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Department for Transport

Course to Zero consultation: UK domestic maritime decarbonisation response form

Introduction

Thank you for responding. Your views will assist in informing the government's approach to accelerating domestic maritime decarbonisation.

Please fill in all relevant sections of this form, providing evidence where possible, and email it to: MaritimeTDPConsultation@dft.gov.uk.

Alternatively send by post to:

Course to Zero consultation
Maritime Environment, Technology and International Division, Maritime Directorate,
Department for Transport, Zone 1-5, Floor 4,
Great Minster House,
33 Horseferry Road,
London, SW1P 4DR

Closing date is 06 October 2022.

Accessibility statement

Read our accessibility statement for SmartSurvey forms (opens in a new window).

Confidentiality and data protection

The Department for Transport (DfT) is carrying out this consultation to gather views on the government's approach to accelerating domestic maritime decarbonisation. This consultation and the processing of personal data that it entails is necessary for the exercise of our functions as a government department. If your answers contain any information that allows you to be identified, DfT will, under data protection law, be the Controller for this information.

As part of this consultation we're asking for your name and email address. This is in case we need to ask you follow-up questions about any of your responses. You do not have to give us this personal information. If you do provide it, we will use it only for the purpose of asking follow-up questions. We're also asking for information about your relationship with the maritime sector and information about your organisation, if you represent one, to better understand your relationship with the issue.

DfT's privacy policy has more information about your rights in relation to your personal data, how to complain and how to contact the Data Protection Officer. You can view it at

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https://www.gov.uk/government/organisations/department-for-transport/about/personal-information-charter.

Your information will be kept securely on a secure IT system within the department and destroyed within 12 months after the consultation process has been completed.

Your details

1. Your (used for contact purposes only):

name:

Professor Stephen R. Turnock

email address:

S.R.Turnock@soton.ac.uk

2. Are you responding:

- [ ] as an individual?
- [X] on behalf of an organisation?

Organisation details

Please answer the following questions (Q.3-6) if you are responding on behalf of an organisation.

3. What is your organisation's name?

Southampton Marine & Maritime Institute (SMMI), University of Southampton

4. Your organisation is best described as:

- [ ] A trade association or body?
- [ ] A business?
- [ ] A non-government organisation?
- [ ] A consultancy?
- [ ] A consortium?
- [X] Another type of organisation? (Please specify). UNIVERSITY

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Major science and engineering research university

5. Who, if anyone, does your organisation represent? Please include the number of individuals that your organisation approximately represents.

The SMMI is a large community of more than 400 ocean-facing scholars from across all faculties of the University of Southampton. Decarbonising maritime and the protection of marine environments, coasts, ports and coastal communities in the UK and around the global are key areas of focus and expertise

6. How were views on this consultation collected, on behalf of your organisation?

These views were collated from discussions and responses of a core group of researchers (~10) who have been strongly involved in the DfT/Innovate Clean Maritime Demonstrator Competition and other concepts such as industrial decarbonisation (IDRIC) and the zero-carbon coastal highway initiative.

Individual details

Please answer the following questions (Q.7-10) if you are responding as an individual.

7. Do you work in the maritime sector?

- [x] Yes (If you tick this box, please answer Q.8)
- [ ] No (If you tick this box, please answer Q.9)
- [ ] Don't know (If you tick this box, please answer Q.9)

8. Which area of the maritime sector do you work in?

Research into all aspects of maritime engineering from ship design, optimisation, to novel green energy systems, and the marinisation and testing of new technologies and zero-carbon fuels (e.g., fuel cells, liquid H2)

9. Do you work in a related or adjacent field of work to the maritime sector?

- [ ] Yes (If you tick this box, please answer Q.10)
- [ ] No
- [ ] Don't know

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10. What is your field of work and how it may relate to domestic maritime issues?

Purpose of this consultation

This consultation aims to achieve three goals:

1. To seek views and evidence on the optimal pathway to net zero emissions in 2050, including where there is scope to accelerate decarbonisation. Our objective is to capture the vital insights of the UK's domestic maritime sector across all its sub-sectors.
2. To gather productive feedback about the remaining barriers to maritime decarbonisation.
3. To collect views on the various additional policy options which could be employed to address these barriers, building on the government's current approach. It is also to provide a space for respondents to present any other ideas or views, which may be helpful to the wider domestic maritime decarbonisation project and have not yet been explored or discussed by the government.

Following the results of this consultation, as per the Transport Decarbonisation Plan commitment, we will establish ambitious, indicative targets for the domestic maritime sector. Echoing the scope of the Transport Decarbonisation Plan, and to ensure that evidence is available to monitor progress towards any targets which are established, it is proposed that these targets only apply to UK domestic maritime vessels. These targets are not expected to cover other sources of emissions within the broader domestic maritime sector. For example, the UK's National Atmospheric Emissions Inventory (NAEI) presents separate estimates of the emissions from domestic maritime vessels. However, it does not separately identify any other sources of emissions within the broader domestic maritime sector. These other sources of emissions will instead be captured at a more aggregated level within the NAEI.

This approach will enable us to robustly measure the success of future policy interventions. These targets will be presented and embedded in the reviewed and refreshed Clean Maritime Plan. This 'Course to Zero' timeline will also shape any future policy interventions and help in reviewing the success of these interventions. The refreshed Clean Maritime Plan will detail the interventions needed to achieve full decarbonisation, providing a clear framework for the sector to decarbonise. It is due to be published in 2023. When establishing indicative targets and committing to any further government interventions in the updated Clean Maritime Plan, we will consider the possible impacts of these interventions on the domestic maritime sector. This includes the potential risks of modal shift, carbon leakage, and any impacts on sector competitiveness and consumers.

While the focus of this consultation is on the GHG emissions from vessels making UK domestic maritime voyages, the government is fully committed to the decarbonisation of the UK maritime sector more broadly. The government is also committed to taking action to address the significant contribution that maritime makes to air pollution in the UK. The refreshed 2023 Clean Maritime Plan will continue to take a holistic approach to tackling all forms of maritime emissions and will provide further detail on the government's approach to addressing other sources of emissions within the sector. International maritime emissions are not within the scope of this consultation because they are regulated by the International Maritime Organization. The UK continues to play a leading role in the work of the International Maritime Organization (IMO) to tackle international shipping emissions. The UK is pressing for greater ambition during the current revision of the IMO's Initial Strategy on the Reduction of Greenhouse Gas Emissions from Ships and negotiations around mid-

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term measures under the Initial Strategy. Where relevant, this consultation discusses the implications of IMO policy for decarbonising UK domestic maritime vessels.

Plotting the course to zero

The Net Zero Strategy pathway for UK domestic maritime vessel emissions

To inform the development of the Clean Maritime Plan (CMP), the government commissioned a major programme of economic and technical research. A key element of this research was new modelling which analysed a range of scenarios for reducing UK domestic maritime vessel emissions. These scenarios analysed the impacts of different levels of ambition for reducing emissions, and how the impacts vary under different assumptions about the availability and prices of alternative fuels.

This modelling has been widely used subsequently, including by the Climate Change Committee in its advice on the level of the Sixth Carbon Budget, and to develop the pathways for shipping that informed the government's Net Zero Strategy. The Net Zero Strategy includes an indicative delivery pathway to 2037 and illustrative 2050 scenarios. Given the objectives of this consultation, the analysis for the intervening years is also presented for completeness. Whilst the Net Zero Strategy includes a range around these estimates, only the central estimates are presented in this consultation for clarity of presentation.

It is recognised that analysis of this nature is subject to significant uncertainty and that this is an area where the available evidence continues to evolve at pace. So, a key objective of this consultation is to capture the broadest range of feedback on the analysis that has been completed to date. To facilitate this, the remainder of this chapter presents the key estimates from this analysis, including on the technological and operational changes and the estimated costs and benefits associated with domestic maritime decarbonisation. Your feedback on this analysis will help to shape the programme of new analytical work that will inform the updated Clean Maritime Plan next year.

Figure 2 (below) reproduces the central estimates for the Net Zero Strategy pathway for UK domestic maritime vessel emissions, which is the best available evidence on the pathway for UK domestic maritime vessels to reach net zero emissions. This chart shows the estimated GHG emissions from the UK domestic maritime vessels between 2020 and 2050, under this pathway. The Net Zero Strategy pathway for UK domestic maritime vessels emissions is based on Scenario D from the CMP research which achieves very close to full decarbonisation by 2050. The use of Scenario D is line with the approach taken by the Climate Change Committee for its Balanced Net Zero Pathway, which was the basis of its advice on the level of the Sixth Carbon Budget.

For comparison purposes, the central estimates for the baseline scenario are also presented. The baseline scenario is based on Scenario A from the CMP research. It shows the estimated GHG emissions under IMO polices that had been agreed at the time the modelling was completed in 2019, including the Energy Efficiency Design Index (EEDI) . However, it does not reflect policies that have been agreed subsequently, including the Energy Efficiency Existing Ship Index (EEXI). The baseline scenario therefore represents a business-as-usual pathway that illustrates what could happen if no further action was taken to decarbonise shipping.

We would like to explore the scope to further accelerate decarbonisation in the UK domestic maritime sector, and the implications of this. As an illustration of the potential for this, a possible accelerated emissions reductions scenario is also presented. Under this scenario, which is based on Scenario C from the CMP research, full sector decarbonisation is broadly achieved by 2040. We would welcome views on the feasibility of achieving net zero earlier than 2050.

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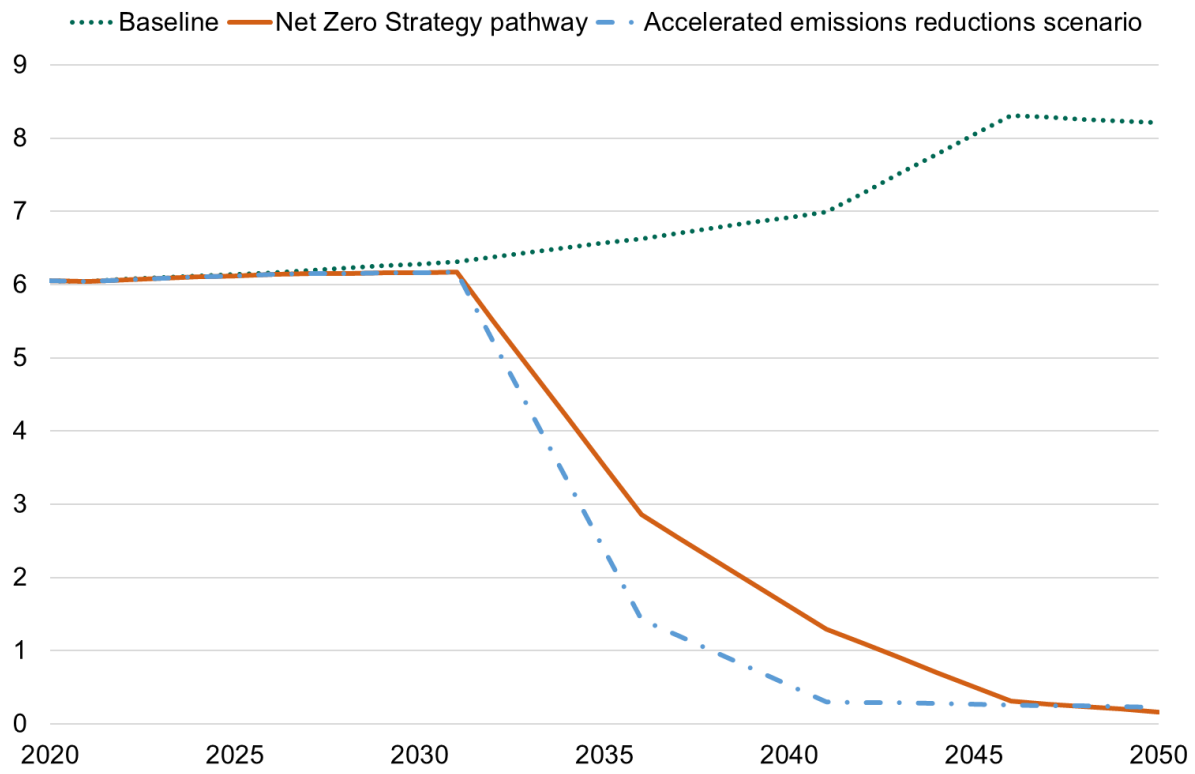

Figure 2 (Above): Estimated GHG emissions from UK domestic maritime vessels between 2020 and 2050 (million tonnes of carbon dioxide equivalent, CO_2e) (central estimates).

