

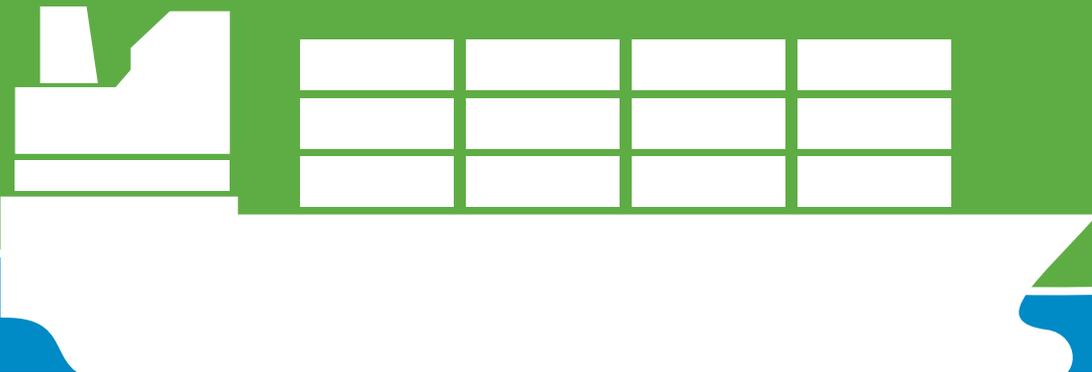


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Clean Maritime Plan





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Clean Maritime Plan

July 2019

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Department for Transport
Great Minster House
33 Horseferry Road
London SW1P 4DR
Telephone 0300 330 3000
Website www.gov.uk/dft
General enquiries: <https://forms.dft.gov.uk>



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Foreword by Minister for Maritime



As the Minister for Maritime, I have made clear my commitment to maintaining the UK's position as a world maritime leader. Maritime 2050, published in January, was our blueprint for the future of the sector, anticipating the challenges and opportunities that lie ahead and recognising the UK's strengths in facing them. This Clean Maritime Plan is the environment route map of Maritime 2050, outlining the UK's pathway to zero emissions shipping.

In April 2018, the UK was a leading voice in the negotiations at the International Maritime Organization, resulting in the first ever Greenhouse Gas Strategy for the sector, agreeing a target of reducing emissions by at least 50% by 2050, and phasing them out entirely as soon as possible this century. The Clean Maritime Plan makes the UK one of the first countries since the agreement of that Strategy to publish our National Action Plan. The Plan clearly demonstrates our ambition and commitment to tackling this important issue, at this pivotal moment for the future of the maritime sector.

A global transition to clean shipping is underway. This route map identifies ways to tackle air pollutants and greenhouse gas emissions in parallel while securing clean growth opportunities for the UK. Research undertaken for the Government suggests that the global market for maritime emission reduction technologies could reach \$15 billion per year by 2050, potentially resulting in economic benefits to the UK of \$690 million per year by the middle of the century.

By 2050, we want zero emission shipping to be commonplace globally. We want the UK to have taken a proactive role in leading this transition, to be seen globally as a role model, and to have successfully captured a significant share of the economic, environmental and health benefits that will follow.

To achieve these aims, it is crucial that industry and government work alongside each other, and not in isolation. I am incredibly grateful to the representatives from across the sector who have engaged with us to develop this plan. To the members of the Clean Maritime Council and its subgroups. To over 80 industry stakeholders attended a full day workshop to share their own visions for the future of the sector. Not to mention the many individuals who have spoken to me directly throughout the year. I look forward to the continuation of this collaborative approach.

The Clean Maritime Plan presents an ambitious vision for the future of zero emissions shipping in the UK. It is an important step on our journey to reducing emissions and embracing global clean maritime revolution. But the real value of the Plan will be in the work that continues beyond it, with the whole sector, Government, industry, researchers and the third sector, working together. The opportunity before us is substantial, and with the UK's proud history of maritime innovation, we can grasp it.

A handwritten signature in black ink, appearing to read 'N Ghani'.

Nusrat Ghani
Minister for Maritime



Endorsements



The UK Chamber of Shipping is proud to have been part of this very important initiative between Government and industry. There is no greater challenge facing humanity than containing and reducing global warming and nor are there many greater threats to all the species of fauna and flora that share this planet with us. Whilst shipping is by far the most environmentally sound method of transporting goods and people, it too needs to do all it can to reduce its environmental footprint, including CO2 emissions. In recent years the Chamber and its

membership have been at the forefront of driving positive environmental change and it looks forward to continuing this vital work with the UK Government.

David Balston, Director of Policy, UK Chamber of Shipping



As an SME leading an ambitious initiative developing maritime renewable energy systems, we have welcomed the Clean Maritime Council's vital initiative. The Council has collaborated across the complex shipping eco-system and made excellent progress to help ensure that the UK benefits from the huge global opportunity arising from the need for urgent transformational shift to zero emission ships across the global fleet. Now is the time pioneer 21st century cleantech solutions and enable them through bold and progressive business models.

Together the Council has been building on our national strengths, reducing business risk and moving fast to create world-leading propositions. We look forward to continuing the process.

Diane Gilpin, Founder & CEO, Smart Green Shipping Alliance



"The Institute welcomes the opportunity to help shape the Clean Maritime Plan – a clear statement by the Government on its desire to mitigate the impact of rapid climate change and curb warming to 1.5°C. It is clear that swifter action is required by all industries to reduce emissions within a limited time-span and the shipping industry is no exception. In light of a fast-approaching crisis, it is encouraging to see that the government is focusing on how innovation and expertise of the UK's maritime community can help us achieve this vital goal."

David Loosley, Chief Executive, Institute of Marine Engineering, Science & Technology (IMarEST)

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Executive Summary

The world's proudest maritime heritage, as a global leader for the 21st century

1. In January 2019 the government published Maritime 2050¹, a strategic vision for the future of the maritime sector building on the earlier 2015 Maritime Growth Study², outlining ambitious recommendations to take the UK maritime industry into the second half of the 21st century. Underpinning the Maritime 2050 strategy are 10 core strategic ambitions, covering a range of topics from competitiveness to technology. These include the intention that the UK 'lead the way in taking action on **clean maritime growth**, enjoying economic benefits from being an early adopter or fast mover.'

2. Building on this strategic ambition, Maritime 2050 sets a vision for clean maritime in the UK as follows:

In 2050, zero emission ships are commonplace globally. The UK has taken a proactive role in driving the transition to zero emission shipping in UK waters and is seen globally as a role model in this field, moving faster than other countries and faster than international standards. As a result, the UK has successfully captured a significant share of the economic, environmental and health benefits associated with this transition.

