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Lessons from Other Sectors for Enabling the Deployment of New Low Carbon Technologies in Shipping

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I. Executive Summary

The International Maritime Organization (IMO) in April 2018 adopted its Initial GHG Emission Reduction Strategy[1], with the aim of reducing international shipping's total annual greenhouse gas (GHG) emissions by at least 50% by 2050 compared to 2008, while, at the same time, pursuing efforts towards phasing them out entirely.

The strategy, adopted by the IMO Member States at the 72nd session of IMO's Marine Environment Protection Committee (MEPC), includes a specific reference to "a pathway of CO2 emissions reduction consistent with the Paris Agreement temperature goals". The Initial Strategy includes candidate short-, mid- and long-term further measures with possible timelines; and it identifies barriers and supportive measures including capacity building, technical cooperation and research and development (R&D).

The IMO will have to design and implement policies to ensure the maritime sector reduces greenhouse gases in a cost effective and swift manner. In designing such measures, the IMO has the opportunity to learn from other sectors that have already tried and tested a variety of policy options to drive investments in reducing greenhouse gas emissions.

This report draws out lessons learnt from various countries and sectors already reducing emissions. It highlights policies that can increase in-sector technology innovation, investment and commercialisation of technologies, and that can be adapted to the maritime sector.

The key findings from the research:

1. The EU energy sector is on the path to reducing emissions, despite being a highly capital intensive sector, by utilising multiple policies. For example, the UK has used at least four different policies to incentivise the electric power generation sector to decarbonise. These include obligations to invest in zero emission technologies, contracts for difference to underwrite investments, and emissions trading and carbon pricing policies.

2. Standardised ways of underwriting investments, including accrediting and issuing certificates for the purchase and use of abatement technologies in the sector, could provide early measures within the strategy. For example, the ship-owner could claim support from a shipping fund for upfront capital costs and any additional running costs on the basis that the ship operates with cleaner propulsion fuels or technologies that would lead to a reduction of a specified quantity of emissions over a given time period.

[1] International Maritime Organisation (2018), UN body adopts climate change strategy for shipping. [online] Available at: http://www.imo.org/en/MediaCentre/PressBriefings/Pages/06GHGinitialstrategy.aspx [Accessed 16 May 2018].

3. Existing funds provide examples of how finance can be raised and distributed through well-defined evaluation processes and a variety of instruments (e.g. grants, loans, guarantees) tailored to the sector's needs. Specifically, the Norwegian NOx Fund has provided over 1,000 grants leading to emission reductions of 16,000 tonnes of NOx in between 2011-17 and has led to a new agreement until 2023 to reduce emissions further.[2] By drawing on these already defined funding bodies, the research identifies seven key design principles for an IMO fund to ensure that revenues raised are well managed and used effectively to reduce emissions.

4. Environmental integrity is essential to ensure that there are real and additional carbon benefits from any project or policy. The aviation sector has developed sustainability criteria to take into consideration the whole carbon lifecycle of low carbon alternatives, such as alternative fuels. Such criteria reduce the risk of double counting and increases the robustness of policy incentives to create real emission reductions. The shipping sector should incorporate lessons from other sectors on environmental integrity to allow for real and additional emission reduction projects. These lessons learnt should assist the discussion of the range of ambition for climate mitigation within the shipping sector and the instruments that will be adopted at the IMO. It is likely that multiple policy instruments will be needed for greenhouse gases to be fully eliminated, but there is a wealth of experience to draw from that can be adapted to suit the particular circumstances of the shipping sector.

[2] The NOx Agreement. NHO [online] Available at: https://www.nho.no/Prosjekter-og-programmer/NOx-fondet/The-NOx-fund/The-NOx-Fund-and-the-Environmental-Agreement/The-Environmental-Agreement/ [Accessed 16 May 2018].

II. Introduction

The IMO has adopted an initial strategy to reduce greenhouse gases from international shipping. While shipping is only at the beginning of its greenhouse gas reduction journey, other sectors around the world have already begun theirs. This paper draws out lessons from some of those sectors, particularly focusing on the UK electricity sector, for the IMO to consider when adopting measures to drive confident and fast decarbonisation in the sector. A separate Environmental Defense Fund (EDF) paper has set out the potential legal pathways for these options which was published in June 2018.[3]

Policy options available to address quantitative limits on greenhouse gas emissions range from the introduction of sector specific regulations to the introduction of softer incentives to drive consumer behaviour. In between are policies designed to give the companies and investors within a sector of the economy the right economic incentives to act. Such policies may seek to achieve various goals – e.g.

- to provide industry stakeholders, customers and the public with information about the actual emissions consequences of their chosen economic activities;
- internalise the price of greenhouse gases emissions;
- cap absolute emissions; stimulate competition and innovation to find cheaper, faster, deeper reductions;
- and/or provide financial rewards in line with the costs and risks associated with the technologies for those who invest in effective abatement.