For all the scenarios, the estimated GHG emissions from UK domestic maritime vessels incorporates both the emissions from the operation of the vessels on voyages and the emissions from vessels when they are berthed at port. However, they do not include emissions from upstream processes like fuel production, which are assigned to other sectors of the economy in the Net Zero Strategy as appropriate, such as the fuel supply sector.

The baseline scenario (the green, dotted line in Figure 2) suggests that without further interventions and significant technological and fuel changes, there is a risk that the GHG emissions from UK domestic maritime vessels could grow. Under this scenario, it is estimated that GHG emissions may increase by around a third between 2020 and 2050, although further work has the potential to reach different conclusions (for example, as the underlying modelling predated the COVID-19 pandemic). In this scenario, the domestic maritime sector would fail to achieve the necessary cuts in emissions and undermine national efforts to ensure that all domestic sectors have reached net zero emissions by 2050.

Under the Net Zero Strategy pathway (the orange, unbroken line in Figure 2) for UK domestic maritime vessels, minimal GHG emissions reductions are achieved below the baseline in the period up until 2030. This is followed by deep cuts in GHG emissions during the early 2030s and continued GHG emissions reductions during the remainder of the 2030s and the 2040s, with GHG emissions ultimately reaching close to zero by 2050. Therefore, on this pathway, the expectation is that the domestic maritime sector would achieve net zero in 2050 principally by making deep cuts in vessel emissions, and that the sector would consequently have minimal reliance on GHG removals in 2050.

For the Net Zero Strategy pathway, the CMP research also suggests that there could be deep cuts in two key air pollutant emissions - sulphur dioxide (SO_2) and primary particulate matter (PM), but significant emissions of nitrogen oxides (NO_x) could remain. This suggests that measures to reduce the GHG emissions from the UK domestic maritime sector could have important co-benefits in the form of reduced air pollution, but that separate measures are likely to be required to further bring

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down air pollutant emissions. This is particularly true for technological approaches such as ammonia-fuelled Internal Combustion Engines (ICE) that are likely to require after treatment systems to comply with the IMO's Tier III NO_X requirements.

Under the accelerated emissions reductions scenario (the blue, dots and dashes line in Figure 2) the decarbonisation of UK domestic maritime vessels is significantly accelerated, with even deeper cuts in GHG emissions achieved during the 2030s, reaching close to zero by 2040. However, in parallel with the Net Zero Strategy pathway, limited emission reductions are achieved during the 2020s under the accelerated emissions reductions scenario. Given developments since the CMP research was completed in 2019 and the uncertainties inherent in analysis of this nature, these scenarios may not fully capture the potential to achieve early emission reductions. Respondents are invited to offer views on how aiming to achieve zero earlier than 2050 could create additional deliverability challenges. Respondents are also invited to offer views on the scope to achieve further early emission reductions during the 2020s, to help reduce the required rate of emission reductions in subsequent years.

1. **What is your feedback on the overall ambition and feasibility of the Net Zero Strategy pathway for domestic maritime vessel emissions (see Figure 2)?**

It may be helpful to provide any evidence that you have on the following topics in your answer:

- subsectors of the domestic maritime industry which you think could have a more ambitious timeline for decarbonisation, where faster rates of change may be possible,

The option not to impose further regulations would induce significant consequences for the environment, as it will only increase the overall carbon footprint of the maritime industry.

As such, the ambition of establishing a zero emission strategy pathway is the only option, with the 2050 aim being the absolute deadline for avoiding an irreversible global warming scenario. That said, a clear distinction must be made between net zero and zero carbon strategies, as certain parts of the maritime industry might be unable to follow both scenarios. Also, the Well-to-wake approach is an important one to be considered since there will be no overall benefit, emissions-wise, if the carbon footprint of the maritime industry is taken over by the energy production industry.

It is also important to distinguish between zero emissions and zero carbon (or decarbonisation) as some alternative propulsion concepts (such as green ammonia) may deliver zero CO_2 emissions but could release significant levels of other pollutants, such as nitrogen oxides (NO_X)[1].

The best approach for large and domestic, zero emission vessels would be through new builds, as research shows that this is the "easiest", most cost-effective way to implement new powertrains and fuel alternatives on-board vessels. Of course, new technologies require time to "mature" by facing the test of time and correct any potential shortcomings on their design hence the concept of retrofits should take place as soon as possible to demonstrate the technology. This would also be in line with imposing stricter emissions regulations prior to initial predictions

Considering all the above, imposing stricter emissions would be the best way towards the first step of net-zero carbon footprint with the final one being the absolute zero one. This way, all technological constraints will be overcome, and subsectors of the maritime industry that will need more time to abate while coastal maritime activities such as ferries, small cargo and bunkering vessels are more than ready to be subjected into more ambitious decarbonisation improvements.

[1] C. J. McKinlay, S. R. Turnock, and D. A. Hudson, "Route to zero emission shipping: hydrogen, ammonia or methanol?," International Journal of Hydrogen Energy, vol. 46, pp. 28282 - 28297, 2021, doi: https://doi.org/10.1016/j.ijhydene.2021.06.066.

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- subsectors of the domestic maritime industry which may be harder to abate and may need more time and resources to successfully decarbonise by 2050,
- whether there are any technological constraints that prevent domestic maritime vessels from achieving zero emissions (as opposed to net zero) in 2050, under specific circumstances.

Please provide as much evidence as possible to support your answers.

Technical and operational changes required to achieve the Net Zero Strategy pathway

The research commissioned to inform the 2019 Clean Maritime Plan, which the **Net Zero Strategy pathway** is based on, also provides evidence on the technological and operational changes required to achieve the Net Zero Strategy pathway.

This research identifies a wide range of technical and operational measures that can be implemented by industry to reduce emissions. This includes improving energy efficiency by using new technologies or by implementing operational changes; and deploying new fuels and energy sources. In the modelling from this research, which underpins the Net Zero Strategy pathway, a range of measures to improve energy efficiency are deployed, including hull coatings, energy saving lighting, and improvements to equipment such as propellers. In addition, the use of solar power and wind assistance onboard vessels further reduces the energy needed from main and auxiliary engines.

However, the modelling suggests that the vast majority of emissions reductions under the **Net Zero Strategy pathway** for UK domestic maritime vessels will be achieved by a switch to low or zero emission fuels. Alongside this modelling, the CMP research included detailed analysis of the cost-effectiveness of different emission reduction options. This analysis found that the cost-effectiveness of abatement options varies substantially across ship types, reflecting the diversity of ships in operation. Nonetheless, this analysis found that for all the ship-types considered, the shift to low or zero emission fuels is needed for material emission reductions to be realised at the scale required to achieve domestic and international decarbonisation commitments.

Figure 3 (*below*) shows how the use of alternative low emission fuels by UK domestic maritime vessels is estimated to evolve between 2020 and 2050 under the central **Net Zero Strategy pathway**. This shows that the proportion of the energy demand from UK domestic maritime vessels, which is met by alternative low emission fuels, is estimated to increase rapidly from around 2030 leading to an almost complete transition to low or zero emission fuels by 2050. Given the uncertainties inherent in this analysis, we would particularly welcome views on the feasibility of achieving the transition to alternative low emission fuels which has been estimated, as well as the scope for commencing this transition earlier.

Figure 3 (Below): Estimated proportion of energy demand from UK domestic maritime vessels met by alternative low or zero emission fuels between 2020 and 2050 under the central Net Zero Strategy pathway

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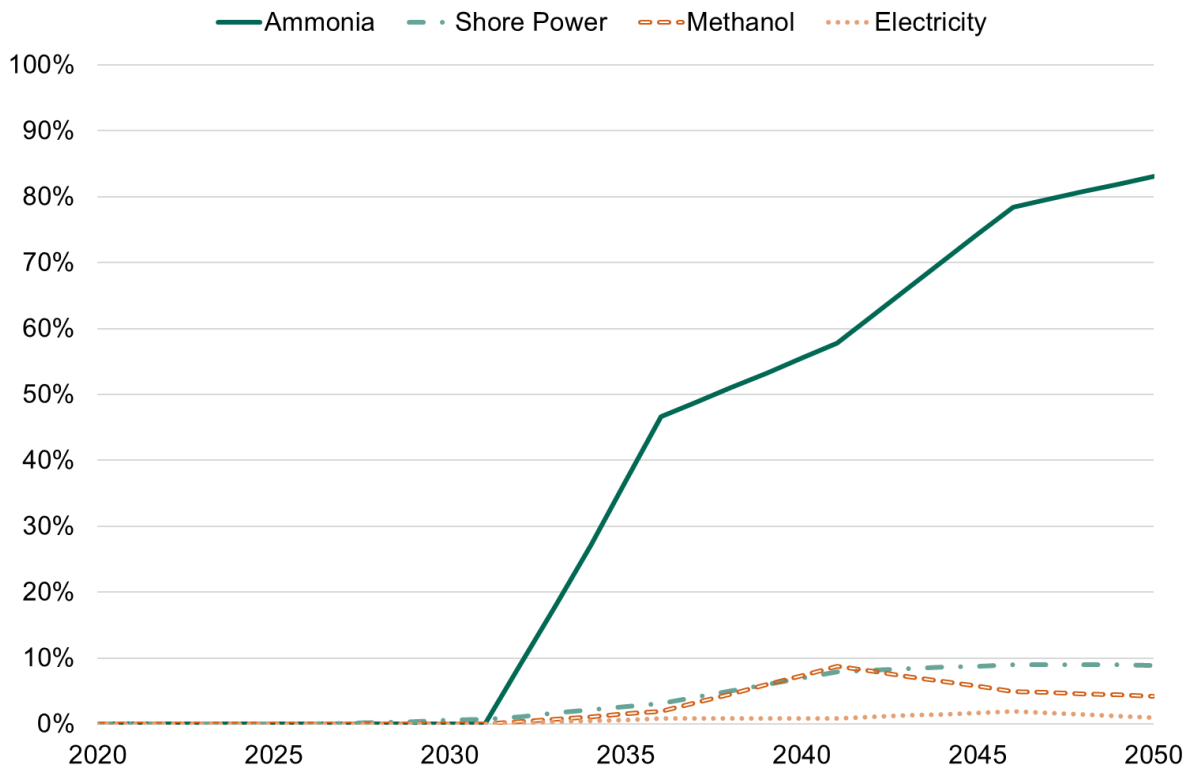

The modelling undertaken as part of this research suggests that liquid fuels will remain crucial, with two low carbon hydrogen-derived fuels (ammonia and methanol), meeting the vast majority of energy demand by 2050. In this modelling, ammonia and methanol are estimated to be more cost-effective than using hydrogen directly, resulting in hydrogen being used as a feedstock rather than as a fuel itself. Ammonia is also generally estimated to be more cost-effective than methanol, and therefore accounts for a much higher proportion of energy demand under the **Net Zero Strategy pathway**.