3. The Clean Maritime Plan is the Environment Route Map of Maritime 2050, setting out in more detail how Government sees the UK's transition to a future of zero emission shipping³. It encompasses the maritime



commitments within the Clean Air Strategy⁴ to ensure that the sector takes the steps necessary to protect human health and the environment from air quality pollutants. At the same time, it recognises the need for all countries to take action to address emissions of greenhouse gases, in line with the Paris Agreement and its temperature goals⁵. In 2018 the UK was a leading voice in the agreement of the Initial IMO Strategy on the Reduction of GHG from Ships ('the IMO GHG Strategy')⁶. The Strategy commits the maritime sector globally to reducing emissions of GHGs from shipping by at least 50% by 2050 compared to 2008, while pursuing efforts to phase them out. While the UK continues to believe that global action is the most effective way to achieve these ambitions, it also recognises the role that national action can play in leading the transition to zero emission shipping. In this context, the Clean Maritime Plan represents the UK's National Action Plan on shipping emissions.

4. But above all, the Clean Maritime Plan is about opportunity. For example, research commissioned by the Government estimates that the economic benefits to the UK across 11 key maritime emission reduction options could reach \$650-890 million per year by the middle of the century⁷. In line with the Government's vision for sustainable economic growth as set out in the Clean Growth Strategy⁸ and Industrial Strategy⁹, the Clean Maritime Plan seeks to support the innovation already present in British manufacturing, technology, fuel production and services, encouraging the translation of this expertise to the potential new clean maritime market.
5. In order to realise the full potential of this clean growth opportunity a collaborative approach from industry and Government

is vital. The Clean Maritime Plan has been developed in close partnership with the maritime industry. This has included an extensive programme of stakeholder engagement, including the establishment of a Clean Maritime Council, alongside workshops and ongoing dialogue. The Council is a strategic advisory body, bringing together leading figures from the maritime industry, academia and Government¹⁰. The Clean Maritime Plan has also been informed by a programme of economic and technical research, available online¹¹.

6. This process of consultation and research has indicated that we are on the cusp of a global transition to zero emission shipping. To reach significant reductions of greenhouse gases and air quality pollutants, energy efficiency technologies will not be sufficient. Low or zero-emission fuels and propulsion technologies will be necessary. Many other countries are demonstrating a keen interest in the development and implementation of such green shipping innovations and are moving swiftly to demonstrate leadership in this field. Maritime 2050 sets out the UK's ambition on this front, while the Clean Maritime Plan sets out a route map for domestic action to respond to this opportunity. It will help ensure that the UK builds on its unique maritime heritage to remain a world leading maritime economy.

Clean Maritime Plan Ambitions

7. It is Government's intention to support a high level of ambition on emissions reduction, providing enough direction to give investment certainty while allowing industry the space to innovate. To assist in providing this certainty, and in line with the recommendations set out in Maritime 2050, we have set out Clean Maritime Plan Ambitions for the UK



maritime sector. A significant increase in technology commercialisation and uptake will be necessary by 2025 and 2035 to make it possible to reach zero emission shipping by the latter half of the century. As such, ambitions are articulated for each of these dates, highlighting the expected direction of travel.

8. These zero emissions shipping ambitions are intended to provide aspirational goals for the sector, not mandatory targets. They can only be achieved through collaboration between Government and industry, promoting the zero emission pathways that maximise the economic opportunities for the UK economy while also minimising costs for UK shipping.

Ambitions

9. In Maritime 2050, the Government set out its vision for the future of zero emission shipping:

“In 2050, zero emission ships are commonplace globally. The UK has taken a proactive role in driving the transition to zero emission shipping in UK waters and is seen globally as a role model in this field, moving faster than other countries and faster than international standards. As a result, the UK has successfully captured a significant share of the economic, environmental and health benefits associated with this transition.”

10. In order to reach this vision

By 2025 we expect that:

- i. All vessels operating in UK waters are maximising the use of energy efficiency options. All new vessels being ordered for use in UK waters are being designed with zero emission propulsion capability. Zero emission commercial vessels are in operation in UK waters.
- ii. The UK is building clean maritime clusters focused on innovation and infrastructure associated with zero emission propulsion technologies, including bunkering of low or zero emission fuel.

By 2035 we expect that:

- iii. The UK has built a number of clean maritime clusters. These combine infrastructure and innovation for the use of zero emission propulsion technologies. Low or zero emission marine fuel bunkering options are readily available across the UK.
- iv. The UK Ship Register is known as a global leader in clean shipping and the UK is home to a world-leading zero emissions maritime sector, with:
 - a. a strong UK export industry
 - b. cutting-edge research and development activities
 - c. the global centre for investment, insurance and legal services related to clean maritime growth.



Clean Maritime Plan Commitments

11. The following are the Government's key policy commitments from the Clean Maritime Plan. These aim to support the sector as it moves towards the vision set out in Maritime 2050, and the Clean Maritime Plan Ambitions.

Commitments

1. Government will launch a call for evidence in 2020 on non-tax incentives to support the transition to zero emission shipping.
2. Government will consult in 2020 on how the Renewable Transport Fuel Obligation could be used to encourage the uptake of low carbon fuels in maritime.
3. Government will launch a 'Greening Finance/Financing Green' for Maritime Initiative at London International Shipping Week 2019.
4. In conjunction with a working group as part of the Clean Maritime Council, Government will undertake a study to identify and support potential UK zero emission shipping clusters.
5. Government will support clean maritime innovation in the UK, beginning with:
 - Providing seed funding to contribute to the establishment of MarRI-UK;
 - Funding a competition for innovation in clean maritime in 2019;
 - Launching a round of Government grant support for early stage research projects related to clean maritime; and

- Establishing a Clean Maritime Award to celebrate leaders in the field of emissions reductions.

6. The Government will establish the Maritime Emissions Regulation Advisory Service (MERAS) by 2020. Supported by the Maritime and Coastguard Agency, MERAS will provide dedicated support to innovators using zero emission propulsion technologies, assisting them through the regulatory process.

12. To help oversee the implementation of these policy commitments in the short-term, the Clean Maritime Council will continue as a strategic advisory body. The Government will publish a review of implementation of the Clean Maritime Plan in 2022.

Next steps

13. The Clean Maritime Plan sets out a national action plan to take UK maritime towards the vision for zero emission shipping set out in Maritime 2050. This action plan is full of opportunity but represents a challenge to all stakeholders in the maritime sector, both public and private. Action will be necessary from Government, industry and the academic sector. But the potential rewards are substantial. The UK has a rich maritime heritage, and we have the opportunity now to turn that wealth of history and experience towards real global leadership in a vast new market. Government is committed to working with the maritime sector to make that vision a reality.