It is unlikely that only one policy option would be able to decarbonise any sector fully, including the shipping sector, instead a variety of measures will be needed.

This paper focuses mainly on the category of policies that provide financial rewards in line with the costs and risks associated with investing in new technologies that are not price competitive with existing options. The options for abating greenhouse gases in any sector range from 'no-regrets' efficiency improvements, to targeted and relatively costly research, development, and deployment (RD&D) of new technologies. Importantly, between these extremes are those options that may exist already but require an enabling policy environment to unleash them and facilitate competition across different alternative technologies or fuels to drive the cheapest, most effective environmental solutions. In some cases, particular technologies or fuels (for example hydrogen or ammonia for use as shipping fuel) may require innovative finance or deployment support to address up front capital costs and higher running costs to enable them to compete on price and enter the market.

The shipping sector sits at such a crossroads, with proven solutions needing policies that incentivise their deployment while driving down their costs. This may come in the form of innovative finance from internalising the external cost emitting greenhouse gases has on the

[3] O'Leary and Brown, IMO Climate Measures, Sabin Center for Climate Change Law, http://columbiaclimatelaw.com/files/2018/06/OLeary-and-Brown-2018-06-IMO-Climate-Measures.pdf

environment and economy. Such a policy, combined with a recycling of revenues raised, can support the high up-front capital costs and additional operational (and other) costs while maintaining a level playing field in highly competitive markets across all types of international shipping vessels. Looking at other sectors that moved beyond the same crossroads, we have found that once proof of concept and uptake in a commercial market is overcome, new technologies can rapidly scale and costs can be reduced dramatically. This in turn leads to a more natural and enduring market in zero and low carbon energy sources that can compete with little or no subsidy. Section III of this paper illustrates how different measures and funds developed in different countries and sectors supported the deployment of proven technologies across different sectors and the lessons shipping could draw from them. Section IV of this paper looks at existing low carbon funds and considers whether any of them would be suitable for use in the shipping industry.

III. Internalising the cost of greenhouse gas emissions

The following categories of policies have been used in stationary sourced energy sectors to bring innovation into otherwise highly capitalised, competitive markets with relatively long-lived assets by internalising the price of greenhouse gases to ensure that quantified emissions reduction targets are met.

Obligations

In the UK power sector, the Non Fossil-Fuel Obligation and the Renewables Obligation operate in a similar manner, requiring electricity companies to purchase electricity from renewable sources, for example nuclear, solar or wind. This has resulted in the UK power sector now producing over 40% of its electricity from renewable sources.[4] Within the transport sector, California and China require manufacturers to supply a certain number of zero emissions vehicles in their fleet. The California policy will have supported almost half a million zero emission vehicles to get on the road by 2020.[5] While in China these interventions have made the country the largest manufacturer of electric vehicles in the world, accounting for around 45% of the world's supply. [6]

These types of obligations are sometimes structured by requiring manufacturers/electricity suppliers to certify that they are meeting their obligations. To reduce costs and aid compliance, these policies may contain trading elements, by which a manufacturer or supplier that does more than it is required to do can trade its surplus compliance to one that under-performs. Stringent monetary penalties for non-compliance, and continuing compliance obligations, are needed to ensure that manufacturers/suppliers don't simply under-perform and then pay to get out of their obligations.

Tariffs

'Feed-in Tariffs' (FiT) have also been used successfully to enable clean technologies to enter existing markets. Investors in clean technologies are guaranteed a set rate of income for the output they provide to the market. For example, the power sector receives income for every MWh of electricity from eligible clean sources. The setting of the tariff rate is based on predicted rates that will be sufficient to encourage investment but not create excess profits for investors. The retailer (e.g. the electricity supplier) meets the costs of providing these guaranteed prices, which passes it

[4] Renewables Obligation (RO) buy-out price and mutualisation ceilings for 2018-19 RO Year (Ofgem, 2018). Available at: https://www.ofgem.gov.uk/publications-and-updates/renewables-obligation-ro-buy-out-price-and-mutualisation-ceilings-2018-19-ro-year [accessed 22 June 2018]
[5] What is ZEV? | Union of Concerned Scientists - ucsusa.org. [online] Available at: https://www.ucsusa.org/clean-vehicles/california-and-western-states/what-is-zev [Accessed 5 Mar. 2018].
[6] Electric cars: China's highly charged power play. [online] Financial Times. Available at: https://www.ft.com/content/00b36a30-a4dd-11e7-9e4f-7f5e6a7c98a2 [Accessed 16 May 2018].

on to consumers. The UK FiT has supported over a gigawatt of smaller scale renewable energy projects coming to market.[7]

A key design feature of such a policy is the setting of the levels of the tariff, which involves estimation of the additional costs for low carbon technologies and a fair rate of return. Tariff levels need to be adjusted over time in light of changes in the market. The actual payment and recovery of the additional cost is born by the electricity companies that are obliged to offer the terms set to eligible generators. A similar structure for shipping could incentivize ships to use fuels that are demonstrated, on a life-cycle basis, to emit low- or zero-carbon (potentially including, e.g., hydrogen/ammonia) for a certain number of years, with the incentive decreasing as the fuels reach market parity on price.