However, the CMP research notes that there is 'substantial uncertainty around both the costs and efficiency of low emission fuels in both the near and long terms.' The research reports that 'even small changes in the costs and efficiency of the low emission fuels could change the commercial incentives to shift towards any of these three options – hydrogen, ammonia and methanol.' Furthermore, the CMP research was completed in 2019, and while it represented the best available information at the time of publication, this is a fast-changing picture with large scale investments in green methanol, hydrogen and ammonia production and testing having since occurred in the maritime sector. Therefore, further work may reach different conclusions on the split between these three fuels in the future.

While shore power also makes an important contribution to reducing emissions, other electricity use is estimated to be minimal in this modelling. However, a further research project commissioned to inform the Clean Maritime Plan identifies the potential that the electricity demand from the use of batteries could be significantly higher than suggested by this modelling. The differences between these two sources further illustrates the uncertainty surrounding which low emission fuels will be preferred in the future, and it is recognised that there may be more diversity in the types of fuel that are used than this modelling suggests, with the potential that different low emission fuels may be preferred under different circumstances.

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For example, while electricity makes up a small share of the projected energy demand, it may have a disproportionate role in decarbonising some vessel or operation types where it has a significant advantage – for example a small ferry on a short, predictable crossing. It should also be noted that battery technology may have a significant role in maximising the on-board efficiency of other energy sources, by allowing load balancing throughout vessel operations. Load balancing refers to utilising an energy storage system to allow the vessel's main engine to run at its most efficient point for the greatest length of time by charging and discharging the battery system at points of low and high engine load. Moreover, fuel and power selection is only part of the picture for a vessel's individual 'course to zero' – the vessel type, operational profile and intended use will have significant impacts on the technology pathway to net zero operations. For example, 'hydrogen fuel' for example would capture vessels using both compressed and liquid hydrogen, and potentially both internal combustion engines and fuel cell systems.

The CMP research also acknowledged that the production of the fuels in sufficient quantity is a significant challenge. Based on the findings of this research, a key factor in achieving the Net Zero Strategy pathway is expected to be enabling the production of a sufficient quantity of low carbon hydrogen. The UK Hydrogen Strategy sets out the government's roadmap for developing the UK hydrogen economy. This outlines that, as low carbon hydrogen production is scaled up through the 2020s, the main production routes are expected to be electrolytic hydrogen production predominantly powered by renewables, and steam methane reforming with carbon capture. The British Energy Security Strategy published in 2022, committed to doubling the UK's ambition for hydrogen production to up to 10GW by 2030, with at least half of this from electrolytic hydrogen.

No biofuels are assumed to be used by UK domestic maritime under the Net Zero Strategy pathway. This reflects the advice from the Climate Change Committee (CCC) that shipping is not among the best uses of biomass in the long-term, again confirmed by more recent CCC advice. This advice discussed the potential for biofuels to contribute to emission reductions in the near-term, noting that 'biofuels used in shipping would displace fossil fuels' but advising that 'choices made in the 2020s still need to be compatible with the long-term best use of bioenergy.'

It will be important that action in the near-term is compatible with achieving the necessary emission reductions required by 2050. We would welcome views on whether there is a role for other fuels in decarbonising UK domestic maritime in the near-term before zero emission fuels become available. This includes views on any synergies where the use of other fuels could support the rollout of zero emission fuels in the long-term, and any risks where the use of other fuels could impede the rollout of zero emission fuels.

2. What role do you think the following alternative fuels and energies may play in decarbonising domestic maritime sector vessels (within your subsector, if appropriate)? What evidence do you have to support this opinion?

- Low carbon hydrogen,
- Low carbon hydrogen-derived fuels like ammonia or synthetic methanol,
- Electricity and battery technologies (various),

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- Onboard renewables e.g. wind or solar power,
- Nuclear power,
- Biofuels (please include the generation and associated production process of biofuel(s) of interest),
- LNG,

Green hydrogen via a fuel cell provides the most direct route for zero carbon shipping with the least emissions. For short routes, for example inland or coastal shipping compressed H_2 will be the most energy effective method e.g. least kWh (windfarm to wake) per tonne.km

Ammonia/Methanol these routes add significant extra kWh penalties compared to Green H_2 primarily for NH_3 via the Haber-Bosch and then subsequent cracking for fuel cell use or emissions abatement/carbon capture[1]. Methanol creation from either previously captured CO_2 or via fossil fuel and then needing carbon capture likewise will require significant additional energy. NH_3 is toxic at low concentrations and would be a major issue in environmentally sensitive waterways. Combustion of both will create PM[2] and especially for NH_3 challenging issues with NO_x and with N_2O in particular a very potent GHG. Combustion of ammonia remains challenging and requires hydrocarbons in mix.

Battery: With rapid reduction in Li-ion battery costs these may now be viable for some shipping applications, particularly as part of a fuel cell-battery hybrid, but are unlikely to power vessels entirely due to low specific and volumetric energy densities. A major challenge is electrical infrastructure: charging overnight is more straightforward, otherwise rapid charging may require additional energy storage at charging stations.

Onboard renewables: Power density is low so other than very slow movements will be challenging as primary energy. However, as secondary then these concepts will play an important part. If large areas on vessels can have marinised solar panels and wind assist devices can be installed, without detriment to vessel operation, then they will provide valuable energy demand reductions.

Nuclear Power: This has potential but the timescale to develop and implement will make effective contribution to meeting 2050 challenging. For domestic shipping in particular the energy provided will be too large for majority of applications and the economics will just not make sense. There will be major on-going security and end-of-life decommissioning issues with nuclear power and radioactive wastes.

Biofuels: Limited scope due to challenges of generating sufficient quantities without major impacts of food production – issues with local air quality emissions remain particularly PM and NO_x. Biofuels will definitely not have a positive contribution towards the final zero strategy as it has been proven a couple of times through well to wheel studies that the overall carbon footprint can be worse. That said, transition fuels combined with a possible retrofit of CO_2 scrubbers is a definite way to move towards the initial net-zero strategy by also implementing synthetic fuels. Such a transition fuel could be LNG, as long as methane slip is eliminated during its utilisation.

LNG: Has advantage that it generates more energy for the same CO_2 however issues with slippage of CH_4 into air with its GHG potential are important (the global warming factor for CH_4 is 30 times CO_2). Can be used with fuel cell (Carnival CMDC1 project) and make significant emissions savings up to 35% CO_2e [2].

CO_2 scrubbers could also be used in a way to provide low carbon hydrogen or even zero carbon hydrogen assuming that it is the reformed result of LNG. Adding to all the above, so far it is indicated through research that LNG will be an important aspect for aiding towards the transition to hydrogen in the longer term, which would help to reach the zero-emission aim. This is due to the many common properties these two fuel sources share, main one being the storage requirements.

To be zero emission, the fuel source must not be hydrocarbon based, hence hydrogen, if produced with electrolysis, is one of the best decarbonization candidates. Ammonia on the other hand, has high energy of formation, requires huge energy to dissociate if used as a Hydrogen carrier for fuel cells, and is extremely toxicity in case of spillage. Consequently, ammonia is not a reliable vector to meet decarbonisation standards by 2050.

Although nuclear energy might be a seemingly “emission-free” powering source, the technology and safety standards associated with it, its resulting cost of operation and the extremely high levels of a potential “leak” prohibits it from becoming commercially viable.

Finally, with the current technology solutions in this sector, it is impossible to propel a ship with on-board renewable energy harvesting solutions, yet it has been proven numerous times that any energy harvested with these methods, could be very well utilised on board for other activities and has a positive impact emission-wise.

[1] C. J. McKinlay, P. Manias, S. R. Turnock, and D. A. Hudson, "Dynamic modelling of ammonia crackers and hydrogen PEM fuel cells for shipping applications," presented at the International Conference on Computer Applications in Shipbuilding, Yokohama, Japan, 13th-15th September, 2022.

[2] L. D. Schiferl et al., "An investigation of ammonia and inorganic particulate matter in California during the CalNex campaign," Journal of Geophysical Research: Atmospheres, vol. 119, no. 4, pp. 1883-1902, 2014.

[3] P. Manias, C. J. McKinlay, S. R. Turnock, and D. A. Hudson, "Performance optimisation of solid oxide fuel cells through waste heat recovery systems for marine applications," presented at the International Conference on Computer Applications in Shipbuilding, Yokohama, Japan, 13th-15th September, 2022.

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- Any other alternative fuels and energies which have not been presented or examined here, that may be important in the UK domestic maritime sector's decarbonisation.

It may be helpful to include further detail in your answer on any alternative fuels and energies that you refer to – production routes for this fuel or energy and the various associated technology and propulsion system(s) of interest.

3. What value do you think different efficiency and energy saving measures could have in helping to achieve domestic maritime vessel decarbonisation (in your sub-sector, if appropriate)?

It may be helpful in your answer to provide evidence to support your views on:

- What you think the most important, applicable, and high-potential efficiency measures are. It may be helpful to consider different engine technologies and designs, vessel designs and modifications, alternative propulsion technologies, power assistance, speed reduction and operational voyage optimisation and,
- The impact you estimate this could have on emissions reductions in the short, medium, and long term.

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Key measures in being able to assess any of the potential options is the total energy budget per either passenger km or tonne.km AND the local air/GHG emissions.

Any fossil fuel derived approach requires CO_2 carbon capture, storage and potentially utilisation. Any such route will require a significant kWh budget.

Any combustion-based route will require exhaust treatment to prevent GHG emissions be it CO_2, N_2O, CH_4 and air quality impacts of NO_x, SO_x, and Particulate Material (PM). Post combustion treatments will increase total energy demands.

Utilisation of renewables (wind/solar) can be used to charge batteries or to generate green H_2 direct. Longer duration voyages are likely to require a more energy dense energy supply than batteries for the foreseeable. Desalination/electrolysis of seawater close to offshore wind locate near to shipping routes/ports or solar farms near to ports would minimize energy loss associated with H_2 transportation. Additional energy penalties are associated with creation of methanol or ammonia even compared to liquefaction of H_2 without significant benefit. Fuel cell systems be they PEM or SOFC should have a first principles overall higher efficiency than combustion.

