INSIGHT BRIEF

The scale of investment needed to decarbonize international shipping

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This Insight Brief is based on analysis by UMAS and the Energy Transitions Commission for the Getting to Zero Coalition, a partnership between the Global Maritime Forum, the Friends of Ocean Action, and the World Economic Forum.

To make the decarbonization of the maritime shipping sector successful, the coming three decades will need to see a fundamental shift towards zero carbon energy sources[1]. This implies a need for significant investments into new fuel production, supply chains, and a new or retrofitted fleet. The aim of this insight brief is to gauge the capital investment needed to achieve decarbonization outcomes in line with the IMO Initial Strategy. This Insight Brief is based on new analytical work conducted by University Maritime Advisory Services (UMAS) and Energy Transitions Commission (ETC)[2].

Around USD 1 trillion in investments needed to decarbonize shipping

The scale of cumulative investment needed between 2030 and 2050 to achieve the IMO target of reducing carbon emissions from shipping by at least 50% by 2050, is approximately USD 0.8-1.2 trillion, or on average between USD 40-60 billion annually for 20 years. This estimate should be seen in the context of annual global investments in energy, which in 2018 amounted to USD 1.85 trillion[3] .

If shipping was to fully decarbonize by 2050, this would require extra investments of approximately USD 400 billion over 20 years, making the total investments needed between USD 1.2-1.6 trillion dollars.

[1] The term zero carbon energy sources should be understood as including zero carbon and net zero carbon energy sources. See definition of zero carbon energy sources: http://www.globalmaritimeforum.org/content/2019/09/Getting-to-Zero-Coalition_Zero-carbon-energy-sources.pdf

[2] The analysis uses the GloTraM model to estimate the profit maximising solutions (combination of decarbonisation choices), given a number of different fuel and machinery options. Some cost reductions over time are incorporated into the projections, but all estimates are uncertain and should be used as a guide to the scale only, due to the rapidly evolving nature of underlying technologies.

[3] International Energy Agency: World Energy Investment 2019

The estimate of investments required is based on ammonia (NH_3) being the primary zero carbon fuel choice adopted by the shipping industry as it moves towards zero carbon fuels[4]. Under different assumptions, hydrogen, synthetic methanol, or other fuels may displace ammonia's projected dominance, but the magnitude of investments needed will not significantly change for these other fuels.

To avoid shifting emissions upstream, it is important that efforts to decarbonize shipping also include the decarbonization of fuel production. The analysis is therefore based on the use of low/zero carbon hydrogen as input to the production of ammonia.

Figure 1 shows the modelled capital investment needed for two different overall rates of decarbonization – a 50% GHG reduction by 2050 on the way to 100% by 2070, as per the IMO mandate, and a 100% GHG reduction by 2050, as per a 1.5°C scenario.