Contracts for Difference

These policies are a variation on the fixed tariff described above. They offer long-term contracts between the government and investors in projects deploying clean technologies. Investors are offered a fixed level of income for a project that takes the risk out of market variation – for example a fixed price contract is offered relative to wholesale energy prices/carbon prices and the difference is compensated from a central fund. In the event the market price is ever higher than the contracted level, the difference is paid back in to the fund.

The costs involved in meeting the terms of the contracts is recovered by a levy applied to all electricity sold on the market. Suppliers collect the levy based on the volume they supply in the market. In the UK the total value of all contracts awarded is kept in check by the setting of a limit on the total sum that can be added to energy bills (the Levy Control Framework), this is based on an estimate of what will be needed to comply with future carbon budgets. The UK Contracts for Difference policy was not originally designed to support only renewable energy, but under a revision is supporting the deployment of at least four gigawatts of offshore wind and other renewable energies out to 2026.[8]

A shipping contracts for difference market could be set up to allow shipowners to bid in with negative emissions e.g. a certain ship will bid in with the minimum they would require to retrofit or operate their ship in a certain way (and so reducing emissions by a certain amount) or the minimum required to convert and run a ship on a low- or zero-carbon fuel. The lowest bids (adding to a certain reduction amount) would be accepted and those shipowners would receive the subsidy.

Cap and Trade

[7] Ofgem.gov.uk. (2018). Feed-in Tariffs: Quarterly statistics. [online] Available at: https://www.ofgem.gov.uk/environmental-programmes/fit/contacts-guidance-and-resources/public-reports-and-data-fit/feed-tariffs-quarterly-statistics [Accessed 5 Mar. 2018].
[8] Gov.uk. (2016). Response to the Levy Control Framework Lessons Learned Report. [online] Available at: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/572544/Response_to_LCF_Lessons_Learned_FINAL_18-11-16__2_.pdf [Accessed 5 Mar. 2018].

Cap and trade policies are designed to be widely applied (the EU's includes nine different industrial sectors, covering around half of Europe's emissions) to create a liquid trade in cost effective carbon abatement. The overall level of abatement these policies require the participants to take is set through distribution of a limited supply of allowances that line up with an agreed decarbonisation target. They enable a trading market in emissions allowances between participants, and sets the price of emitting by the balance of supply and demand in the market. They establish the environmental goal in advance by fixing the quantity of allowable emissions; abatement costs are then "discovered" through the marketplace. One important goal of these systems is to tap competition and transparency to grind down the costs of abatement. Experience with these systems indicates that typically, the costs of abatement are far lower than the ex-ante expectations. While this demonstrated ability to achieve environmental goals at lower-than-expected costs is of value for society overall, investors in particular technologies can be disappointed by the lack of price certainty. To address this, some systems have instituted price floors and strategic reserves of allowances, such as is the case in the California trading system. Another goal of such systems can be to raise funds to help defray the transition costs of decarbonisation, including programs to help workers train for the transition. If that is a goal, these systems can design programs to auction portions of the allowances, and either direct the auction revenue to such programs, as has been done in the EU and California, or rebate the auction revenue to the industry directly, as the U.S. Acid Rain Trading Program did. A number of submissions from various countries have outlined how cap and trade could work for the shipping sector.[9]

Carbon levy or tax

A carbon levy or tax sets a price for carbon emissions but does not set a quantity of emission reductions to be achieved or a fixed total volume of emissions to stay within. Such policies drive reductions in emissions that, on a discounted-present-value-basis, cost less than the carbon price. If, taking into account substitution elasticities, the discounted-present-value of the levy is less than the comparable cost of innovation to develop and deploy long-term investment in decarbonisation, economically rational investors will choose to pay the levy instead of investing in new technologies to reduce their exposure to the carbon levy. The setting of the level of the levy is key to determining the environmental outcome and a range of options exist for determining the appropriate level. There are three main ways to set the levy price:

1. The Social Cost of Carbon: the cost of the damage done per tonne of CO_2 or other greenhouse gases.[10]
2. Using a Marginal Abatement Cost (MAC) Curve: MAC curves show the marginal cost of different interventions and associated emissions reductions. The level of the levy can then be set on this basis, taking into account discounted present values over time. A real world example is the UK's carbon tax, which is set at a level which aims to incentivise natural gas