1. The Case for Action: Tackling Emissions and Capturing Clean Growth Opportunities

Tackling Emissions

14. Maritime transport is often described as the backbone of international trade and the global economy. Around 80 per cent of global trade by volume and over 70 per cent of global trade by value are carried by sea and are handled by ports worldwide¹².
15. The UK's maritime sector is substantial. There are 51 major ports in the UK, which together handled just under half a billion tonnes of commercial cargo¹³ and over 22 million passengers¹⁴ in 2017. This accounts for around 95% of UK trade. The maritime sector directly contributes £14.5 billion Gross Value Added (GVA) to the UK's economy a year and directly employs 185,700 people¹⁵. If taken as a group, the Red Ensign Group¹⁶ would have the 10th largest registered trading fleet in the world at the end of 2018, totalling 59.6 million deadweight tonnage¹⁷.
16. The UK also enjoys a globally significant maritime tourism and leisure industry. Total revenue from the UK's leisure, superyacht and small commercial marine industry was put at £3.12 billion in 2017 with export success counting for just over 30% of the sector's total revenue. Our cruise sector is an exciting and fast growing one with 1.96 million cruises sold in the UK in 2017, half of which started at a British port¹⁸.
17. The UK's maritime services sector is also significant. Maritime business services directly contribute £2 billion GVA to the UK economy. When impacts on the wider economy are accounted for, including the rest of the maritime sector, this rises to nearly £5 billion. The City of London is a



global leader in this area; the largest share of worldwide marine insurance premiums and shipbroking transactions occur in the UK, comprising 35% and 26% of the global market respectively¹⁹.

18. Like other important sectors of the economy, the maritime sector is increasingly aware of its environmental and social impacts. As set out in Maritime 2050, the impacts of the sector in terms of emissions to air – in the form of both air quality pollutants and greenhouse gases – require attention.

Air Quality Pollutants

19. Air pollution is a major public health risk ranking alongside cancer, heart disease and obesity, and poses the single greatest environmental risk to human health in the UK. This underlines the importance of the recently published UK Clean Air Strategy (CAS)²⁰. Recent research commissioned by Public Health England has found that the health and social care costs of air pollution in England could reach £5.3 billion by 2035²¹. Certain air quality pollutants such as nitrogen oxides are also known to affect biodiversity²². The CAS, published in January 2019, outlined how actions to reduce emissions of 5 key pollutants could cut the costs of air pollution to society by £1 billion every year by 2020, rising to £2.5 billion every year from 2030²³.
20. Our understanding of the evidence on air quality pollutant emissions from shipping and wider port activity is growing rapidly. The latest evidence shows that shipping generates emissions to air of several pollutants harmful to human health: nitrogen oxides (NOx), sulphur dioxide (SO₂), particulate matter (PM_{2.5} & PM₁₀), volatile organic compounds (VOCs) and ammonia (NH₃). In 2016, domestic shipping²⁴ alone accounted for 11% of the

UK's total domestic NOx emissions, 2% of primary PM_{2.5} and 7% of SO₂²⁵. However, a recent analysis carried out by Imperial College, using Automated Identification System (AIS) data²⁶ showed that, in 2016, NOx emissions from UK international shipping and shipping in transit were three and six times higher respectively than for UK domestic shipping, and so have a more significant impact on air quality in the UK.

21. The fuel used for shipping has historically been some of the most polluting fuel used across all transport modes. The introduction of Emission Control Areas (ECA) has helped limit the sulphur content of maritime oil but this is still typically an order of magnitude higher in these fuels than in those used in, for instance, road vehicles²⁷.
22. To date, domestic policy on transport-related air pollutant emissions has largely focused on roads (particularly in relation to nitrogen dioxide concentration). As a result, average levels of nitrogen dioxide at the roadside are at their lowest level since the Government first started to collect these statistics²⁸. As emissions from road transport begin to decrease because of significant mitigating intervention – as set out in the Government's Road to Zero Strategy²⁹ – the contribution of relatively smaller sources of air pollution, including the maritime sector, will increase.

Greenhouse Gases

23. In terms of CO₂ emissions, shipping is considered one of the most efficient modes of transport³⁰. However, it also represents a substantial source of GHG emissions.
24. The most recent study by the IMO estimates that international shipping accounted for 2.2% of global CO₂ emissions in 2012³¹. This is equivalent to the total emissions



of Germany, the world's 4th biggest economy³². If no further action is taken then estimates from the IMO suggest that the CO₂ emissions from international shipping could grow by between 50% and 250% by 2050³³, and a study for the European Parliament suggests that international shipping could account for 17% of global CO₂ emissions by 2050³⁴.

- 25. The UK does of course contribute to these global maritime GHG emissions, both through international shipping calling at UK ports³⁵ and UK domestic shipping. UK domestic shipping accounted for 5.9Mt of CO₂ equivalent in 2017, equating to 1% of all domestic emissions. Domestic and international shipping together were responsible for 13.87Mt of CO₂ equivalent in 2017³⁶.
- 26. As a percentage of the UK's overall GHG emissions, shipping's contribution (both international and domestic) is 3.4%³⁷. As emissions from other parts of the economy decrease in line with UK commitments and action on climate change, the contribution

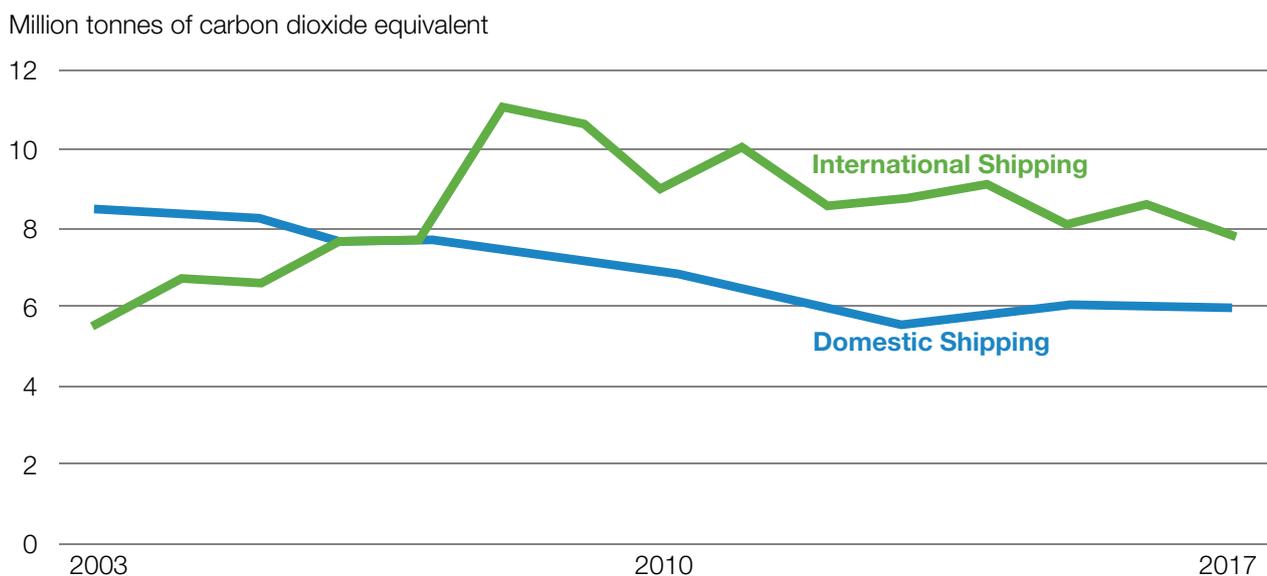
of relatively smaller sources of GHGs, including the maritime sector, will increase.