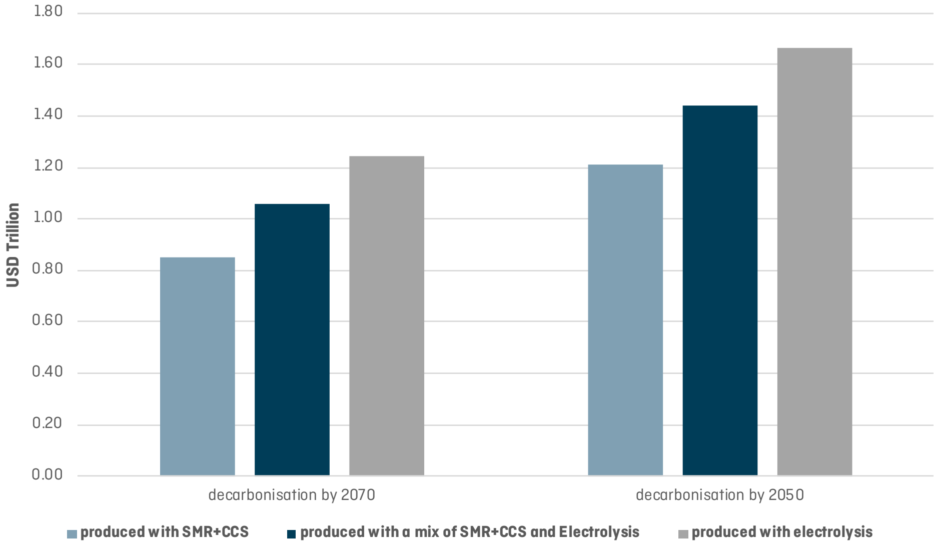

Figure 1: *Total investments needed to achieve IMO decarbonization targets and investments needed to fully decarbonize shipping by 2050*

The investments needed depend on the production method for the hydrogen used to produce ammonia. The figure shows the total investment in infrastructure needed for three different methods of hydrogen production: pure electrolysis production, production based on pure steam methane reformation (SMR) with carbon capture and sequestration (CCS), and a mix between the two.

The investment to produce hydrogen from natural gas with carbon capture and sequestration is estimated to be lower than production of hydrogen from electrolysis. However, it cannot from this be concluded that hydrogen from SMR+CCS will be cheaper than hydrogen from renewable electricity, as this will also depend on the price of the energy feedstock.

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4 Ammonia (NH_3) is primarily produced through a chemical process where hydrogen reacts with nitrogen taken from the air to form ammonia. The competitiveness of ammonia in the model stems from the fact that ammonia is cheaper and easier to store (both onshore and onboard) than hydrogen and cheaper to produce than synthetic hydrocarbons such as methanol.

The major need for investment is upstream in energy and fuel production

Investment needs can be broken down into two main areas: Ship related investments, which include engines, on-board storage and ship- based energy efficiency technologies, and land-based investments, which include investments in hydrogen production, ammonia synthesis and the land based storage and bunkering infrastructure.

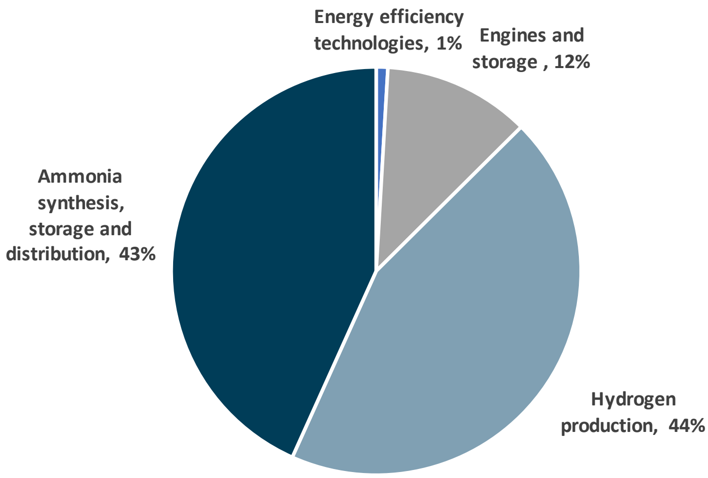

***Figure 2**: Investment breakdown across vessels and land-based infrastructure*

The biggest share of investments is needed in the land-based infrastructure and production facilities for low carbon fuels, which make up around 87% of the total investment[5]. Hydrogen production make up around half of the total land-based investments needed, while ammonia synthesis and storage and bunkering infrastructure make up the other half.

Only 13 % of the investments needed are related to the ships themselves. These investments include the machinery and onboard storage required for a ship to run on ammonia both in newbuild ships and, in some cases, for retrofits. Ship-related investments also include investments in improving energy efficiency, which are estimated to be higher due to the higher fuel costs of ammonia compared to traditional marine fuels.