[9] For example, see submissions to the IMO: MEPC 61/4/22, MEPC 59/4/24, GHG-WG 1/5/5, MEPC 60/4/22, MEPC 60/4/26 and GHG-WG 3/3/8.
[10] Climate Damage on Production or on Growth: What Impact on the Social Cost of Carbon?, Guivarch, C. & Pottier, A. Environ Model Assess (2018) 23: 117. https://doi.org/10.1007/s10666-017-9572-4

over coal, on the thesis that to the extent that gas has a lower climate impact per BtU, its use is preferable as a bridge to zero-carbon technologies in the future.[11]

3. Raising a Set Amount: the shipping sector could attempt to raise a set amount in order to support certain zero-emission vessel deployment numbers or the additional operational costs of low carbon steaming for a specific amount of vessels.

Section V of this report goes into detail on how those funds could be spent to support such deployment or higher operational costs.

[11] Researchbriefings.files.parliament.uk. (2018). Carbon Price Floor (CPF) and the price support mechanism. [online] Available at: http://researchbriefings.files.parliament.uk/documents/SN05927/SN05927.pdf [Accessed 5 Mar. 2018].

IV. Ensuring Environmental Integrity

One of the most important lessons to ensure environmental integrity, learnt across multiple jurisdictions, is that the entire carbon lifecycle of low carbon alternatives, such as alternative fuels, need to be fully accounted for. This is because burning carbon fuels emits CO2 into the atmosphere, whether from fossil fuels or alternative fuels. The benefit of alternative fuels comes from the supply chain which actually sequesters more carbon (or emits less carbon) than fossil fuel production.[12] Calculating the full life cycle contribution of fuels is difficult and results vary widely depending on the nature of the solution. Ensuring incentives do not encourage use of fuels that are actually worse for the climate is important but not straightforward. There is evidence, for example, that the European Union's decision to "count" palm oil as "carbon-neutral," regardless of how the palm oil was produced, has led to enormous increases in deforestation in Southeast Asia.[13]

Paragraph 6 of Assembly Resolution 39-3 of the International Civil Aviation Organization (ICAO) Assembly Resolution (October 2016), establishing the Carbon Offsetting and Reduction Scheme for International Aviation (CORSIA), states that "a methodology should be developed to ensure that an aircraft operator's offsetting requirements under the scheme in a given year can be reduced through the use of sustainable alternative fuels".[14] In pursuit of this methodology, the international aviation sector has undertaken a multi-year process to develop lifecycle accounting standards for alternative fuels. This ensures their carbon benefits – and disbenefits, if they are more greenhouse gas intensive than conventional fuels – can be appropriately credited (or debited) in airlines' efforts to meet the ICAO target of carbon-neutral growth from 2020. It also ensures that these emission reductions are not being double-counted by host countries where the fuels originate. This work has sought to build on work already undertaken in a variety of forums, including, for example, the Roundtable on Sustainable Biofuel (RSB)[15]. Shipping should carefully take account of the work undertaken by, and lessons learned from, the ICAO process. The shipping sector will also need to consider carefully any incentive for alternative fuels and technology to ensure that such incentives take into account the best available science.

Furthermore, environmental integrity requires us to take into consideration the additionality of support. This means the development of any new policies must take into account other pre-existing incentives and ensure that any policy put in place creates more emission reductions than would have occurred without its implementation. To calculate if a policy will create additionality, a baseline must be developed with the occurrence of additionality being determined by assessing whether a proposed activity is distinct from the baseline. For example, within the shipping sector, this may involve developing a baseline of emission reductions from current policies, such as the

[12] Timothy D et al, Fixing a Critical Climate Accounting Error, Climate change, Science, 326 23 OCTOBER 2009 527.
[13] Will the EU call the palm oil nations' bluff (2018) Transport and Environment. www.transportenvironment.org /newsroom/blog/will-eu-call-palm-oil-nations%E2%80%99-bluff [Accessed 5 Mar. 2018].
[14] Assembly Resolution 39-3 of the International Civil Aviation Organization (ICAO) Assembly Resolution, 2016.
[15] IUCN. (2008). Roundtable on Sustainable Biofuels. [online] Available at: https://www.iucn.org/content/roundtable-sustainable-biofuels [Accessed 16 May 2018].

EEDI and SEEMP, and assessing how a carbon price creates additional emission reductions beyond that baseline.

The majority of policy options discussed in this paper require that real world outcomes can be measured so that abatement can be quantified. An early measure that could form part of the greenhouse gas strategy would be to introduce standardised accreditation and certification for abatement in the sector, calculated from fuel inputs, which could be based on the IMO Data Collection System[16] (DCS). For example, a ship investing in a cleaner propulsion mechanism could claim support on the basis of the operation of the ship over a given time period. It would be possible to verify this using a combination of voyage logs, fuel delivery notes and Automatic Identification System.