Existing Emission Policy

Air Quality Pollutants

- 27. There are limited regulations or policies in the UK specifically to incentivise reductions of air pollution from shipping. To date, the UK's main priority in tackling ship emissions has been exerting influence at an international level.
- 28. Air pollution from shipping is regulated by the IMO through the International Convention for the Prevention of Pollution from Ships (MARPOL). Annex VI of MARPOL entered into force in 2005, with, among other things, the aim of minimising airborne emissions from ships. As well as overarching European Directives on ambient air quality³⁸, the European Commission has also introduced specific Regulations for progressively integrating maritime emissions into the EU's policy for reducing its domestic GHG and pollutant emissions³⁹.

Figure 1: UK domestic and international shipping emissions (CO₂e)



Source: DfT (2018) Energy and Environment Data Tables: <https://www.gov.uk/government/statistical-data-sets/energy-and-environment-data-tables-env>

29. The UK has played a leading role in negotiating international limits to pollutant emissions from shipping, for example in the establishment of the North Sea Emissions Control Area (ECA). An ECA represents an area of seaspace identified under international maritime law for additional air pollution controls, intended to address areas of significant vulnerability to air pollution from maritime sources such as busy shipping lanes. The North Sea and English Channel are covered by an ECA which was declared in 2005 and entered into force in 2006 under the MARPOL Convention. The area initially covered only SO_x emissions and restricted ships to fuel containing not more than 1.5% sulphur (or a technical equivalence). This sulphur limit was further revised to a maximum of 1.0% in 2010 and finally 0.1% in 2015.
30. In 2016 it was agreed at the IMO that the North Sea would become a NO_x ECA. This will enter into force on 1 January 2021 and will require newbuild ships delivered after that date to operate against the IMO's 'Tier III' (most stringent) NO_x control standards. In practical terms, this means that new ships operating in these waters will need to reduce their NO_x emissions by around three-quarters. This represents significant progress, and the industry has invested in new technologies like exhaust gas cleaning systems and liquefied natural gas (LNG) as a fuel to meet these new limits.
31. In 2008, Member States at the IMO agreed to a 0.5% sulphur limit for global shipping outside emission control areas (ECAs) from 2020 (subject to a review on fuel availability), a reduction of three percentage points from the current limit. This decision was confirmed in 2016 at the IMO's Marine Environment Protection Committee (MEPC). The UK continues to co-operate closely with other Member States at the IMO on detailed technical and operational

matters related to the introduction of the 0.5% sulphur cap. The IMO is making good progress, and we are confident outstanding issues will be resolved before the implementation date.

32. At a domestic level, the Government's Clean Air Strategy (CAS)⁴⁰, which was published in January 2019, sets an ambitious and holistic approach to improve air quality and reduce emissions of air pollutants across all sectors, including the maritime sector. The CAS was designed to deliver the emission reductions needed to achieve emission ceilings in 2020 and 2030, halving the impacts of air pollution on human health and the environment. In the CAS, the Government committed to developing the Clean Maritime Plan, alongside a Clean Maritime Council to inform the development and implementation of the Plan. Also in the CAS, Government committed to publish in 2019:
- A **Call for Evidence** to explore options for standardising environmental regulations for vessels operating domestically within the UK, including inland waterways.
 - A consultation on options for extending the North Sea **Emissions Control Area** beyond its current geographical limits or establishing new, geographically distinct, Emissions Control Areas around the UK coast.
 - Guidelines to advise ports on how to develop effective and targeted **Air Quality Plans**.
33. Further detail on these commitments is set out below.

Greenhouse Gases

34. In relation to greenhouse gases, at an international level, the UK has recently been at the forefront of pushing for an



ambitious strategy to reduce GHGs from shipping at the IMO⁴¹. In April 2018, Member States at the IMO agreed in this strategy a commitment to phasing out GHG emissions from shipping as soon as possible in this century and reducing GHGs by at least 50% compared to 2008 by 2050. This commitment from the IMO sends a strong signal to the whole shipping sector on the need for investment in the development of low- and zero-carbon fuels and innovative energy-efficient technologies. Member States of the IMO are working now to develop detailed measures which will ensure the 2050 target is attained.

35. Domestic policy relating to emissions of GHGs from the maritime sector is based around the Climate Change Act 2008, under which the Government sets five-yearly carbon budgets which currently run until 2032. These restrict the amount of GHGs the UK can legally emit in a five-year period.
36. Emissions from domestic shipping are included in both the carbon budgets and the 2050 target. Although emissions from international shipping are not currently included in the UK's targets under the Climate Change Act 2008, our carbon budgets put the UK on a trajectory consistent with a 2050 target which includes these emissions. While this national policy sets the context for national targets on emissions, there are currently no specific sectoral targets in place for UK domestic or international shipping emissions. Likewise, Government has not yet formally accepted any planning assumption for international shipping emissions. Further consideration of the UK's national GHG reduction targets, and the question of international shipping's

