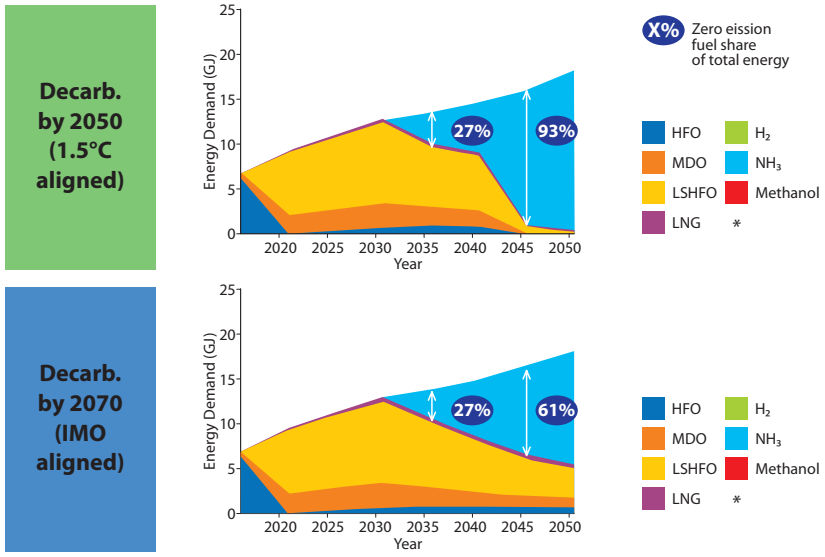
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The ambition of the Getting to Zero Coalition is to have commercially viable zero-emission vessels operating along deep-sea trade routes by 2030. But at what degree of adoption do zero-emission fuels become "commercially viable?" An S-curve based analysis suggests that zero-emission fuels need to make up 5% of the international shipping fuel mix by 2030 to enable decarbonisation in line with the Paris Agreement goals.

The Getting to Zero Coalition aims for "commercially viable" zero-emission ships by 2030 but has yet to quantify this target. Such a target would help mobilise commitment and action across stakeholders. Energy companies would have greater confidence in demand when planning green fuel development projects. Cargo owners could get mobilised to pay a premium for zero-emission fuels on a corresponding per cent of their freight. Investors could quantify the amount of investment needed across the value chain. Shipowners could plan investments in newbuilds and retrofits. And regulators could be called on to ensure a level playing field is in place to enable the transition.

In 2019, UMAS conducted a study to describe the most technologically feasible paths to achieving decarbonisation for international shipping by 2050, putting the sector in line with a 1.5°C trajectory – and by 2070 – the International Maritime Organization (IMO) aligned course. In both cases, zero-emission fuels needed to make up 27% of energy by 2036. So, what does that mean for the fuel adoption rate required by 2030?

Fig. 1. Decarbonisation trajectories for international shipping



** or equivalent fuel that meets the GtZ zero carbon emissions definition*

Sources: UMAS GloTraM; UK Clean Maritime Plan

Estimating shipping's tipping point

The adoption of zero-emission fuels in shipping is bound to follow an S-curve, as has been the case with all historical industrial transformations. An S-curve consists of three stages. It starts with a slow emergence phase when there is rapid learning, and the costs begin to come down. After this, the

[1] *The views expressed in this Insight Brief are those of the authors alone and not the Getting to Zero Coalition or the Global Maritime Forum, Friends of Ocean Action or the World Economic Forum.*

diffusion phase sets off with the rapid adoption of the new technology, with positive feedback loops between different actors raising confidence, increasing demand and investment throughout the value chain. The curve flattens out again in the reconfiguration phase as the new technology is adopted and new normal establishes.

To estimate the "tipping point" shipping needs to achieve by 2030 for rapid diffusion of zero-emission technology post that date, we generated an S-curve to fit the UMAS 2036 and 2046 milestones. These establish that to reach decarbonisation by 2050, zero-emission fuels need to represent 27% of total energy by 2036 and 93% by 2046. Though the Getting to Zero Coalition has not yet agreed on a target year for full decarbonisation, it is preferable to have a 2030 target that enables decarbonisation in line with the Paris Agreement. The resulting curve indicates the need for a 5% adoption rate of zero-emission fuels by 2030.