Cost-effective ship based solar and wind assist will all reduce energy required per km.tonne

All new vessels need to be enforced to be zero emission as soon as possible or at least within 2 to 5 years. Existing vessels need to have incentives/penalties to support their conversion to lower GHG fuel systems. Expectation ought to be that like with electric cars although adoption will be initially slow there will come a tipping point where the new approaches have been shown to be lower cost and then there will be no question as to which approach to adopt. There is a similar analogy with offshore wind and its rapid reduction in cost as industry scales up. The same is likely to be true for electrolysis of H_2 and implementation of fuel cell/battery power trains.

There needs to be a huge increase in renewable electricity generation even greater than 6th Climate Change Committee recommendations to provide energy to produce H2 and an excess of power for batteries and shore-power.

4. How should the technological transitions required to decarbonise the domestic maritime sector best be supported? What evidence do you have to help refine our understanding in this area?

It may be helpful in your answer to provide evidence to support your views on:

- What technological and operational changes are required between now and 2050 for UK domestic shipping to achieve net zero,
- Whether there are any trade-offs between reducing emissions in the short-term and achieving the emissions reductions that are required in the long-term to achieve net zero,
- What you think future fuel and energy demands of the domestic maritime sector may be (within your sub-sector, if appropriate),
- Feasible timelines for rolling out new alternative energy systems, bunkering facilities and zero emission capable vessels,

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- How you think existing maritime assets and infrastructure can be most effectively retrofitted, recycled, or phased out to support decarbonisation,
- What levels of research and development you think are required to achieve a successful 2050 net zero trajectory, in the short, medium, and long term.

Measures (can follow practices in Switzerland) for their lakes. All new build vessels must be emission free. Any vessel removed from the water must be converted to emission free

Port fee structure could significantly increase cost of access to port for those vessels which generate emissions or offer significant incentives to clean vessels. Could make this size based and would need to be rolled out for all UK ports. Could agree with regional ports to follow practice of US west coast states to prevent access to those vessels which don't make environmental standards.

These will increase transport costs but could subsidise in a similar manner to successful roll out of FIT for renewables e.g. get extra payment for every clean tonne.km and over time reduce amount as costs of technology adaptions will fall.

Investing in short term measures that only have limited impact on CO_2/emissions will, if anything, detract from achieving the longer term goal of achieving zero emissions. It is better to go with the likely long term solutions now and maybe go a little slower but then be able to more rapidly adopt as the challenges have been fixed. The technology solutions are available today but need to be scaled for production and operational experience gained. R&D investment needs to focus on the overall approach to how kWh required per km.tonne is reduced as energy will be more expensive at least in short-to-medium term.

For instance, the ability to design low energy ship hull forms tailored for sea-state and where bow shapes/stern/propulsion configurations are suited to electrical power trains. Operational aspects that allow ships to steam slower but deliver in same timescale by for example minimising time in port/bunkering. This realisation of marginal gains, if adopted at scale, can make a large improvement.

The costs of meeting the Net Zero Strategy pathway

The research underpinning the Net Zero Strategy pathway suggests that significant investment will be required both within the UK domestic maritime sector and the wider private sector to achieve the required level of emissions reductions. Based on this research, the overall costs incurred by UK domestic maritime vessels are estimated to total in the billions of pounds between now and 2050.

Figure 4 (below) presents annual estimates of the additional costs for the decarbonisation of UK domestic maritime vessels under the central Net Zero Strategy pathway. This is split between capital costs, non-fuel operating costs and fuel costs. In this context, capital costs refer to additional capital

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expenditure on UK domestic maritime vessels only. The estimated capital costs presented here are the actual capital costs estimated to be incurred in the domestic fleet each year and have not been annualised. This would include, for example, the additional costs associated with the changes to machinery onboard ships that will be required to use low emission fuels such as ammonia.

Additional capital expenditure will also be required in the fuel supply sector and at ports, such as refuelling infrastructure. This capital expenditure was not directly quantified in this research. However, where possible, it was taken into account in the fuel price assumptions used to estimate the additional fuel costs incurred by the UK domestic maritime sector. Other evidence suggests that, at the global level, the capital costs of the landside investments required to decarbonise shipping could significantly exceed the capital costs of vessel investments.

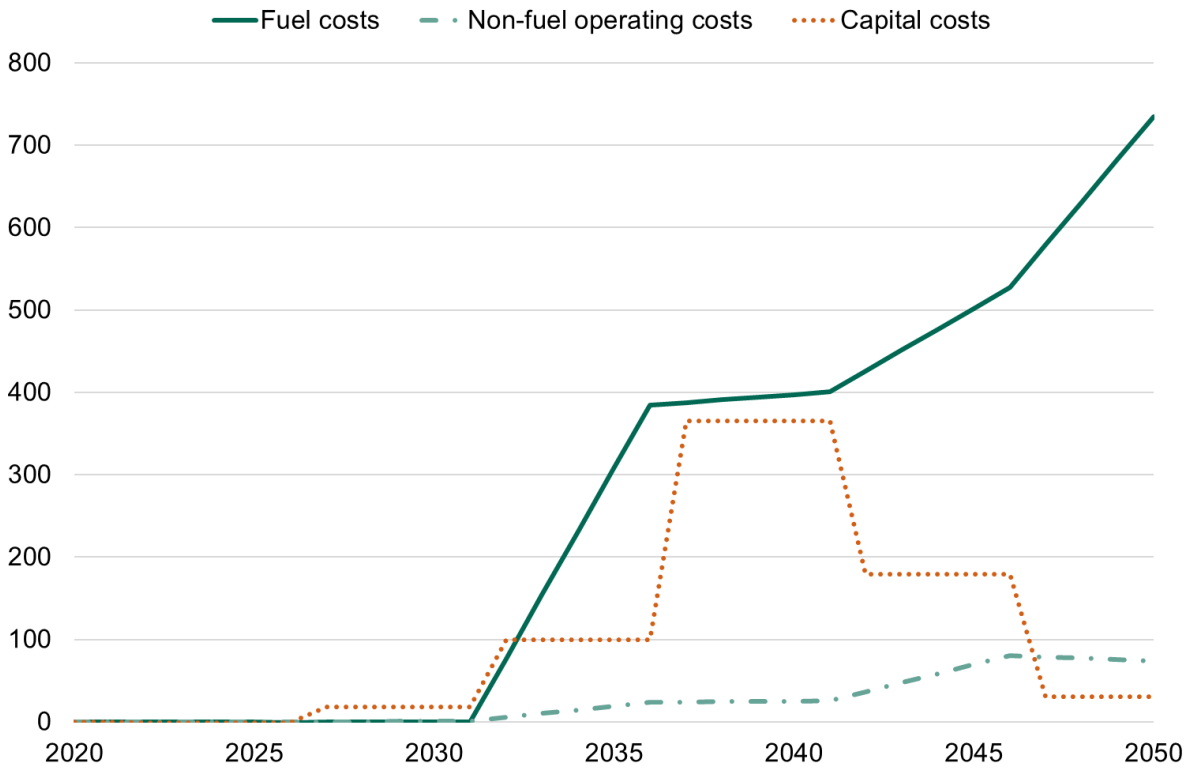

Figure 4 (Above): Estimated additional costs for UK domestic maritime vessels under the central Net Zero Strategy pathway (£ million, 2020 prices). These estimates have not been discounted.

Figure 4 shows that for UK domestic maritime vessels, the increase in fuel costs is estimated to be the most significant additional cost, reflecting that new fuels like ammonia are estimated to be significantly more expensive than conventional maritime fuels. The increase in capital expenditure for UK domestic maritime vessels is also estimated to be significant, particularly in the late 2030s and early 2040s. In contrast, the increase in non-fuel operating costs for UK domestic maritime vessels is estimated to be much smaller. The additional costs shown in this chart represent the difference in the estimated costs between the central Net Zero Strategy pathway and the baseline.

As an example of this, the increase in the additional fuel costs during the 2040s is being caused by several factors. Under the central Net Zero Strategy pathway, total fuel costs are estimated to increase over the 2040s, including because there is a significant increase in the use of ammonia whilst the price of ammonia is assumed to remain constant. In contrast, under the baseline scenario, total fuel costs are estimated to peak around the mid-2040s and decrease during the second half of the 2040s. This leads to the difference in fuel costs between the two scenarios growing at a significantly faster rate than the increase in total fuel costs under the central Net Zero Strategy

pathway. Due to the uncertainty inherent in analysis of this nature, further work has the potential to reach different conclusions.

While the costs of decarbonising the domestic maritime sector are expected to be significant, it is important to recognise that, in many cases, these costs will only represent a small percentage of the value of the goods being transported. For example, a European Commission study regarding the inclusion of maritime in the EU's Emissions Trading System concluded that 'this would only marginally increase the import prices of goods, as transport cost generally represent a small share of commodity prices.' The UK government is interested in continuing to build a picture of the impacts of decarbonisation across the sector. In addition, as shown in the next section, the costs for UK domestic maritime vessels are expected to be significantly outweighed by the benefits of meeting the Net Zero Strategy pathway.

The benefits of meeting the Net Zero Strategy pathway

Decarbonising the UK's domestic maritime sector is expected to bring a range of very significant benefits, improving the overall welfare of society. The estimated value of the reductions in the GHG emissions under the central Net Zero Strategy pathway is shown in Figure 5 (below). The value of the reductions in the GHG emissions alone is estimated to significantly exceed the total costs that will be incurred by UK domestic maritime vessels to deliver these emission reductions over the period to 2050. The value of these benefits is estimated to rise to over £3 billion per year by 2050 (2020 prices). Whilst it is not possible to disaggregate these benefits between different sectors of the economy, it is expected that the maritime sector will benefit from action that reduces the effects of climate change. For example, as set out in Maritime 2050, the effects of climate change could include 'increased flooding of ports from tidal surges, more frequent extreme weather events and coastal erosion'.