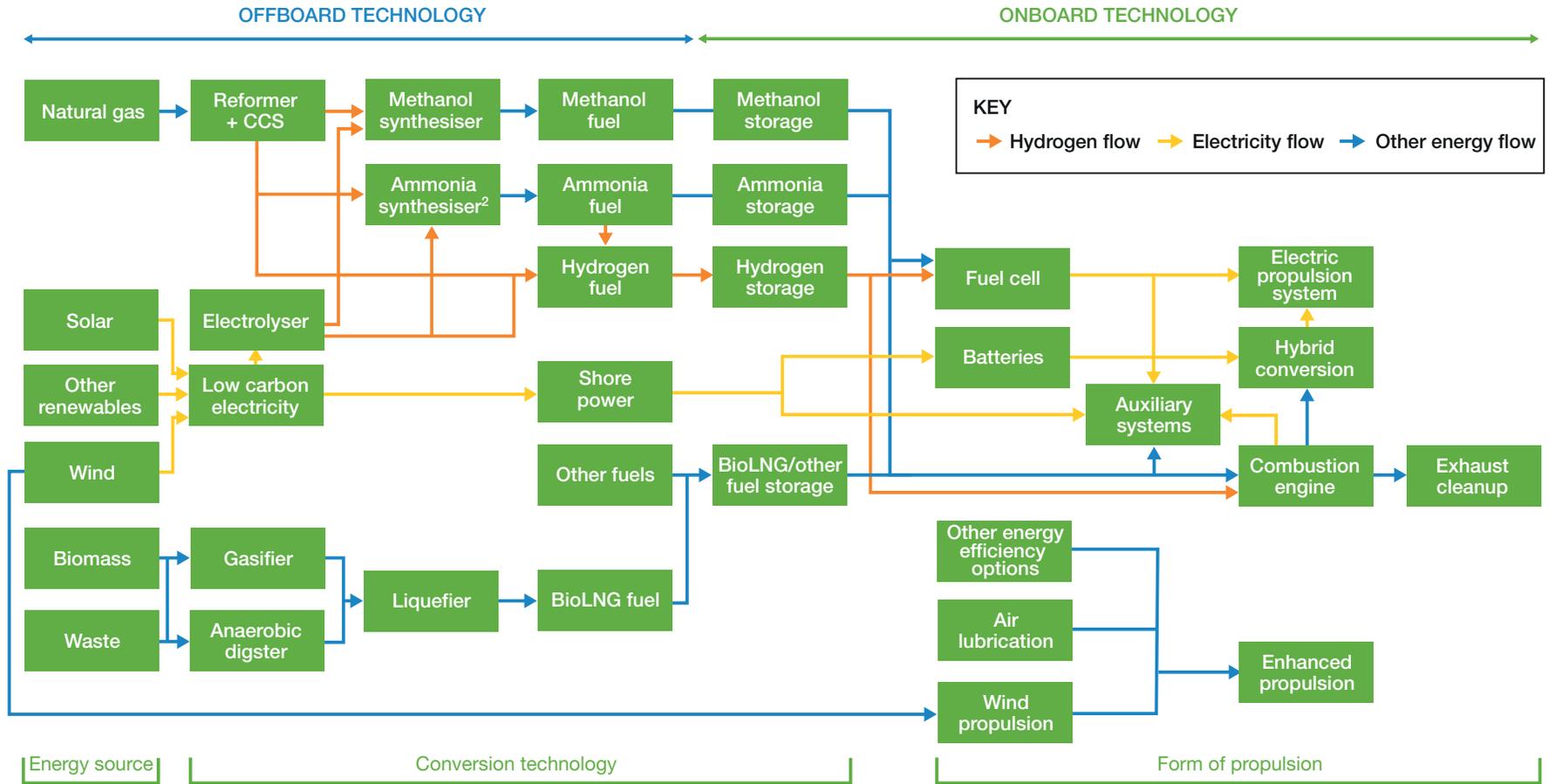
inclusion therein, is set out below (see 'The Role of Targets').

37. On a smaller scale than sector-wide targets, there are certain domestic policies which encourage the uptake of zero emission shipping, most notably the Renewable Transport Fuel Obligation (RTFO). As well as applying to the road sector (on a mandatory basis) and aviation sector (on an optional basis), the RTFO currently applies to fuel suppliers for the non-road mobile machinery (NRMM) sectors, the definition of which includes inland shipping and recreational craft that do not normally operate at sea.

Clean Growth Opportunities for the UK

38. To reach the challenging international targets set for the reduction of GHGs and air quality pollutants, a global transition towards zero emission shipping is required. This will involve a transformation of the shipping industry as well as port and bunkering infrastructure. While certain fuels are phased out, the transition will open up new technology/fuel sectors and related supply chains. In the context of the UK, this Clean Maritime Plan sees zero emission shipping as a future whereby no GHGs or air quality pollutants are emitted by vessels (of all types) operating in UK waters or in the ship-to-shore activities required to facilitate those operations.
39. Figure 2 below summarises a range of technologies and fuels which may have the potential to play a part in the global transition to zero emission shipping, and Table 1 gives a simple explanation of the operation of these⁴². This list is not intended to be exhaustive.

Figure 2: Technologies and fuels on a pathway to zero-emission shipping



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

Source: Frontier Economics for DfT

Table 1: Technologies and fuels on a pathway to zero-emission shipping

	Technology/Fuel	Technology/fuel usage	Further detail
Alternative fuel propulsion	Methanol	Can be used directly in an internal combustion engine or fuel cell.	Can be used as a fuel itself or a store for hydrogen.
	Hydrogen		Can be used as an input to ammonia or methanol production as well as a fuel itself.
	Ammonia		Can either be used as a fuel itself, or as a carrier for hydrogen before the hydrogen is used as the fuel.
	Biofuels	Used directly in an internal combustion engine.	Various types of biofuels from different sources of biomass (e.g. crops, wastes) possible.
Non-fuel propulsion	Hybrid propulsion	A diesel engine acts as a power source, charging batteries, which power an electric motor, often in order to keep the diesel operating at its most efficient load point.	Diesel engine power converted to electric drive.
	Fully electric propulsion	No diesel engine. An electric motor is entirely powered by batteries, which are charged whilst the vessel is in port.	Batteries charged onshore.
	Shore-power (cold-ironing)	Use of an onshore power supply (rather than onboard diesel engines) to run auxiliary (non-propulsion) electric systems while the vessel is in port.	Does not substitute propulsion energy, only auxiliary loads and only when in port.
	Wind propulsion	Can take various forms, such as: <ul style="list-style-type: none"> – Sails – Flettner rotors – Kites 	
	Solar power	Use of photovoltaic cells to convert solar radiation into electric power using the available space on deck.	Enhances primary propulsion or auxiliary supply.
Energy efficiency options	Various	Examples include: <ul style="list-style-type: none"> – Rudder Bulb – Air Lubrication Bubbles – Pre-Swirl propeller ducts – Vane wheel – Hull scrubbing – Trim optimisation 	These are all options that have potential to improve energy efficiency of vessels ⁴³ .