[16]Verifavia-shipping.com. (2016). EU MRV vs. IMO fuel consumption data collection system Verifavia Shipping. [online] Available at: http://www.verifavia-shipping.com/shipping-carbon-emissions-verification/press-media-eu-mrv-vs-imo-fuel-consumption-data-collection-system-155.php [Accessed 16 May 2018].

V. Redistributing the Finance Raised

The distribution of any funds raised from climate policies is as important as the choice about how to set the rate. The shipping industry will face the question of whether to send any monies raised out of sector (i.e. purchase offsets on a market) or use the money to support in-sector decarbonisation. In addition, the difficult question of how Common But Differentiated Responsibilities and Respective Capabilities (CBDR-RC) could be operationalised for shipping remains. One potential way would be to incorporate CBDR-RC into the use of any the finance raised.[17]

Given the scale and nature of the shipping sector, which benefits from the availability of low carbon technology alternatives, the IMO should strongly consider the introduction and management of its own climate mitigation fund. This will ensure access to funding is available to all participants in the market seeking finance to compensate for investments in clean technologies with a higher risk profile or long payback periods.. The IMO can establish such a fund in ways that help address particular challenges in different regions of the world whilst still upholding the 'no more favourable treatment' principle.

The estimated costs for a clean transition differ depending on scenarios due to the external factors involved (e.g. electricity price and demand for alternative fuels in other sectors).[18] However, if the IMO sets a levy with the explicit aim of raising a set amount of money rather than on the basis of the social price of carbon or using a MAC curve, a very simplistic calculation provides an estimate of the scale of any potential fund. For example, USD of at least 50bn per annum could be raised from a $25 levy of the price of a tonne of fuel that could be used to fund innovative finance to help drive the transition to decarbonisation.[19] This type of change in fuel price is not by any means large in the context of standard marine fuel price fluctuations, and therefore has been seen to not create a large impact on the cost of goods in developing countries according to established studies.[20] However, the impact to states and differentiation are topics that need further discussion and research. Nevertheless, any effect on final consumer prices should be much reduced by recycling the money from the levy back into the industry decarbonisation fund. Any costs to consumers further need to be balanced against the costs of climate change if emissions are not reduced. A well-managed fund could also look to add in additional funds from sources other than just a levy on fuel, including multilateral development and private finance.

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[17] EDF will produce a separate paper on this topic later in 2018.
[18] International Maritime Organisation (2018), ISWG-GHG 3/3 and Zero Emission Vessels 2030. How do we get there (2017) [online] Lloyd's Register and UMAS. Available at: https://www.lr.org/en/latest-news/defining-decarbonisation-pathway-for-shipping-zero-emission-vessels-2030-study-released/
[19] Calculations are based on the per annum average HFO consumption rate from 2007-2012 as outlined in the Third IMO GHG Study 2014 against average HFO price from August 2017 to February 2018.
[20] See: Krammer, P. (2017). International trade and tourism in a CO2-constrained world. [online] Available at: http://discovery.ucl.ac.uk/10041128/1/PhD%20Final%20-%20online%20version.pdf [Accessed 5 Mar. 2018] and CE Delft. (2013). Research to assess impacts on developing countries of measures to address emissions in the international aviation and shipping sectors. [online] Available at: https://assets.publishing.service.gov.uk/media/57a08a1c40f0b6497400041a/61002-Final_report_June21.pdf [Accessed 5 Mar. 2018] and Vivideconomics.com. (2010). The competitive impacts of carbon pricing in maritime transport — Vivid Economics - Putting economics to good use. [online] Available at: http://www.vivideconomics.com/publications/the-competitive-impacts-of-carbon-pricing-in-maritime-transport [Accessed 5 Mar. 2018].

Any fund design would also be able to draw on existing lessons learnt from other systems. For example, the failure of the Clean Development Mechanism in the areas of human rights[21], transparency, additionally and geographic distribution of projects provides valuable lessons for the IMO to ensure that these controversies are avoided to ensure a well-managed fund.[22]

Norway has demonstrated the advantage of learning from past policies, as seen by the development of a fund to reduce NOx emissions from shipping that is an alternative for ships to pay into instead of a wider tax, ensuring that the revenue raised goes back in sector. Norway drew on its experience of its carbon tax which was too low to create effective change in emissions. Instead, when designing policy for NOx emissions they worked with the industry to develop a fund creating buy in and driving real emission reductions.[23] Specifically, the Norwegian NOx Fund has provided over 1,000 grants leading to emission reductions of 16,000 tonnes of NOx in between 2011-17 and has led to a new agreement until 2023 to reduce emissions further.[24] This has allowed the costs and capital risks to be reduced so that investors can access new technologies such as LNG gas and battery powered engines. This model is effective on the national level. The IMO fund could take lessons from it as well as its advisory board and project approval process.[25]

In designing the IMO's own fund, a range of options exists to recycle funds in targeted ways:

1. Fixed sum grants – providing money for pilot projects can help deliver proof of concept and demonstration projects, paying for up front R&D and capital costs as banks have little interest in financing these projects. However, such fixed sum grants do not necessarily guarantee that a project will deliver on-going emissions reductions through deployment of the solution over time if operating costs remain too high to compete in the market. There is a risk of overpaying for low results. As a result, on their own, grants may have a limited impact beyond achieving some specific research outcomes.