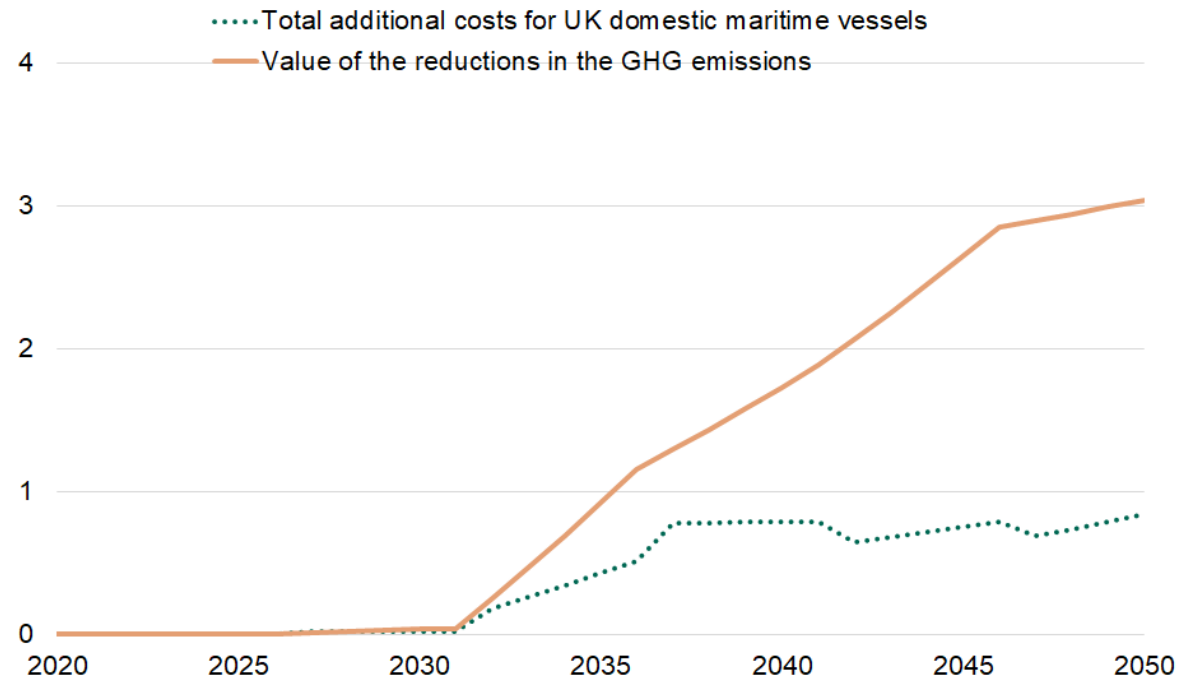

Figure 5 (Above): Estimated value of the reductions in the GHG emissions from UK domestic maritime vessels under the central Net Zero Strategy pathway, and the estimated total additional

costs for UK domestic maritime vessels (£ billion, 2020 prices). These estimates have not been discounted.

The expected reductions in the air pollutant emissions from UK domestic maritime vessels are another important benefit, with research commissioned by the government highlighting the significant contribution that shipping makes to air pollution in the UK. It is expected that the nature of these benefits will vary depending on how emissions are reduced. For example, the CMP research concludes that 'there are significant potential benefits from shore power for controlling air pollution emissions when ships are in port and close to centres of population where impacts of those emissions may be greatest.'

A range of wider economic benefits are also expected. In 2019, it is estimated that maritime directly supported around 227,000 jobs in the UK. By helping to address the sector's environmental impacts, the increased use of low carbon technologies and fuels will help to future-proof jobs in the UK maritime sector. In addition, it is expected that maritime decarbonisation will support the growth of green jobs in the UK in markets for clean maritime technologies. Research commissioned by the government assessed the UK's competitiveness across 11 key clean maritime technologies, and found that the UK has strengths which may allow it to compete in a range of markets, particularly in those which relate to low or zero carbon fuels. More broadly, it is expected that maritime decarbonisation will also support green jobs elsewhere in the UK economy. For example, the UK Hydrogen Strategy reports that current evidence suggests that developing a UK hydrogen economy could support up to 100,000 jobs by 2050 across our industrial heartlands and across the UK. As outlined above, low carbon hydrogen-based fuels are likely to play a crucial role in the decarbonisation of the domestic maritime sector.

Finally, it is recognised that decarbonising the UK's domestic maritime sector has the potential to generate significant reputational benefits for the sector. This is supported by social research commissioned by the Department for Transport on young people's perceptions of maritime careers. 'Climate change' was identified by 46% of UK young people (based on an online survey of 2,326 young people) as a factor that would prevent young people from pursuing or staying in a career in Maritime.

5. Are you able to provide any additional evidence on the costs and benefits associated with decarbonising UK domestic maritime vessels?

It may be helpful in your answer to:

- Review the estimation of costs and benefits provided in this consultation and provide any evidence which would help to refine this understanding, including your assessment of the sub-sector specific costs and benefits of decarbonising (if appropriate),
- Include any evidence that you have on how the costs of maritime decarbonisation will affect the cost of goods or passenger journeys,
- Include any other evidence on costs or benefits that may arise as a result of decarbonisation and any potential impacts that this may have across the value chain and consumers.

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Post invasion of Ukraine the energy costs assumptions are likely to shift significantly. If Europe as a whole shifts to more renewables and rapidly shifts to H_2 production at the same time, then the fuel cost for the future will be lower earlier.

Capital investment needs to start now with investment in new build with every public procured vessel, enforcing leisure industry to shift. These will all provide the steppingstones to drive down long term costs.

Renewable energy, local H2 production and electrification of all possible processes will provide UK with better climate achievements but also important energy and resource security. It will enable electricity markets to break tether to international gas prices and make economy less subject to large geopolitical fluctuations in oil and gas prices.

Next steps for developing the Course to Zero

The 'Course to Zero' intermediary decarbonisation targets which will be published in the refreshed Clean Maritime Plan in 2023, will be indicative, rather than statutory legal targets. However, the Course to Zero targets may inform, and subsequently be complemented by regulatory measures which include setting statutory targets within a given policy area. The Course to Zero targets are intended to help set the direction for the domestic maritime sector, to guide the design of future policy interventions, and set a benchmark to measure success against. These targets will likely apply to the domestic maritime sector holistically, capturing the potential of sub-sectors which may be able to decarbonise faster, as well as those which may prove harder to abate. They will not therefore, target individual operators, or ports. They may, however, potentially include specific targets for certain subsectors of the domestic maritime industry.

There are a wide range of potential options for intermediary targets that could be adopted by the government, and we would welcome views on which targets would be most impactful. Options include targets for the overall level of GHG emissions from the UK domestic maritime sector that are compatible with the government's Net Zero 2050 target. Options also include targets for the technological and operational changes that are required for the sector to meet net zero GHG emissions, such as around the uptake of low and zero emission fuels, vessels, and technologies. These targets could be formulated as absolute numbers or percentages to best represent the objective of the target.

Targets may be set on an annual basis, or for 5-year intervals, mapping on to the existing timetable of carbon budgets, or they may follow an alternative rhythm which may better capture and cater to cycles of change within the maritime sector. There are also expected to be other detailed design considerations. For example, for any targets to achieve a certain level of emissions, consideration will need to be given to how to account for any emission reductions purchased or sold by the sector, including within the scope of any economic instrument.

The central Net Zero Strategy pathway presented in this consultation (Figure 2, orange trajectory) provides one possible trajectory for the domestic maritime industry to follow, to achieve net zero by 2050. In theory, this trajectory could potentially be used to set intermediary, indicative targets for

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the domestic maritime sector. For example, under the central Net Zero Strategy pathway, low carbon fuels (including electricity) account for around 42% of total fuel used by the domestic maritime sector in 2035 (in Terawatt-hours). However, DfT recognises the importance of using the best possible evidence when developing the intermediary targets that will be included in the refreshed Clean Maritime Plan. Decisions on these targets will therefore take account of any improvements to our evidence base between now and the completion of the refreshed Clean Maritime Plan, including the evidence that is submitted in response to this consultation.

6. **How should intermediary, indicative decarbonisation targets for UK domestic maritime sector vessel emissions be formulated?**

It may be helpful to provide evidence to support your views on:

- What types of targets would be the most impactful,
- What years or periods the targets should be set for,
- Whether targets should apply to the entire sector or whether there should be separate targets for different subsectors,
- Any other detailed design considerations.

The simplest option is to require all new build to be zero carbon by 2030 at latest. Adapt port fee structures to incentivise retrofit. This does require investment in renewable energy, electricity distribution and storage, and low carbon or green H2 production.

Overcoming the barriers to maritime decarbonisation

To inform the development of the Clean Maritime Plan, the DfT commissioned research on the barriers to the commercial deployment of maritime emissions reductions options, which was published in 2019. This research classified barriers into five categories: economic barriers, including market failures and non-market failures, structural barriers, policy/regulatory barriers, organisational barriers, and behavioural barriers. The research assessed the impact of each barrier and identified the following barriers as the highest-impact obstacles to maritime decarbonisation.

1. **Negative externalities (economic barrier):** At present, maritime fuel prices do not reflect the costs of their GHG and air pollutant emissions. This means that there is currently a suboptimal incentive for ship owners and operators to invest in reducing emissions.
2. **Split incentives to invest (economic barrier):** For example, ships are often owned by one set of organisations and then leased to others to operate them (charterers). This could reduce the incentives for owners to invest in reducing emissions, for instance by increasing energy efficiency, as some of the associated benefits may be realised by charterers, such as when the charterer pays for fuel.

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3. **Imperfect information on emission reduction options and imperfect information flows between owners and charterers (economic barrier):** For example, independent performance data relating to new technologies may not be available, leading to high uncertainty for ship owners and deterring them from making investments. There may also be limitations to the information available to charterers on the fuel efficiency of different vessels, reducing the premium that is paid for more fuel-efficient vessels and the rewards for ship owners who make investments in improving fuel efficiency.
4. **Existing infrastructure and onboard technologies (structural barrier):** The existing infrastructure in ports and shipyards can limit the deployment of emission reduction options. For example, the handling of cargo in ports by cranes can conflict with wind propulsion technologies which require high masts, and existing refuelling infrastructure may impede the use of new fuels that require different infrastructure, such as hydrogen and methanol.
5. **Inter-organisational coordination failures (organisational barrier):** For example, ship owners may not want to invest in certain emission reduction options, such as alternative fuel technologies, until the supporting infrastructure is put in place. However, ports may not want to invest in the supporting infrastructure until the demand can be credibly demonstrated.

Other 'medium impact' barriers to decarbonisation, identified in the research, are as follows:

- The cost of capital when borrowing funds to make investments in decarbonisation, particularly when lenders perceive investments to be risky.
- Hidden costs, including, for example, the risk that vessels powered by new alternative fuels may have a reduced cargo capacity to make room for new, larger fuel tanks.
- Current market operations, including, for example, that currently charterers may be penalised if they arrive late at destination ports, which could limit the scope for slow steaming.
- Existing government policy may inadvertently hinder the uptake of certain abatement options.
- Intra-organisational coordination failures, such as a finance director being in favour of implementing a cost-effective abatement option due to the possibility of long-term savings, but the operations director being against this change as they seek to minimise short-term disruption.
- Imperfect decision-making processes leading to sub-optimal investment decisions ('bounded rationality'), such as biases in favour of solutions that are readily available or familiar.
- A short-term viewpoint when investment decisions are made ('myopic outlook'), such as a focus on short-term cost savings.

The examples given here are not exhaustive. For instance, as discussed earlier in this consultation, there is currently significant uncertainty regarding the relative cost-effectiveness of different future fuels and consequently which of these fuels will be the optimal choice under different circumstances. This is another example of imperfect information on emission reduction options, which may deter industry from making investments. The CMP research also identifies several other lower impact barriers. In addition, it is important to note that other literature identifies further barriers that are not covered in this report. These include, for instance, the safety risk associated with new fuels and technologies on board vessels and the risk that skills gaps in the maritime workforce may exacerbate those safety risks.

7. What are the most significant barriers to domestic maritime decarbonisation at scale (if appropriate, within your subsector)?