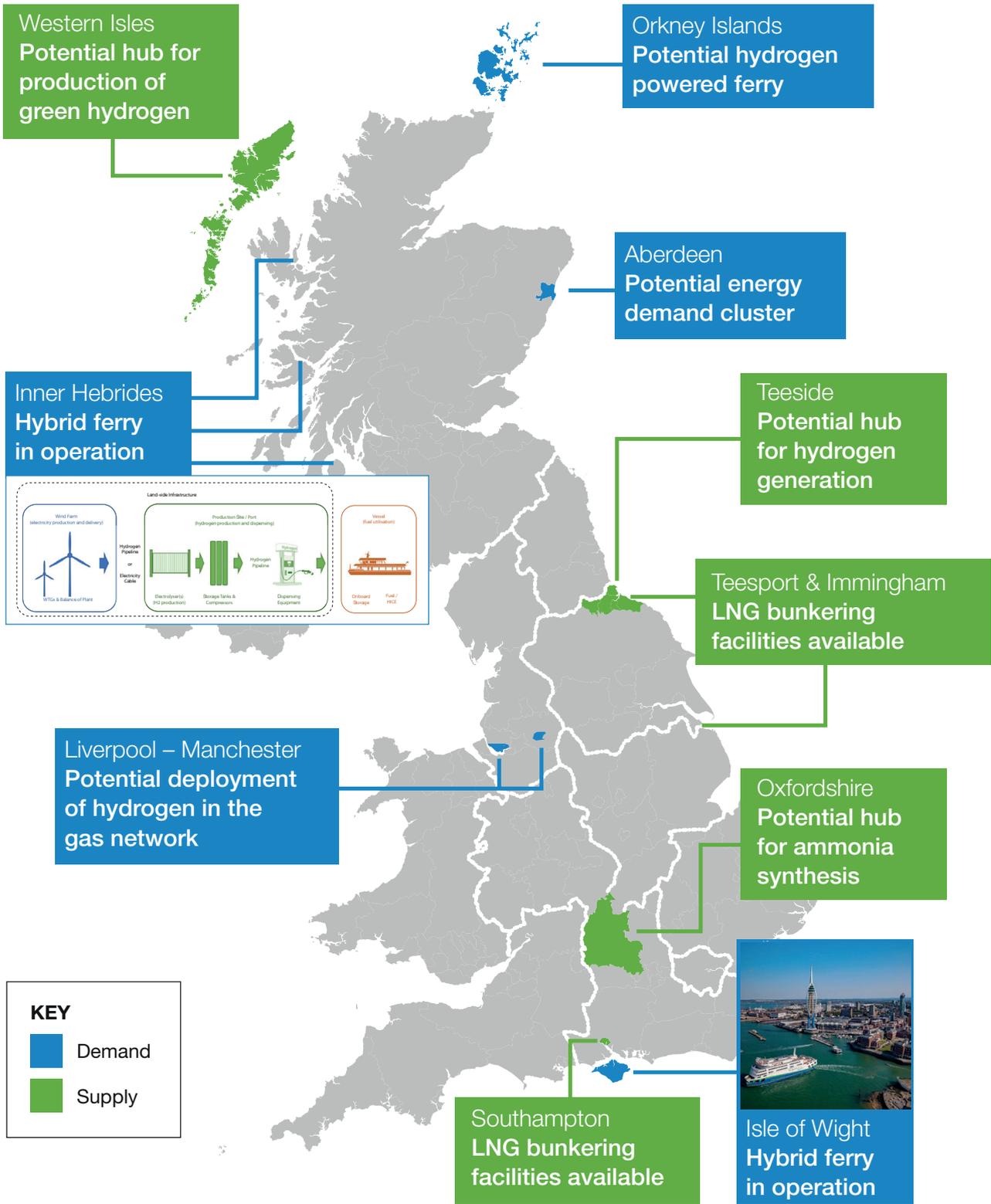
40. These technologies and fuels all have different 'lifecycle emissions', dependent on the emissions generated in their production, distribution and use. For instance, in the case of electric propulsion, lifecycle CO₂ emissions depend on the source of electricity (whether generated by renewable energy or fossil fuels), and for hydrogen propulsion, on the production methodology of the hydrogen fuel. Equally, lifecycle emissions are an important consideration in other fuels, not listed above, which are generated with a substantial proportion of fossil fuels (e.g. 'efuels'⁴⁴ and liquefied natural gas (LNG)).
41. Markets for many of the technologies in Figure 2 are largely nascent at present,

with uptake of low emission shipping technologies primarily centred on a wide array of energy efficiency or exhaust-cleaning systems. Given the early stage of development of these markets, there remain opportunities for countries to build up expertise or dominance in wide parts of the zero-emission shipping supply chain.

42. Figure 3 overleaf identifies a number of areas in the UK which have the potential to act as demand or supply hubs for low- or zero emission propulsion options. These areas are based on preliminary research undertaken for the Clean Maritime Plan. Further work is required to identify potential UK geographical clusters for clean maritime technologies.