2. Low/zero interest loans – where capital expenditure is needed to uncover fuel savings with a relatively quick payback, investments can be triggered by providing low or zero interest loans. This has been used to encourage energy efficiency retrofits in buildings in both Germany (KfW Development Bank) and the UK (Salix Finance) (see table 1 for more detail).

[21] 155 Kylie Wilson, 'Access To Justice For Victims Of The International Carbon Offset Industry' [2011] SSRN.
[22] Shishlov, I. and Bellassen, V. (2012). 10 LESSONS FROM 10 YEARS OF THE CDM. [online] CDC Climat Research. Available at: http://www.cdcclimat.com/IMG/pdf/12-10-05_climate_report_37_-_10_lessons_from_10_years_of_cdm.pdf [Accessed 16 May 2018].
[23] The NOx Agreement. [online] Available at: https://www.nho.no/Prosjekter-og-programmer/NOx-fondet/The-NOx-fund/The-NOx-Fund-and-the-Environmental-Agreement/The-Environmental-Agreement/ [Accessed 16 May 2018].
[24] The NOx Agreement. [online] Available at: https://www.nho.no/Prosjekter-og-programmer/NOx-fondet/The-NOx-fund/The-NOx-Fund-and-the-Environmental-Agreement/The-Environmental-Agreement/ [Accessed 16 May 2018].
[25] The NOx Agreement. [online] Available at: https://www.nho.no/Prosjekter-og-programmer/NOx-fondet/The-NOx-fund/The-NOx-Fund-and-the-Environmental-Agreement/The-Environmental-Agreement/ [Accessed 16 May 2018].

3. Contracts/Contacts For Difference – underwritten contracts that guarantee a fixed rate of income over time can help to increase investor confidence in bringing technologies to market that would otherwise struggle to compete due to higher operating costs. Contracts can be awarded to anyone meeting the requirements or through a process of negotiation with a regulator, or via an auction (see below). In all cases, given the volume of finance will not be infinite and liabilities accrue as more contracts are signed, some form of competitive selection process or cut off point will be needed to keep costs reasonable and stay within a budget.

4. Certificate based support – it is possible to reward investors in cleaner projects by creating a certification system for the outcome/output and create a value for that certificate. One way of creating that value is by stipulating that a certain volume of a given output must be introduced into the market over a period of time. For example, X% of all cars sold must be zero emissions, rising by a further X% every year, or X% of all fuels provided must be below XgmCO2e/tonne. Providers of these outputs are awarded certificates that are sold to those needing to meet the requirement to support innovation. The purchase of the certificates can be done by individual firms or from a central fund collected from all firms. Rather than dictate a fixed volume of output to be procured, with no price guidance, it is also possible to decide on a fixed value for the certificates that will be awarded – leaving the volumes contracted at that price less certain. Different values for different technology bands could also be included which would enable a range of technology options at different stages in their cost curve to be commercialized (e.g. onshore and offshore wind).

5. Reverse Auctions – are a more competitive means of determining who receives the support and can be used in conjunction with any of the four other methods listed above. Through the reverse auction, sellers would bid for the prices that they are willing to sell emission reduction technology at as opposed to buyers placing bids of how much they wish to pay. In shipping, this could be arranged by shipowners bidding in for the deployment and support of technological projects that specify a certain quantity of emissions reductions.

6. Agreed Incremental Costs – this provides for the increase in total costs resulting from an increase in production or other activity. The Global Environment Facility has used it as a way to analyse the costs incurred when expanding a project that provides for local and national benefits to provide more global benefits, instead of simply paying for the entire project. For example, a country may wish to expand its electricity output, and under the agreed incremental costs, the project would receive funds for the extra costs of running a solar plant instead of a coal plant.[26]

[26] Global Environment Facility (2007), Operational Guidelines for the Application of the Incremental Cost Principle Global Environment Facility Available at: https://www.thegef.org/sites/default/files/documents/OPERATIONAL.GUIDELINES.FOR_.THE_.APPLICATION.OF_.THE_.INCREMENTAL.COST_.PRINCIPLE_0_0_0.pdf . [Accessed on 16 May 2018].