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It may be helpful to refer to the barriers listed above, in this chapter. Please highlight any significant barriers which have not yet been discussed here.

If making references to maritime skills, it may be helpful to describe in your answer, what role you think the government should take in supporting the maritime workforce on skills, safety, and training. For example, what steps need to be taken to support maritime engineers, seafarers, and port workers and when should these steps be taken?

Please provide as much evidence as possible to support your answer.

Lack of tax on marine hydrocarbon fuels or carbon pollution that means it remains cheaper to pollute air and sea than to adopt cleaner technologies. Many promising vectors towards green maritime remain conceptual and systems need to be tested at scale and marinized to ensure performance and safe operation. New systems and new approaches, be they fuel cells, batteries, H2, ammonia or nuclear, will need a radically different and more highly trained seafaring workforce to safely operate and maintain both vessels and port infrastructure. Regions such as Solent well placed to develop such training for national and international audience.

International policy approaches

While domestic shipping emissions are regulated through the UK's domestic regime, responsibility for international shipping emissions lies with the International Maritime Organization (IMO), the UN specialised agency for shipping. Several measures have already been proposed and/or implemented internationally to help overcome or circumvent barriers to maritime decarbonisation through direct regulation of the sector. Action taken at the international level may usefully support the decarbonisation of domestic shipping under certain circumstances, including when vessels perform both domestic and international voyages. It would also support the UK to achieve its domestic carbon budgets which include international shipping emissions, as well as domestic shipping emissions, in the Sixth Carbon Budget (2033-2037). International steps taken, to date, on this issue are listed below.

- In 2018, the IMO adopted its Initial Strategy on the Reduction of Greenhouse Gas Emissions from Ships. This sets out a vision to peak and reduce GHG emissions from international shipping and phase them out as soon as possible this century. The Initial Strategy includes a commitment to reduce total annual GHG emissions from international shipping by at least 50% by 2050 compared to 2008 levels and reduce the carbon intensity of international shipping by at least 40% by 2030 and 70% by 2050.
- The Initial Strategy will be revised in 2023. Under the Transport Decarbonisation Plan, the UK committed to press for greater ambition during the upcoming review of the Initial Strategy, and to urge for accelerated decarbonisation. In September 2021, the UK government announced its intention to advocate for the IMO to adopt an ambitious target of zero emissions from international shipping by 2050.
- The IMO has taken a regulatory approach to improving the energy efficiency of vessels and accordingly, achieve a reduction in their GHG emissions. In 2021, the IMO agreed a package of new measures adding further energy efficiency requirements to MARPOL Annex VI, which sets out the Energy Efficiency Design Index (EEDI) and Ship Energy Efficiency Management Plan (SEEMP). These new amendments include a technical requirement to reduce carbon intensity, the Energy Efficiency Existing Ship Index (EEXI); and operational carbon intensity reduction

requirements, based on a new operational carbon intensity indicator (CII) for existing ships which make international voyages. All such vessels over 400GT are subject to the EEXI and existing vessels operating internationally over 5000GT are subject to the CII.

- The IMO is currently focusing its discussions on future interventions to accelerate decarbonisation in the medium- and long-term, including market-based measures (MBMs), such as a fuel levy or emissions trading system and/or standards-based regulations.

Outside of the IMO, the UK is taking a leading role in other international initiatives to help tackle barriers to maritime decarbonisation. These initiatives are intended to assist the industry in overcoming economic, structural, and organisational barriers to decarbonisation through targeted, collaborative action.

- At COP26, the UK launched the Clydebank Declaration for Green Shipping Corridors. A total of 24 states have now signalled their intent to support the establishment of 'green shipping corridors' under the Declaration - routes between two or more ports on which zero-emission shipping solutions are demonstrated and supported.

- Operation Zero, also launched at COP26, convenes industry stakeholders across the North Sea's offshore wind value chain to accelerate the decarbonisation of operation and maintenance vessels in the sector.

- Finally, the UK is also a core member of the Zero-Emission Shipping Mission, launched in 2021 under the second phase of Mission Innovation. A goal of the Shipping Mission is for ships capable of running on zero-emission fuels to make up at least 5% of the global deep-sea fleet by 2030. It brings together an ambitious alliance of countries, private enterprises, research institutes and civil society to develop, demonstrate, and deploy zero-emission fuels, ships, and fuel infrastructure together by 2030, making zero-emission ocean going shipping the natural choice for ship owners.

In addition to our leading role at the IMO and in international initiatives, we closely monitor other relevant developments internationally and consider how they may interact with our domestic policy. For example:

- In 2021, the European Commission also announced a raft of new policy proposals as part of their 'Fit for 55 Initiative', designed to ensure that the EU meets its target of 55% reduction in carbon emissions by 2030. One key proposal 'FuelEU Maritime', is intended to reduce the GHG intensity of the energy and fuels used by ships by up to 75% by 2050. The proposed regulatory measure would set a continent-wide fuel standard, or maximum limit on the GHG content of energy used by vessels calling at EU ports.

- This Fit for 55 initiative also includes a proposal to expand the existing EU Emissions Trading System (EU ETS) to include emissions from maritime transport. It also includes plans to review the Renewable Energy Directive, with a focus on transport, and to revise existing legislation to accelerate the deployment of infrastructure and alternative power supply for ships in ports. It is important to note that these Fit for 55 proposals from the European Commission have not yet been adopted at the EU level.

8. Which international policies, programmes, and initiatives do you expect will have the most impact on how the UK's domestic maritime sector decarbonises?

This could include, but is not limited to:

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- Any planned or implemented policies, formulated by international organisations like the IMO and EU, or
- Initiatives designed by the maritime industry, specialist interest groups and other individuals.

Please provide as much evidence as possible to support your answer.

Despite slow progress in the discussions at the IMO around MBMs (through the introduction of a carbon tax for example), there remains a consensus on them being most efficient in incentivising reliance on alternative fuels and putting shipping on course to meet the targets of the GHG Strategy. However, many hurdles persist, notably concerns about the impact of such measures on Small Island States and Least Developed Countries.

Initiatives involving the corporate supply chain, *i.e.* major manufacturers and cargo interests (for example, the Cargo Owners for Zero Emission Vessels) are providing the ultimate push for the global shipping industry to decarbonise, which would have evident ramifications on UK domestic shipping. Importantly, these are not only concerned with shipping *per se*, but rather involve pledging to reduce the emissions of the wider value chain including road and rail transport (for example the commitment of Maersk, Unilever, Ikea, and others brought together under the Climate Group umbrella, to the EV100+ initiative). These initiatives provide the market demand from manufacturers and cargo interests who are looking to transport their goods globally, and are pledging to do so through chartering ships that align with a trajectory that exceeds the GHG Strategy's current targets and aligns with net-zero by 2050 and Paris Agreement objectives. In reality, however, this entails that shipowners who do not align with this trajectory will be under growing pressures of bankruptcy as cargo interests become less willing to trade on their ships. Testament to the crucial role which these initiatives play is the Science Based Targets initiative, which is organised by several environmental and international organisations including the United Nations. The initiative has been pushing companies to make net-zero commitments that are consistent with the Paris Agreement and is anticipated to accredit only those companies that adopt high standards of measurement and disclosure of climate data, and have serious carbon-mitigation plans in place (including scope 3 emissions).

However, these initiatives alone would not suffice in creating the necessary incentivising environment for shipping to meet its decarbonisation targets. It is important to recognise the role which initiatives and commitments from key stakeholders of the maritime transport sector, *i.e.*, banks, insurers, and industry stakeholders (charterers/shipowners, shipyards, ports, *etc.*) play in creating the necessary incentivising environment to catalyse investment decisions by shipowners and producers of zero-carbon shipping fuels to make the transition towards decarbonisation. These initiatives are concerned with creating a sustainable business model that would afford the requisite clarity for investment decisions by stakeholders in the shipping industry, most notably shipowners and producers of alternative fuels. To that end, it is important to continue to showcase what is feasible to scale up demand (*e.g.* Clydebank Declaration for green shipping corridors and the recently announced Action Plan for the Zero-Emission Shipping Mission). But equally, the initiative by 30 leading banks, jointly representing approximately USD 185 billion in shipping finance (more than two thirds of the global ship finance portfolio) to sign up to the Poseidon Principles, allows international shipping banks and financial institutions to play a crucial role which enables them to promote responsible environmental stewardship throughout the global maritime value chain. Moreover, initiatives such as the Net-Zero Insurance Alliance and the Poseidon Principles for Marine Insurance; coupled with frameworks governing cargo-owners and shipowners' alignment of their chartering activities with decarbonisation objectives such as the Sea Cargo Charter, entail that, ultimately, access to finance, cargo, and insurance will be restricted to shipping companies that commit themselves to objectives that exceed those set out in the current IMO GHG Strategy.

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9. What do you think are the key lessons from international policies, programmes, and initiatives that we should consider in our approach to decarbonising the UK domestic maritime sector?

The challenge of decarbonising shipping should not be tackled in silos. It should be addressed not as a shipping problem, but one for the entire value chain, even at domestic level. It is important to recognise that some of the initiatives mentioned in the response to question 8 are underpinned by initiatives such as the Glasgow Financial Alliance for Net Zero and the UN-convened Net-Zero Banking Alliance (bringing together a global group of banks that represent nearly 40% of global banking assets).

Fostering collaborations between industry, policy and research is important to continue to drive down costs and develop emission reduction technologies. As technologies are demonstrated, the focus should tilt towards closing the circle and ensuring that the technological advances/showcases inform regulatory development as certainty around what is achievable and its impact on the industry become better understood (including cost-benefit analysis).

Refining our current policy approach: Economic measures

The UK government recently published a consultation on expanding the UK's Emissions Trading Scheme to the domestic maritime sector. As cited above, this market-based measure, alongside the funding committed to research and development through UK SHORE, are expected to be critical economic interventions which will help to unlock and accelerate decarbonisation. However, the available evidence suggests that further, complementary economic measures might be able to help further expedite the process of maritime decarbonisation. It is important for the government to explore these other options, given the current uncertainty associated with reaching an agreed international approach to regulating and incentivising maritime decarbonisation, and recognising the wide range of barriers to decarbonisation identified in research. The Clean Maritime Plan also committed the Department to exploring ways of developing green finance for maritime decarbonisation and incentivising investment from outside of the maritime sector, as well as within it. Further economic measures could also provide an opportunity to boost the UK economy. The government therefore may wish to consider potential complementary economic measures.

The Maritime and Coastguard Agency (MCA) has led industry working groups on financial products to address issues surrounding incentivising investment in maritime decarbonisation and consider the evidence base for more significant intervention. The MCA and DfT will continue to work closely with industry and other government departments to explore any financial products which could help the sector meet its decarbonisation goals. These products also offer potential to create new business opportunities for the UK and ensure that the sector remains a great place to invest. To complement this work in the short-term, the government could consider reviewing some limited, fiscally-neutral interventions to help incentivise maritime decarbonisation. For instance, the government could review the opportunities and risks associated with amending the costs of UK flag ship registration and offering green discounts for ships deploying green technology. The Isle of Man has recently adopted such a policy to help encourage operators to invest in green technology.