Figure 3: Areas of potential demand and supply for clean maritime technologies

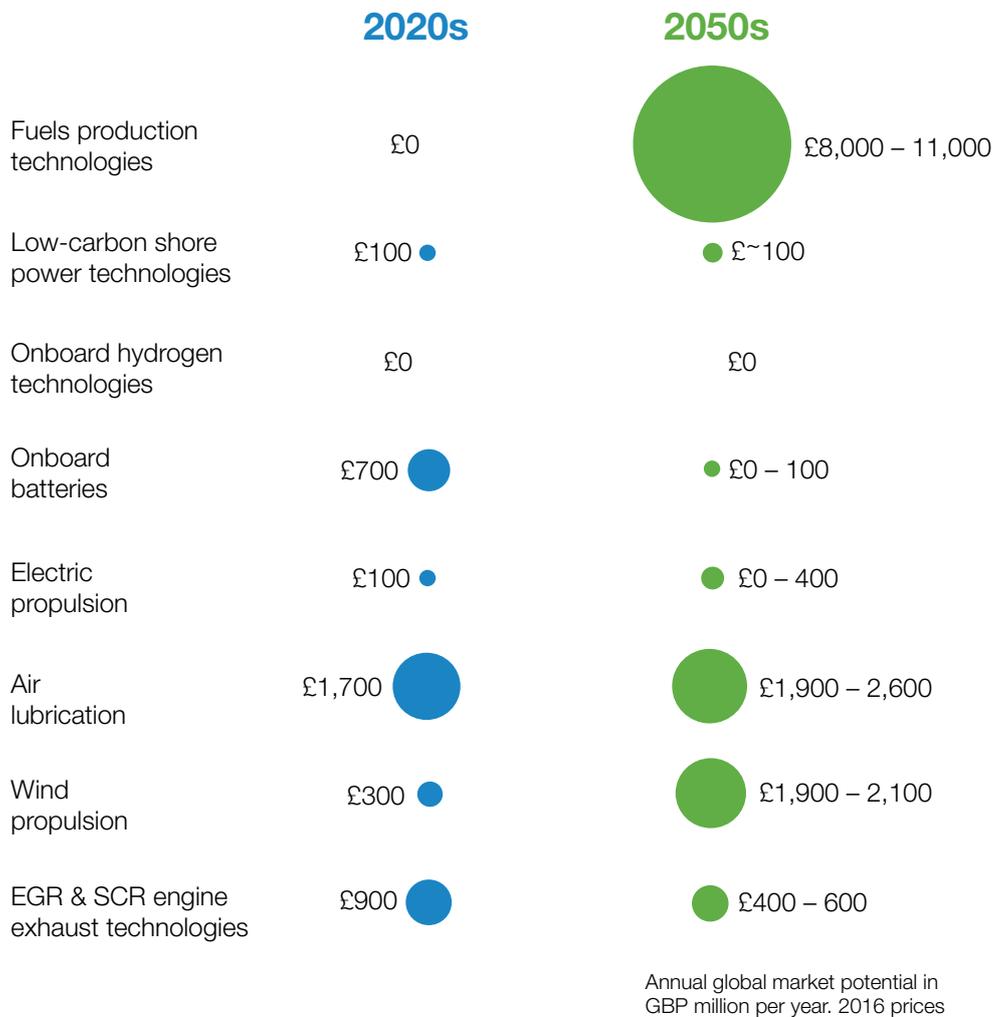


43. Scandinavian countries, particularly Norway and Sweden, have been frontrunners in sustainable shipping and the use of alternative fuels. In Norway a NOx levy and fund have been in place for over 10 years, which has funded NOx abatement measures such as selective catalytic reduction (SCR) and engine modification onboard ships⁴⁵. Norwegian partners are currently building Project ZEFF, a Zero-Emission Fast Ferry designed to carry up to 300 passengers, which will be powered by hydrogen and batteries with a cruise speed of 25–45 knots using hydrofoils⁴⁶. Countries across Asia are also making early moves

into green shipping technologies. Most recently, China has committed to enforce the IMO global 0.5% sulphur cap around its territorial waters in 2019, one year ahead of the agreed implementation date of January 2020⁴⁷.

44. Research commissioned by the Government has assessed the UK's competitiveness across 11 key maritime emission reduction options, 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 fuels⁴⁸.

Figure 4: Potential annual future global market for maritime emission reduction options⁴⁹



Source: Frontier Economics for DfT



45. In particular, the research estimated that the global market for the elements of alternative fuel production technologies⁵⁰ in which the UK has a particular competitive advantage (for example, upfront design) could rise to around \$11–15 billion per year (£8–£11 billion per year) by the middle of the century, and that if the UK were able to maintain its current export market share (which is estimated to be around 5% of the relevant global markets), this could result in economic benefits to the UK of around \$490 - 690 million per year (£360–£510 million per year) by the middle of the century⁵¹.

46. Figure 4 visualises the estimates of the potential annual global market size for the different maritime emission reduction options assessed in the research.

47. More specifically, the research identified hydrogen and ammonia production technologies as offering the most significant potential economic benefits to the UK. The reasoning for this was as follows:

- Hydrogen production technologies: “The UK is well placed in relation to hydrogen production technologies. The UK’s extensive experience in natural gas and reformer technologies would be a key advantage here. In addition, the UK is already a world leader in electrolysis activities, which are directly relevant to hydrogen production for zero emission shipping. It is estimated that the UK currently has around a 9% global export market share of reformer and CCS technologies, which are likely to be important elements of hydrogen production for zero emission shipping. Both China and the USA currently have market shares in excess of 10% in this area.” There is currently no take-up

of hydrogen fuel in the global fleet. If policies and incentives are in place to move towards zero emission shipping by the middle of the century, hydrogen fuel usage may increase or remain low depending on future cost effectiveness. However, hydrogen production technologies are an important input to ammonia and in some cases methanol fuel which may have substantial expected take-up.

- Ammonia production technologies: The UK also has a strong competitive position in relation to ammonia production technologies. In particular, the UK has a strong domestic position for ammonia catalyst supply, and ammonia-based fertiliser is produced in volume in the UK. This is important because catalyst supply is a high-value part of the supply chain. The current take-up of onboard ammonia fuel technologies is relatively low so this is a nascent market at present.”

The Clean Maritime Plan: A Route Map

48. Recognising the international imperative to move to zero emission shipping, the need to have a holistic approach to tackling all forms of maritime emissions to air, and the potential economic opportunities associated with the global transition to alternative propulsion, Maritime 2050 articulated the Government’s ambition to actively drive the transition to zero emission shipping in its waters, as follows.

“In 2050, zero emission ships are commonplace globally. The UK has taken a proactive role in driving the transition to zero emission shipping in UK waters and is seen globally as a role model in this field, moving faster than other countries and faster than international standards. As a result, the UK has successfully captured

a significant share of the economic, environmental and health benefits associated with this transition.”

49. Maritime 2050's environment chapter outlines the need for a co-ordinated approach across government, industry and academia to reach this vision. It recognised the following principles as a foundation for achieving this vision.

- **Move quickly:** the need for action to reduce the environmental impacts of the maritime sector is urgent and the transition must take place rapidly.
- **Be bold:** the UK will lead by example, positioning itself as a world leader in thinking and action on minimising environmental impacts of the maritime sector.
- **Play to our strengths:** prioritise interventions which benefit the UK, addressing market failures and amplifying investment in areas where the UK has potential comparative strengths.
- **Reduce business risk:** give consistent and strong support for investment in the transition to green shipping. Deliver proportionate, well-evidenced regulation, while maintaining a level playing field.

- **Be innovative:** in line with the government's commitment to raise spending on R&D, increase support for innovation throughout the maritime technology life-cycle.
- **Take a systems approach:** policies should consider the whole supply chain, including infrastructure and linkages with other sectors of the economy (e.g. power networks and hydrogen supply).
- **Collaborate:** government, industry and academia need to work more closely together and form lasting partnerships.

50. The Clean Maritime Plan is a national action plan to drive the UK towards the vision for zero emission shipping. Shaped by the principles above, it sets out a pathway which encourages fast, bold action, playing to the UK's competitive advantages. It aims to assist in giving business certainty over the future policy landscape, and seeks to shape public interventions bearing in mind the need for a systems approach. The Plan seeks to support innovation in the maritime sector and is underpinned by a collaborative approach, having been guided by extensive consultation, research and advice from industry through, for instance, the Clean Maritime Council.





2. Our Approach

51. Work to develop the Clean Maritime Plan began in March 2018, with a public consultation on the Maritime 2050 strategy. Published in January 2019, Maritime 2050 is the Government's vision for the future of the Maritime sector⁵². The strategy's ambitions are focused into seven themes, highlighting how every part of the maritime sector has a role to play in securing a strong future. Environment is a key theme of Maritime 2050, and is broken down into four sub-themes: Zero Emissions Shipping; Minimising Wider Environmental Impacts from Shipping; Adapting to Climate Change, and the continuing role of International Leadership. The Clean Maritime Plan is a route-map of the Maritime 2050 strategy, focused on the issue of Zero Emissions Shipping, exploring how the UK can address emissions of

greenhouse gases and air pollutants from shipping in parallel.