VI. Existing Investment Support Funds for Climate Mitigation

As the above list of options to recycle the funds within the sector in the previous section illustrates, funds are as diverse as the issues they aim to resolve. The table below outlines a range of international and national climate funds that could provide design options for an IMO fund. These funds have provided access to a range of technologies from lower emission engine types in the shipping sector (Norwegian NOx Fund) to improved energy efficiency technology and infrastructure (Salix Recycling Fund).

Table 1: Overview of Funds that Finance Climate Mitigation

Fund	Country	Purpose	Financed By	Fund Size USD
Climate Technology Centre and Network (CTCN)	International (UNFCCC)	Research and development assistance and capacity building	Voluntary contributions by countries and other funds, namely.	52.5 million since 2012
Global Environment Facility (GEF)	International (UNFCCC)	Assists developing countries to meet international environmental obligations	Governments of developed and developing member states	17 billion in grants and mobilised an additional 88 billion in financing for more than 4000 projects in 170 countries since 1992
Green Climate Fund (GCF)	International (UNFCCC)	Provide funding to developing countries for mitigation and adaption projects	Government and private sector	Have approved over 5 billion to be distributed since 2016
(Pilot) World Bank Methane Auction	International (World Bank)	Stimulate investment in projects to reduce GHG emissions	Backed by multiple governments	45 million since 2015
KfW	Germany	Funds German owned companies (including ship owners) to carry out energy efficiency and environmental projects at reduced interest rates.	National Government through KfW's 'Energy Turn Around Programme' and 'Environmental Programme'	The Energy Turn Around Programme distributed 127 billion between 2012 and 2016. While the Environmental Programme distributed 43 billion in 2016.

White Certificate Scheme	Italy	Stimulate reduction of energy consumption by investing in energy efficiency	National Government	N/A
Norwegian NOx Fund	Norway	Funds technological innovation projects to reduce NOx emissions from shipping	Shipping Industry based on fuel consumption and emission factor	86.5 million annually
Wave Energy Scotland	UK (Scotland)	Fund technological innovation research into wave energy	National Government	35.3 million since 2014
Contracts for Difference	UK	To reduce risk of investing in renewable energy projects for energy suppliers	Electricity suppliers, through a supplier obligation levy	1 billion annually
Non Fossil Fuel Obligations and Renewables Obligation	UK	To increase the level of electricity supplied from nuclear power and renewable energy sectors	Originally the Fossil Fuel Levy, on all electricity consumption in the UK. Since 2001, electricity suppliers bid for the electricity in competitive auctions	Distributed 612.7 million in 2017
Feed-In-Tariff	Germany	To increase renewable energy	Independent power producers (costs passed on to households, businesses and cooperatives)	25 billion pa (2014)
Salix Recycling Finance Fund	UK	Increasing public sector energy efficiency	Initially national government. Money saved from projects to cut energy costs are 'recycled' back into the fund.	792 million since 2004

IMO and external Funds

The IMO has already engaged with some external funds. For example, the GEF has provided finance for capacity building. However, the GEF is limited in its ability to fund deployment of new technologies in the shipping sector, as its mandate is to assist fulfilling international environmental conventions, focusing on capacity building for developing countries. In addition,

any project requiring more than USD 2 million can only be dispersed to Government agencies, not to private sector actors, and the fund has a complex approval process.

Another example is the IMO work with regional banks (such as the European Bank for Reconstruction and Development) to provide low risk capital for the financing of low carbon technology deployment in the shipping industry. This is welcome, but has the risk of creating market distortion with only a limited number of countries being able to access the funds available (only 66 countries can access the finance compared with the 173 member states of the IMO). The IMO is well-placed to raise and distribute its own fund to meet its climate change objectives. The IMO created International Fund for Compensation for Oil Pollution Damage (IOCP) and a similar body could be created within the sector to oversee the disbursement of funds to drive investment in addressing the risk of climate change. Although, it is envisioned that the industry will pay into this fund via a carbon price (i.e. bunker fuel levy), rather than governments themselves as in the case of the IOPC.

VII. Principles underpinning an IMO Fund

We believe a climate mitigation/technology support fund under the IMO would require a clear but flexible guiding instrument to meet the decarbonisation challenge. Any fund should encompass the following principles:

1. *Answerable to IMO rules and mandates.* Currently the only fund that is answerable to the IMO is the IOPC. If the IMO were to contribute financing to other funds, specifically those designed to mitigate and adapt to climate change these would be answerable to the UNFCCC. This becomes an issue when wishing to treat all ships and shipowners the same as these funds are limited to financing projects in developing countries only. Additionally the eligibility to use the GCF for shipping projects was rejected by UNFCCC during COP 17 in Durban.[27] For this to change in the future it would require detailed and potentially lengthy negotiations between the IMO and UNFCCC.