Based on this, the **UN Climate Champions** have set 5% zero-emission fuels by 2030 as the **Race to Zero Breakthrough** for international shipping, campaigning to achieve this near term milestone to ensure that the sector is on track for net-zero emissions before 2050 (the Race to Zero Breakthroughs for nearly 30 sectors were launched at the World Economic Forum's Davos Agenda in January 2021).

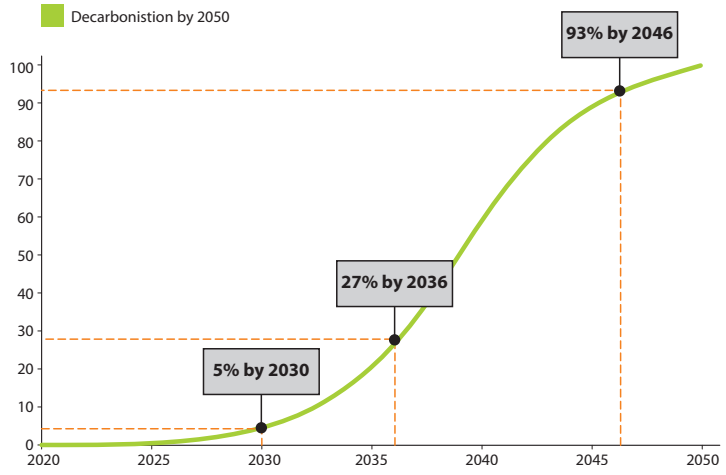
How can the 5% target be reached?

There are three primary sub-segments of shipping that could move first and achieve this 5% target. Firstly, container traffic is likely the first shipping sector to start to decarbonise as a few ports/routes account for a large share of volume, and the sector is closer to the end consumer. For example, ten large deep-sea routes accounted for seven million tonnes of CO_2 in 2018. These routes could make up 0.8% of the total 5% needed.

If ammonia is selected, ammonia and LPG tankers are well suited to be the first movers. It is also valid for ships used to transport other hydrogen-derived fuels. Ammonia transport alone accounted for approximately 0.1% of emissions in 2018. Together with LPG tankers, the sum could be 2% of the total 5% needed. It is an upper bound and would require high rates of transport demand growth.

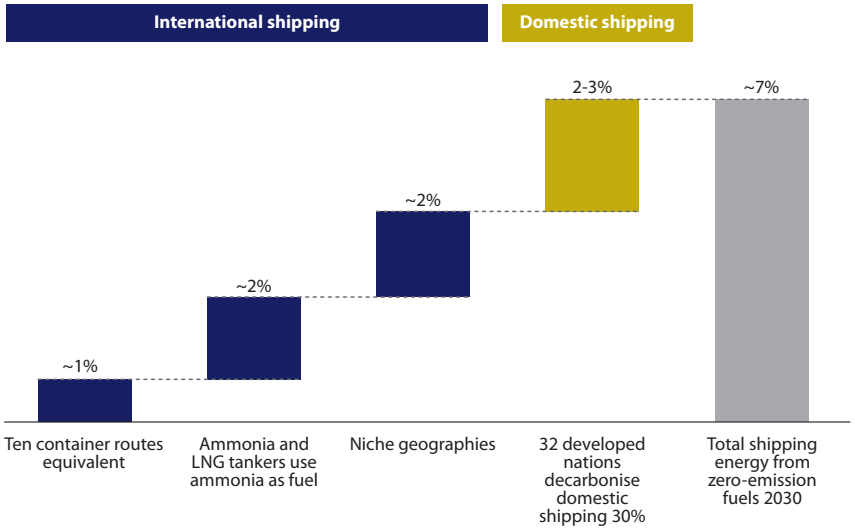
Niche international routes (non-container shipping) have a high likelihood of enabling conditions for zero-emission fuel first movers. For instance, Chile-US, Japan-Australia, Dubai-Singapore, Australia-Singapore, and Denmark-Norway could provide another 2%.