In the medium to long term, the government could consider a range of alternative methods to help incentivise green investment. This could include, for example, reviewing longer-term investment vehicles such as loan mechanisms to support maritime decarbonisation. The government could also investigate international examples of economic interventions to support maritime decarbonisation and review their potential for success in the domestic UK sector in the longer-term. Further evidence would be needed to assess the need for such measures, taking into account the impact of current initiatives, proposals, and policies. All of these policies would need to be considered alongside any new regulatory measures associated with maritime decarbonisation, which may render such options

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obsolete. We would welcome your views on whether there are any additional interventions, targeting economic barriers, that the government could explore to complement and enhance our current approach.

10. Are there any additional interventions targeting economic barriers that the government could explore introducing to complement and enhance our current approach, in the short, medium, and long term?

It may be helpful to consider in your answer how you think the costs of maritime decarbonisation should be most fairly be shared across the supply and value chain.

Please provide as much evidence as possible to support your answer.

There is a concern that the shipping industry would fall behind in competing with other key industries that are decarbonising and relying on the "clean fuels" of the future. Regulations should be in place to determine where shipping sits amongst other industries because it is currently using the "bottom of the barrel" type of fuels, which places it in a competitive disadvantage compared to other industries when it switches to using alternative fuels. This is made even more problematic in light of the current energy crisis that the world is experiencing. Support for the shipping industry can be in the form of subsidies for example.

Refining our current policy approach: Regulatory interventions

Regulatory interventions could require, encourage, or facilitate change that results in maritime decarbonisation. Regulations could, for example, target the vessel itself, its design and operations or rules associated with its sale and purchase. Regulations could also target marine fuels and energies, their production, sale, or use. Regulatory interventions could also help to target domestic maritime vessel emissions more indirectly via alternative avenues like the requirement to report GHG emissions. As discussed previously in this consultation, the UK has implemented, and is exploring, a wide range of regulatory measures to support the decarbonisation of the UK's domestic maritime sector.

However, there are a variety of further regulatory measures which the government could consider introducing at the domestic level, that develop or complement the UK's existing portfolio of work in this area. It is recognised that there are a range of barriers to the uptake of emissions reduction options by domestic maritime, and that further interventions may be required if we are to overcome all of these barriers. It is also recognised that different interventions may be appropriate under different circumstances to reflect the diversity of the domestic maritime sector (such as the wide range of different vessels that perform domestic maritime activity). The government will keep this package of interventions under review and introduce further interventions where warranted. We would welcome views on any further regulatory interventions to help tackle barriers to decarbonisation that complement and help to optimise existing regulatory plans and proposals. Some of the possible, further regulatory measures which are discussed below.

Regulating efficiency and energy saving measures on board domestic maritime vessels

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The shift to alternative low or zero emission fuels and energy sources is understood to be the critical factor in achieving net zero domestic maritime emissions (see Chapter 1). However, efficiency measures could also play a significant role in meeting this target. Incorporating fuel efficiency measures could help, not only to reduce GHG emissions in the short term but help to make the shift to alternative fuels technologically and economically viable in the long-term. Reducing the overall energy demand of a vessel would make decarbonisation more technologically feasible, given the reduced energy density associated with many of the alternative low and zero emission fuels and energies under consideration, when compared with traditional marine fuels. Vessels which have incorporated efficiency measures may also be cheaper to operate given reductions in fuel costs (compared to vessels that have not made these investments), making alternative fuel pathways more economically viable.

When taken together, significant, cumulative emissions reductions may be achievable by implementing measures, like incorporating additional power assistive and or propulsion technologies and making operational changes like slow steaming. Adapting the vessel's design and infrastructure including altering the engine technology of a vessel can also contribute to a tangible reduction in GHG emissions. The Retrofit Project run by the Danish not-for-profit Green Ship of the Future, reported that, at its peak, a significant reduction in CO_2 emissions was possible through retrofittable and proven technological solutions on a sample of high-volume vessels. The government could investigate the possibility of setting standards around mandatory efficiency technologies and measures that must be included in new vessels. This could build on IMO energy efficiency requirements for those vessels which may be subject to these regulations already or introduce entirely new requirements for those vessels not currently subject to IMO energy efficiency regulation. We would welcome views on the potential benefits and impacts associated with such an intervention.

11. What are the potential benefits and impacts associated with mandating or incentivising the incorporation of energy efficiency and energy saving measures on board domestic maritime vessels, where possible?

Please provide as much evidence as possible to support your answer.

Lower fuel costs and lower pollution and CO2 emissions. Develop mindset of operators towards optimisation of procedures and lowering pollution.

Regulating retrofit capabilities for new domestic maritime vessels

The Clean Maritime Plan expressed an ambition that by 2025, "all new vessels being ordered for use in UK waters are being designed with zero emission propulsion capability." This raises the question of how 'zero emission propulsion capability' should be defined, and how we might ensure that vessels are being designed with 'zero emission propulsion capability'. One possible interpretation of 'zero emission propulsion capability' could be that vessels are designed to be able to be retrofitted with zero emission propulsion technologies, in a least cost manner. For example, this might include

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ensuring that the storage space requirements for new fuels and the need to replace equipment are factored into the design of new vessels. Possible interventions include:

- Establishing a clear standard for ‘zero emission propulsion capability'
- Producing guidance setting out actions that can be taken to meet the standard when designing new vessels, following e.g. undertaking a study of the implications of different options for retrofitting and factoring these findings into vessel design
- Putting in place a voluntary process to enable new vessels to be accredited as meeting the standard
- Introducing regulations requiring new vessels to meet the standard

Building in retrofitting capabilities for vessels may also provide a degree of future-proofing for assets in the short- and medium-term, as they may be less likely to be penalised by any future domestic regulations or international regulations (if applicable). The government could examine the costs and benefits associated with introducing incentives or regulations which ensure or encourage new-build ships to incorporate retrofitting capabilities, as described above. The government could also explore introducing new policies, like a mandatory review of emissions reductions options within shipping companies, which could assist decision-making by switching the default position of inaction. We would welcome views and evidence on the costs and benefits associated with these interventions.

12. What are the potential benefits and impacts of developing a zero-emission capability standard, either as a mandate or incentive for new ships? What do you think is a reasonable definition of zero-emission capability?

Regulating the safety and security of innovative technologies on board domestic maritime vessels: standards and certification

To protect the health, safety, and security of mariners, ports, local communities, and the marine environment, there are several regulatory processes which new vessels and alternative maritime fuels and energies must undergo before they can be deployed. However, the government could investigate whether it was possible to convene all relevant regulators more effectively, to help coordinate the required processes associated with regulating alternative maritime fuels and vessels, both domestically and at the international level. These regulators would include, but are not limited to, the Maritime and Coastguard Agency, Health and Safety England, the Environment Agency, Devolved Administrations, local governments, and authorities.

Regulators could also explore if there was scope to amend elements of these processes to help expedite decarbonisation, without sacrificing the safety and security guarantees that they provide.

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For example, the Clean Maritime Plan research suggested that the government 'could, in theory, modify the current regulatory constraints that are in place and help to coordinate changes in fuel and vessel standards and certifications at the international level. Merchant shipping legislation has been traditionally prescriptive. This approach does not necessarily work for innovative technologies which are yet to be proven. Hence, for innovative technologies, a more goal-based approach is adopted, where a gap analysis is carried out against the established regulations and any identified gaps supplemented by a safety case to mitigate risks. This case by case approach helps to build understanding of new technologies so that, should regulations change, they would be applicable to the needs and risks of this technology. Currently, however, this means that vessels powered by alternative fuels, like hydrogen for example, must follow this 'alternative design' principle which presents a potential regulatory barrier. Under this approach, each ship design will have an individual certification application process, that will need to be approved by the vessel's flag State for operation, adding cost, time, and risk to the process.

However, where appropriate, the MCA has, and will continue to, publish separate, supplementary guidance that is aimed at managing the risks associated with any specific technologies. Marine Guidance Note 664 was published in March 2022 to provide guidance on how to process an application for the certification of vessels operating in UK waters that use innovative technology or where a risk-based approach is used. Furthermore, given the growth of innovative technologies in the Workboat sector, revisions are being made to the Workboat Code to include annexes on remotely operated unmanned vessels and battery/hybrid operated workboats. The Clean Maritime Plan research suggests that alternative fuels require development of fuel-specific safety standards. This would help to simplify and speed up the certification and deployment of new low and zero emission vessels operating on innovative technologies, as well as potentially encouraging further investment in the sector. However, there is a risk that domestic standards may conflict with any international fuel-specific safety standards which may be introduced for vessels. We would welcome views on how best to ensure that domestic maritime regulations support and facilitate the rollout of low and zero emission vessels in the short medium and long term.

13. Are you aware of any domestic or international regulatory measures that you think currently discourage progress toward maritime decarbonisation, and should be reviewed by the government?

This could include either current policies and regulations, both domestically and internationally, or possible future interventions which, in your view, may undermine or impede the progress of decarbonisation.

UK Government lifting shale gas moratorium and support for new oil and gas licensing round.

Freeports must encourage in deed as well as words green, zero carbon technologies and approaches.

Lack of ambition in renewable electricity generation (needs to be much larger), slow progress on carbon capture and storage, and lack of planning for large scale H2 storage for major export ports will curtail adoption of new green technologies.

14. Which regulatory interventions do you think the government should support in the short, medium, and long term to help accelerate decarbonisation and complement existing plans and proposals?

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Greatly increase renewable electricity production and invest in green H2 production via electrolysis; investigate desalinisation/electrolysis for H2 generation from seawater;

Invest in critical UK manufacturer in key technologies – *e.g.*, UK manufacturer of solid oxide fuel cells so UK doesn't fall into the same issues as current catch up in battery production.

Carbon capture and storage needs to be taken forward at pace as essential transition to low carbon society.

Regulating the carbon intensity of marine fuels and energies

The government could also investigate the costs and benefits associated with regulating the carbon intensity of fuels used in domestic maritime journeys. This could complement proposals made by the EU Commission for a fuel standard measure like FuelEU Maritime. Such an intervention could send a clear signal to the maritime industry about the end-date for greenhouse-gas emitting fuels and vessels within the maritime sector. It could also make operating on green fuels and energy sources economically competitive by limiting the availability of carbon intensive fuels. Depending on when such a measure was introduced, it could encourage early investment and rollout of alternative fuels and energy processes, helping to ensure that the sector meets its net zero emissions target. However, the risks associated with this measure, would need to be thoroughly investigated. These include the risk of carbon leakage, the difficulties in assessing lifecycle emissions for all maritime fuels and energy sources, and the challenge of ensuring that alternative green fuels and technologies are available in sufficient quantities. Such a measure would also need to align with any other international regulatory regimes as effectively as possible. We would welcome views on the potential benefits and impacts associated with such an intervention.

15. What are the potential benefits and impacts of mandating the carbon intensity of fuels and energies used in the domestic maritime sector?

A direct benefit would be the reduction of the marine industry's carbon footprint. This could be provoked by ship owners and managers through their effort to avoid heavy fines, while minimising the consumption of carbon intensive fuels.