2. *Funds stay within sector*. International markets in climate mitigation efforts exist and provide a cost effective solution in the short term for sectors and companies finding it difficult to decarbonise. However, it is clear that the shipping sector has huge potential to decarbonise using existing and close to market solutions. It is therefore not in the long-term interest of the IMO to merely direct revenue raised from within the sector to a financing body and suite of projects outside the sector. Such an approach would reduce the sector's ability to stimulate investment – leaving it exposed to future liabilities arising from the greenhouse gas emissions for which it is responsible.

3. *Prevent market distortion*. Shipping is an international sector, thus existing funds, which limit the beneficiaries by region or by country, would increase the likelihood of market distortion. By creating an international fund under the IMO this would ensure that all ship-owners have the opportunity to access the funding but not all shipowners may be in similar positions in terms of readiness to engage with the fund. The IMO could therefore prevent market distortion by introducing rules to direct the finance towards specific objectives in different regions or allocate certain proportions of the available finance on a route-centred basis. For example, projects which finance vessels travelling only between developing countries could be granted a fixed amount of the finance than vessels that travel predominately between developed and developing countries in order to encourage broad participation.

4. *Adequate support for Research, Development and Deployment*, The scale of the opportunity in addressing greenhouse gas emissions from shipping is roughly equivalent to the challenge of decarbonising Germany's economy (or the UK's economy twice). A fund would therefore need to be large enough to support investments at scale over a sustained period until such time as new zero emissions technologies and fuels are price competitive and mainstream. To

[27] Porttechnology.org. (2011). Shipping's contribution to Green Climate Fund blocked in Durban - Port Technology International. [online] Available at: https://www.porttechnology.org/industry_sectors/shippings_contribution_to_green_climate_fund_blocked_in_durban [Accessed 5 Mar. 2018].

ensure that innovative solutions become commercialised and the higher operating costs of a low carbon vessel can be recovered in the market, deployment support policies will be needed.

5. *Evaluation of Projects,* supported by the fund. Projects will need to be assessed and approved against a fair and transparent set of published criteria. Robust monitoring reporting and verification processes need to be in place to ensure policies are delivering that is intended. In addition, the non-climate aspects of projects relating to other environmental and social safeguards will also need to be taken into account. This includes upholding human rights by creating processes to take into consideration the concerns of local communities who might be impacted and providing a whistleblower mechanism.

6. *Ensuring Additionality,* in order to maximize fairness and efficiency it is important to ensure financing is not approved for projects that would have gone ahead anyway. This is a key test that must be incorporated into the fund's approval process. In the context of shipping an additionality test would need to be applied to the finance raised to commission new builds and retrofits of existing ships - proof would be required that there is a finance gap that needs filling, which cannot be filled by other funds or financial incentives already available elsewhere.[28]

7. *Self-sufficient,* in order to serve the needs of the international shipping sector it would be prudent for any fund to be self-sufficient and not reliant on any additional sources of revenue. The IMO could take advantage of the revenue from a carbon pricing mechanism, recycling all revenue raised directly into the sector. No other existing funding mechanism has the ability to do this on a global basis.

[28] For example, ship-owners who benefit from other funds (e.g. the Norwegian NOx fund), should not also be able to benefit from the IMO fund without proving additional reductions.

VIII. Conclusion

The international shipping sector has the potential to be the most sustainable means of bulk transport from a climate change perspective by adopting an ambitious greenhouse gas reduction strategy, including a quantified trajectory for emissions reductions. Specific emission reduction policies already exist for shipping – namely, the EEDI and the SEEMP, which require technical and operational measures to improve energy efficiency. And while these policies require ambitious revision, we know from experience in other sectors and countries that no one policy will bring about an effective transition to a net zero greenhouse gas economy, rather a suite of policy options will be required.

The IMO should build on lessons learned from other sectors. One option it should seriously consider is the use of a fund to distribute monies raised to support additional investment in low carbon shipping and meet the ambitious mitigation targets the sector sets for itself. Such a fund could be established by introducing a form of carbon pricing policy. Indeed, industry representatives have already considered a proposal to establish a fund to support the transition in shipping (e.g. MEPC 71/7/4). This paper has attempted to capture some of the lessons that can be learned from other sectors across the world in how they have decarbonised, especially in ensuring the deployment of new low carbon technologies, in order to assist the IMO in the design of a measure that would drive the deployment of low carbon vessels onto the seas.

The shipping industry has long been the lowest impact form of transport, both locally and globally. By establishing these instruments, the IMO would ensure that there is strong confidence and incentives for the sector to meet ambitious mitigation targets and regain its 'green' reputation. As illustrated, the shipping industry has a number of policy options that can help ensure implementation of the wide decarbonisation options for shipping.