Fig. 2. Zero-emission fuel adoption rate (per cent of fuel per year)



Sources for Figs. 2-3: COP26 Climate Champions; UMAS

Fig. 3. Zero-emission fuel adoption contribution per lever 2030 (per cent of total shipping propulsion energy)



In addition, domestic shipping could account for another 2-3%. A total of 32 developed nations make up approximately 50% of domestic shipping emissions. If they achieve 30% of energy from zero-emission sources, this will correspond to 15% of domestic shipping energy and 2-3% of total shipping energy. Therefore the UN Climate Champions have set 15% of zero-emission fuels by 2030 as the Breakthrough necessary for domestic shipping.

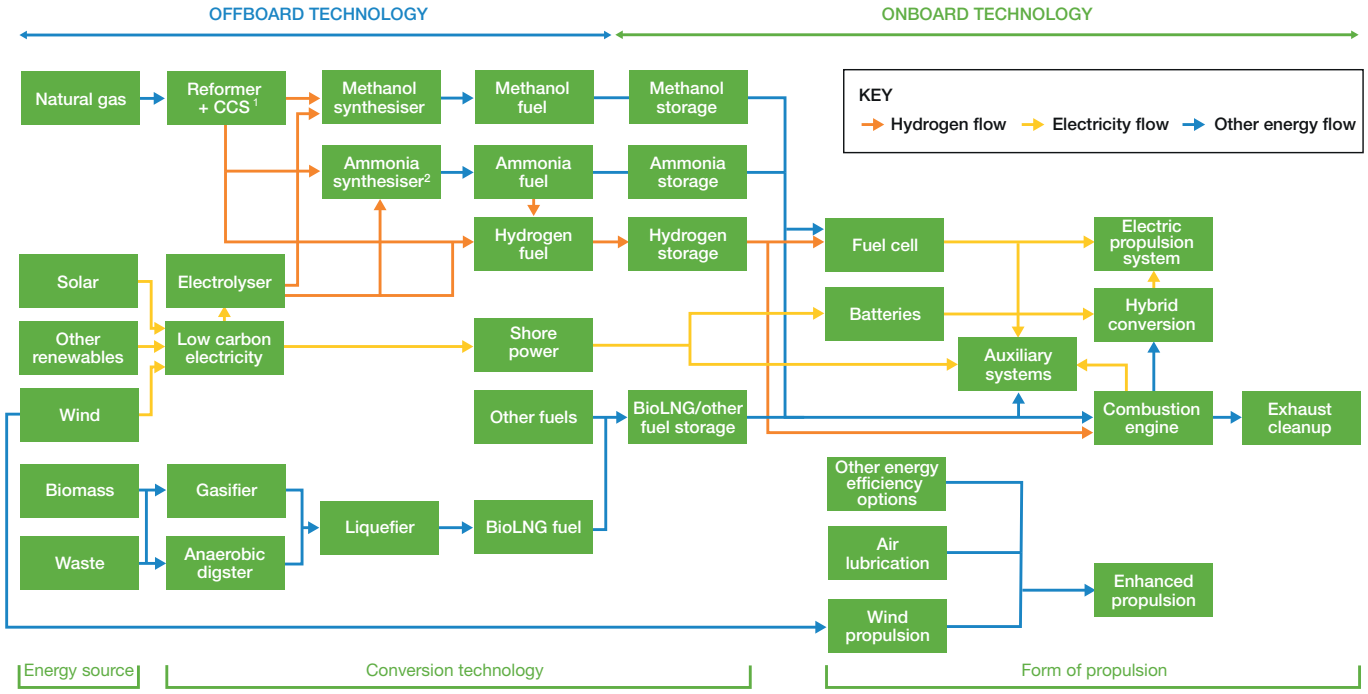
Can supply meet a 5% demand by 2030?

The Getting to Zero Coalition's definition of "zero carbon energy sources" is intended to be inclusive of fuels derived from zero-carbon electricity, biomass, and the use of carbon capture and sequestration. It excludes, however, energy sources derived from carbon capture and utilisation based on the combustion of fossil fuels. The definition includes green hydrogen and its derivatives, such as ammonia and methanol, blue hydrogen and its derivatives, and sustainable biofuels.