As expected, a negative impact could be the increased cost of mandating the use of less carbon intensive fuels which can significantly increase costs of vessel operation and building, forcing owners and managers to "curb" regulations in order to stay afloat, financial-wise.

Refining our current policy approach: Information programmes and voluntary action

Convening stakeholders and co-ordinating the end-to-end rollout of low and zero emissions vessels, fuels, and infrastructure for the maritime sector

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Research suggests that the government could 'play a co-ordinating role in assisting the shift from existing infrastructure to new facilities that would support the deployment of' emission reduction options'. For example, under Operation Zero, the Government has convened a coalition of 30 industry stakeholders from across the offshore wind supply chain to accelerate the decarbonisation of the operations and maintenance vessels working in the North Sea's offshore wind farms. The government has also established a Clean Maritime Council with maritime industry and experts to help advise and support the government's maritime decarbonisation policy work. However, in some countries, like Denmark, the government has taken a substantial role in convening the energy sector to deliver more renewable energy, particularly in relation to maritime fuel and energy demand. This has involved developing bespoke strategies and fuel partnerships with maritime sector representatives and convening and co-ordinating stakeholders from across a range of sectors, beyond the maritime sector.

Similarly, the government has developed, and continues to develop several strategies relating to alternative renewable fuels and energy sources (Hydrogen strategy, Electricity Networks Strategic Framework, British Energy Security Strategy and Low Carbon Fuels Strategy). These take the energy demand from the maritime sector into account. However, the government could consider whether it was possible to align work on alternative fuels and energies with the maritime sector's infrastructure and vessels rollout more closely in the medium- to long- term. The government could explore whether it would be helpful to develop a maritime-specific strategy for the deployment of low and zero emission fuels and technologies which included consideration of fuel production, storage, transportation, and wider infrastructure needs of the sector.

However, it may be more appropriate and effective for this cross-sector co-ordination to be led by the private sector, specifically the maritime and energy sectors themselves. For instance, the International Chamber of Shipping (ICS), who represent over 80% of the world's merchant fleet, recently signed a Partnership Agreement with the International Renewable Energy Agency (IRENA) to help coordinate this process directly. We would welcome views on how the government can collaborate further with the maritime sector to support the rollout and deployment of alternative renewable fuels and energies.

16. What more can the government do to help convene the maritime industry, connect, coordinate, and support its collaborative efforts to decarbonise the sector?

It may be helpful in your answer to include:

- What role you think the government should take to help to develop a strategy to roll out alternative energy supplies to UK ports, bunkering facilities, and maritime infrastructure,
- Your perspective on the role of government versus the role of the private sector in infrastructure development to support maritime decarbonisation,

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- How maritime energy and fuel infrastructure development should be supported and managed across the UK.

Needs a plan to provide to or generate at large amounts renewable energy in the UKs major (all?) ports. Needs improve interconnectors between power generation and usage for battery storage or shore power.

Needs to build H2 storage as well as electricity storage in ports.

Need CCS and CO2 shipping facilities.

Needs research and testing facilities to marinise and test promising technologies and systems that are yet to be trialled at sea or at scale.

Please provide as much evidence as possible to support your answer.

Producing bespoke guidance and best practice guidelines to assist maritime decarbonisation

The lack of clear guidance on emissions reductions options for owners and operators has been cited as a key barrier to achieving investment in green maritime vessels, fuels, and technologies. There are also other knowledge gaps and areas where best practice guidance could be helpful to stakeholders across the maritime value chain. Ongoing research and development projects like UK SHORE and the work of the Zero-Emission Shipping Mission are intended to provide greater clarity about alternative fuel and vessel options as green technology develops in the maritime sector.

The government could examine potential measures to ensure that the results of research and development and the evolving green maritime technology picture are shared as widely as possible with the maritime sector. Equally, the Clean Maritime Plan barriers research suggested that if the government were to set a ‘clear policy direction for shipping fuels’, this 'could provide more certainty and mitigate some of the risk of investment’. Currently, the UK government has taken a position of ‘technological neutrality’. DfT could instead consider the costs and benefits associated with formulating an official technology forecast or outlook document for the domestic maritime sector, in collaboration with the maritime industry, experts and other government departments.

The CMP research also suggested that ‘the publication of additional information on the long-term value of abatement options by government could help to shift companies away from the status quo’. In addition, the CMP research suggested that ‘providing clear, accessible information such as best-practice guidelines’ could help by ‘simplifying the decision processes of ship owners’.

The Maritime and Coastguard Agency is working to better understand the technology options for the shipping industry and has been undertaking research to develop a Technology Matrix that was announced at London International Shipping Week 2021. The Matrix is an in-house software model utilising real ship, technology and emissions data which is designed to review the feasibility of different green technology pathways for various vessel types used in the domestic sector. The MCA is planning to publish the first release of information from this project in Summer 2022 which will focus on options for windfarm crew transfer vessels and small ferries, and will continue development of the model with larger passenger vessels and general cargo ships being the next group of ships in focus. The government could consider developing this Matrix, and similar, further projects to provide a readily accessible running commentary and analysis of technological developments and their potential for subsectors of the domestic maritime sector.

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Finally, the CMP research also suggests that the government 'could encourage the sector to move away from certain established contractual behaviours that are currently acting as a barrier.' This could include exploring possible mitigations for late arrival charges, which may help to encourage slow steaming and reduce vessel GHG emissions. The government could consider providing best practice guidance on this issue.

17. Does government have a role in providing advice or greater clarity on the technology and investment options for the domestic fleet?

It may be helpful to consider in your answer:

- If the government's commitment to technology neutrality is a barrier, which affects the pace at which the maritime sector can decarbonise (within your sub-sector, if appropriate)?
- How the UK government can best provide greater clarity on emissions reductions options?

Current best advice is coming from class societies (e.g, DNV, ABS > LR) and well-funded research institutes such as the Maersk-Moller- McKinley Centre for Decarbonisation. UK is currently ceding thought leadership to Scandinavians, US and east Asia. Needs UK capabilities to trail and test new approaches. Need finance to de-risk development of new approaches and support first adopters.

18. Should the government explore options to disincentivise contractual behaviours which are creating a barrier to decarbonisation? How should government approach this?

Yes – need to stop subsidies to north-sea hydrocarbon industry and channel money towards green energy approaches. Needs to recognise that maritime decarbonisation challenges are different from other sectors (automotive, steel) and need specific maritime approach. Need equivalent investment to the Aerospace Technologies Institute etc – to accelerate the testing and adoption of new maritime powering systems.

Encouraging public and consumer engagement with, and investment in, maritime decarbonisation efforts

The government could explore ways to encourage public and consumer engagement with efforts to decarbonise the maritime sector. This could mean both helping customers to understand which maritime operators are making successful efforts to decarbonise their operations, as well as encouraging them to select 'greener' operators, whether as a passenger, individual consumer, or commercial charterer/importer. Clear monitoring and reporting of emissions by operators may affect how consumers select maritime services and thereby support the whole sector decarbonising The 2019 research published alongside the Clean Maritime Plan suggested the government could

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incentivise 'the sharing of standardised and verifiable performance-monitoring information with charterers', which 'would make the fuel efficiency of vessels more transparent'. The CMP research also suggested that the government could 'mandate ship owners to make the performance-monitoring data publicly available if they wished to operate from UK ports.' Such measures could help to de-risk investment and promote collaboration across the value chain. Transparent, accurate and consistent reporting of GHG emissions may also affect how operators themselves respond to their own emissions, given the increased levels of public scrutiny which such reporting systems could precipitate.

Last September, the MCA published an information notice (MIN 669 (M+F) giving details of a new UK reporting system for recording CO_2 emissions from vessels over 5,000 Gross Tonnes (GT). This UK Monitoring, Reporting and Verification (UK MRV) system applies to those vessels transporting cargo and/or passengers for commercial purposes to and from UK ports. Operators of vessels which are subject to the UK MRV began collecting CO_2 emissions data on 1 January 2022 for the 2022 reporting period. It is the government's intention to make the data publicly available and to report annually on the key findings. The data is expected to be an important constituent of any future emissions reduction regime, providing the evidence and data needed to support any future decarbonisation measures.

As a comparatively new system, we cannot be certain if the UK MRV as currently designed will deliver all the information and evidence needed to support all future requirements. One option might be to extend the reporting requirements to large vessels that are currently outside the scope of the UK MRV. At the same time, we are aware that many ships over 5,000GT which are reporting under the UK MRV also have to submit separate emissions reports to the International Maritime Organization and to the European Union, adding to the burden on ship operators and resulting in some duplication. The government's intention is to review the UK MRV in the short to medium term, to consider if it fully meets our requirements and whether it can be streamlined to minimise the burden on industry. We would welcome views on how the MRV system might be improved to support public and consumer engagement with maritime decarbonisation efforts.

Correspondingly, the government could consider the benefits and costs of requiring domestic maritime operators, charterers, and major importers to publish their official carbon footprint on a regular basis. The government could also consider introducing certification for operators, charterers or importers based on their efforts to reduce emissions and decarbonise their operations. It is possible that such measures could help the wider supply chain choose 'greener' suppliers, encouraging the appetite for alternative low or zero emission fuels, energy, and vessels.

The government could also explore ways to encourage charterers and importers to commit to selecting shipping options which are low carbon or fully decarbonised. Many charterers and importers have already made such commitments. This could mean exploring interventions that would assist consumers in identifying which businesses are taking action to bring down their maritime-related emissions, for example, by publicising which importers are 'greenest' in terms of ships transporting their imports. This may complement a range of existing ongoing work since, in the UK and the EU, company reporting increasingly mandates the publication of business' environmental information. We would welcome views on which interventions would be most helpful to engage interest and support for maritime decarbonisation across the value chain, including from the public and other consumers of maritime services and operations.

19. How do you think the UK's MRV system could be improved to help support public and consumer engagement with maritime decarbonisation?

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Could develop green food mile / green package labelling?

20. What role do you think the government should play in encouraging public engagement and consumer investment in maritime decarbonisation efforts?

It may be helpful in your answer to include:

- How the government could most effectively encourage consumers and stakeholders to invest in greener maritime.

Subsidize routes using zero-carbon / low carbon approaches, advertise and reward.

Next steps

A summary of responses, including the next steps, will be published within three months of the consultation closing on. Paper copies will be available on request.

The evidence provided in response to this consultation will inform the formulation of indicative decarbonisation targets for the domestic maritime sector and will shape the long-term interventions which the government plans to make in this area. Both the targets and longer-term interventions required to achieve full decarbonisation will be included in the refreshed Clean Maritime Plan, due to be published in 2023.

If you have questions about his consultation, please contact: MaritimeTDPConsultation@dft.gov.uk.

Final Comments

21. Do you have any other comments to share with us, about any aspect of domestic maritime decarbonisation?

It may be helpful in your answer to include:

- Any evidence that you have about possible consequences of decarbonising the maritime sector that the government may not have considered, and should be concurrently planning to mitigate,

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- Where you think the UK government should be focusing its efforts strategically to help achieve net zero domestic maritime emissions.

22. Do you have any other comments?