[5] This breakdown is based on the scenario where shipping achieves a 50% reduction in GHG emissions by 2050 using a combination of SMR+CCS and electrolysis to produce zero carbon hydrogen. The other scenarios show a similar but not identical distribution of costs.

Green and blue hydrogen potential feedstocks for zero carbon ammonia

A major component of the investments is related to the production of low/zero carbon hydrogen, which can either be produced from natural gas using steam methane reformation (SMR) combined with carbon capture and storage (blue hydrogen) or from renewable electricity and water through electrolysis (green hydrogen).

The relative competitiveness of the two options is a function of the investment costs and the prices of electricity and natural gas and will be significantly influenced by technology development and policy choice. In the medium- to long-term, the rapidly falling price of renewable electricity[6] and a reduction in electrolyser costs are expected by some to make electrolysers the lower cost production solution in many geographies[7] – even if electrolysers are a more expensive option in capital cost terms.

Meanwhile, costs of CCS are also expected to decrease as technologies move beyond pilots and demonstrations. Acceleration of cost reductions for CCS would allow for a competitive marketplace between green and blue hydrogen, likely influenced by contextual geography and policy.

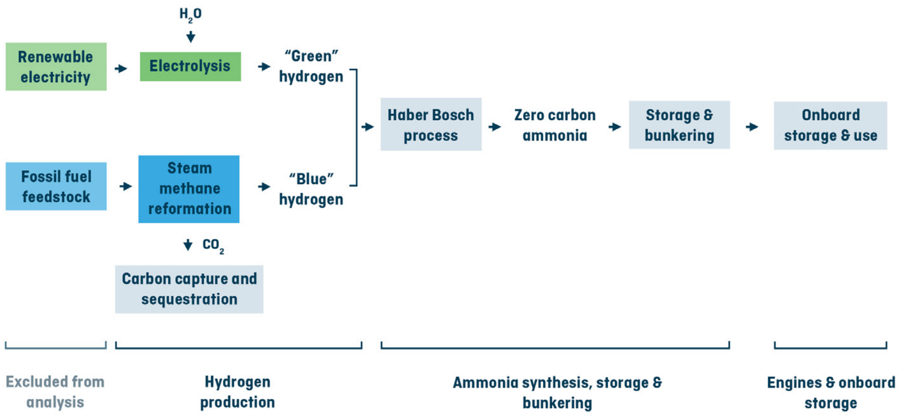

***Figure 3**: Zero carbon ammonia production chain*

Synthesis and conclusions

Whilst research and development is valuable across all technology areas pertinent to shipping's decarbonization, the opportunity to reduce the overall costs of decarbonization is greatest in the upstream production of fuels. This emphasizes the need to involve stakeholders across the full fuel value chain to make the transition possible in the most economically efficient manner.

6 https://www.bloomberg.com/news/articles/2019-08-21/cost-of-hydrogen-from-renewables-to-plummet-next-decade-bnef

7 https://www.yara.com/news-and-media/news/archive/2019/yara-and-engie-to-test-green-hydrogen-technology-in-fertilizer-production/

Hydrogen and ammonia have multiple applications in today's economy and likely increasing roles in the global economy across energy storage, low carbon heat, transport fuels and, in the case of ammonia, as a key input in the production of fertilizer. This means that investments in hydrogen and ammonia production can serve other purposes than supplying fuels for shipping, which can create synergies and reduce the investment risk, especially in the early phase of the transition.

Finally, it is important to note that the significant investments needed to decarbonize shipping can only be expected to happen if there is a long term commercially viable business case. Technological developments alone – although very important – are not expected to be enough to create such a business case as the costs of zero emissions fuels are expected to be significantly higher than traditional fossil fuels used in shipping in the coming decades.

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.

About the Getting to Zero Coalition
The Getting to Zero Coalition is an industry-led platform for collaboration that brings together leading stakeholders from across the maritime and fuels value chains with the financial sector and other committed to making commercially viable zero emission vessels a scalable reality by 2030.