In terms of scalability, hydrogen-derived fuels have the most considerable long-term potential for rapid scaling in the following decades. As such, they should be a significant part of the 2030 fuel mix. Therefore, a key question is: will it be possible to supply enough hydrogen-derived fuels for international shipping to enable up to a 5% penetration by 2030?

UMAS estimates that the overall energy need for shipping will be 12.9 Exajoules in 2030. Five per cent of this amounts to 0.64 Exajoules (or 15.8 million tonnes of heavy fuel oil equivalent). Assuming that the hydrogen-based fuel used is ammonia, to produce it in this amount would require roughly 60 gigawatts of green hydrogen electrolyser capacity.

Fig. 4. Technologies and fuels on a pathway to zero-emission shipping



[1] *Steam Methane Reformer (SMR) + Carbon Capture & Storage*
[2] *Equipment used for the Haber Bosch process*

Source: Frontier Economics for UK Department for Transport

The 60 gigawatt of green hydrogen electrolyser capacity for shipping by 2030 is achievable when considering the large-scale ambitions announced by leading economies. To name a few: Australia has committed more than $500m to back new hydrogen projects; Chile is aiming for five gigawatts of electrolysis capacity under development by 2025; China has a goal to support demand for 60 million tonnes of hydrogen by 2050 (equivalent to 510-gigawatt electrolyser capacity); the EU's 2020 Hydrogen Strategy articulates an objective to install at least 40 gigawatts of renewable hydrogen electrolysers by 2030 and support production of up to ten million tonnes of renewable hydrogen by the same year (eq of 85-gigawatt electrolyser capacity); and Japan that intends to boost the amount of power it plans to generate using hydrogen, looking to burn about 10 million tonnes annually by 2030 (eq of 85-gigawatt of hydrogen electrolyser capacity).

In addition, the Green Hydrogen Catapult is an initiative by seven green hydrogen industry leaders – Yara, Iberdrola, Ørsted, ACWA Power, CWP Renewables, Snam, and Envision – to deliver 25 gigawatts of green hydrogen electrolyser capacity by 2025 at $2/kg. Their long-term goal is to align the production and use of green hydrogen with a trajectory that displaces fossil fuels at a rate consistent with achieving net-zero global emissions by 2050. With a green hydrogen price of $2/kg, the cost of green ammonia would be roughly double that of heavy fuel oil.

Unlocking green hydrogen

Several other actions are needed to reach the right quantity and price of green hydrogen and boost zero-emission fuels by 2030. For example, large scale system demonstrations would help to showcase feasibility and draw conclusions. Freight purchasers can also give essential demand signals by committing to use zero-emission fuels even if available at a certain premium. The need for rapid deployment of capital and low-cost, long-term investments requires institutional investors and IMO regulation in line with Paris targets focusing on operational efficiency measures and incentives to adopt zero-emission fuels.

In conclusion, a quantified target for zero-emission fuel adoption by 2030 would help mobilise industry stakeholders. Zero-carbon fuels will need to account for approximately 5% of the fuel mix by 2030 to decarbonise international shipping by 2050 (1.5°C aligned). Even if the target is a 50% absolute reduction by 2050, this still requires rapid growth of zero-carbon fuel use in the 2030s, which requires a similarly small initial use by 2030.

Achieving this is feasible on all counts – regarding fuel supply, vessel technology, port infrastructure, safety, demand, government commitment, and finance. □

GLOBAL MARITIME FORUM

The Global Maritime Forum is an international not-for-profit organisation committed to shaping the future of global seaborne trade to increase sustainable long-term economic development and human wellbeing. Head to **www.globalmaritimeforum.org** to learn more.

Getting to Zero Coalition

The Getting to Zero Coalition – a partnership between the Global Maritime Forum, the Friends of Ocean action, and the World Economic Forum – is a powerful alliance of more than 120 companies within the maritime, energy, infrastructure and finance sectors, supported by key governments and IGOs. The Coalition is committed to getting commercially viable deep sea zero-emission vessels powered by zero-emission fuels into operation by 2030 – maritime shipping's moon-shot ambition. Go to **www.globalmaritimeforum.org/getting-to-zero-coalition** to find out more.