52. The Clean Air Strategy, published in January 2019, sets out the Government's plans to address air pollution across the UK, setting out the comprehensive actions needed across all parts of government and society to improve air quality⁵³. The strategy contains three significant commitments for the maritime sector, to be published in 2019, in line with the Clean Maritime Plan:

- A **Call for Evidence** to explore the emissions from vessels operating domestically within the UK, including inland waterways. The aim of this work is to collect a body of evidence that will give a clearer picture of the extent of emissions from domestic and inland waterway vessels.



- A consultation on options for extending the North Sea **Emissions Control Area** beyond its current geographical limits or options to establish further, geographically discrete Emissions Control Area's in UK waters. These options will aim to extend limits on SO_x and NO_x emissions provided under international law in order to contribute to improving air quality in the UK.
- Guidelines to advise ports on how to develop effective and targeted **Air Quality Plans**. These Plans will set out commitments by individual ports to reduce emissions from their operations and to support the reduction of emissions from their customers. Following publication on these guidelines, ports within scope will be asked to make initial commitments by 31 December 2019 and to produce their plans in June 2020.

53. The Clean Air Strategy also includes a further commitment to publish the Clean Maritime Plan, and to establish a Clean Maritime Council. The Council was launched by Minister Nusrat Ghani in October 2018⁵⁴. A strategic advisory body made up of industry representatives, academics and key government departments, the Council has played a vital role in reviewing and developing the Clean Maritime Plan. The Council formed three 'Task and Finish Groups', drawing representation from beyond its core members. These 'Task and Finish Groups' were focused on the topics of Incentives, Standards and Regulations, and Energy Systems Integration. The work of these three groups was fed back to the main Council and presented at a large industry workshop held in March 2019. The Clean Maritime Plan workshop was attended by

over 85 key industry stakeholders, helping ensure that the Plan brings in the varied views from across sector. To complement this consultation, the Government also commissioned a package of economic and technical research to provide a detailed evidence base for the Clean Maritime Plan. This research is available online⁵⁵.

54. The following sections of the document set out the key policy commitments of the Clean Maritime Plan in more detail. Based on analysis of feedback from the Clean Maritime Council, policy is broken down into four main areas:

- Economics
- Infrastructure
- Innovation
- Regulation

55. Policy commitments are set out in each area, alongside key elements of consultation feedback and relevant findings from economic and technical research. Finally, there follows a mapping exercise highlighting the links between the policy commitments of the Clean Maritime Plan and the recommendations in Maritime 2050.

Governance

56. The policy commitments of the Clean Maritime Plan will be implemented over the coming years, with advice from the Clean Maritime Council, which may draw on wider stakeholder views. The Council will keep oversight of progress against the policy commitments and ambitions.

57. The Government will publish a review of implementation of the Clean Maritime Plan in 2022. At this stage, the operation of the Clean Maritime Council will be reviewed.



58. While the Clean Maritime Plan deals only with those Maritime 2050 recommendations relating to zero emission shipping, the other environmental recommendations of Maritime 2050 are also of key importance. Progress against these recommendations will be

monitored through the wider Maritime 2050 reporting process. This Annual Report will also report on progress against those recommendations of Maritime 2050 which fall outside the scope of the Clean Maritime Plan.





3. Economics

The Role of Targets

59. The Government's Maritime 2050 Strategy contained the following commitments:

- *Government will consider the merits of introducing a medium-term target for emissions of GHGs and air quality pollutants from UK shipping. Further detail on this consideration will be set out in the Clean Maritime Plan.*
- *Government will consider the introduction of a target to reduce emissions of GHGs and air quality pollutants from UK shipping towards zero. Further details on the government's long-term plans to reduce emissions from UK shipping, will be set out in the Clean Maritime Plan, taking into account the IMO's 2050 GHG target.*

- *Government will work to ensure maritime greenhouse gas emissions are appropriately taken into account in national and international emission reporting. The government will carefully consider the CCC's advice on the inclusion of international shipping within carbon budgets. Further information on the Government's plans will be set out in the Clean Maritime Plan.*

60. UK domestic policy relating to emissions of GHGs from the maritime sector is based around the Climate Change Act 2008, which requires that the UK contributes to global emission reductions by reducing UK GHG emissions by at least 80% of 1990 levels by 2050. In order to meet this target, the Government has set five-yearly carbon budgets which currently run until 2032.



These restrict the amount of GHGs the UK can legally emit in a five-year period.

61. At present, emissions from domestic shipping are included in both the existing carbon budgets and current 2050 target. Although emissions from international shipping are not currently included in the UK's targets under the Climate Change Act, our carbon budgets put the UK on a trajectory consistent with a 2050 target which includes these emissions.
62. On 2 May 2019, the Committee on Climate Change published its report 'Net Zero: The UK's Contribution to Stopping Global Warming'. This recommended that the UK should legislate as soon as possible to reach net-zero greenhouse gas emissions by 2050. The Committee also advised that this revised target should cover all sectors of the economy, including international shipping.
63. In June 2019, the UK became the first major economy to legislate for net zero emissions, setting a target for 2050. Although emissions from international shipping and aviation are not formally included within the legislation at this point, it is essential that these sectors play their role. To ensure we are on the right trajectory for net zero emissions across the economy, we will continue to leave 'headroom' for international shipping and aviation emissions in our carbon budgets. Since the 1997 Kyoto Agreement on climate change, international shipping and aviation emissions have been dealt with via the IMO and ICAO respectively. This is important given the global nature of these industries. Government continues to be of the view that action to tackle emissions from these sectors must be done globally to be effective. The UK will continue to take a leadership role at the IMO, pushing for

the most ambitious measures to deliver the vision, and emission reduction targets, of the IMO GHG Strategy. The UK will continue to advocate strongly at the IMO for the most ambitious measures to deliver the vision, and emission reduction targets, of the IMO GHG Strategy. Government will keep our approach to the inclusion of international shipping and aviation emissions in our legislation under review, taking account of progress in the IMO and ICAO.

64. In relation to regulations for domestic shipping, following publication of Maritime 2050, Government has commissioned research which indicates that the introduction of targets for maritime emissions can act as a useful signal of the direction of emissions policy⁵⁶. As well as raising public awareness, this research identified that targets can provide additional certainty to firms (both in the maritime sector and related sectors) to inform their investment decisions, and contribute to addressing the barriers to reducing shipping emissions, such as "by encouraging owners to take a longer-term view of their assets and investments".
65. The extent to which targets may bind market participants depends on the regulations which underpin them. However, it is clear that targets are necessary in order to support an effective domestic regulatory environment. Following stakeholder feedback during the development of the Clean Maritime Plan, it was established that further consultation would be required to determine the exact nature of any binding target. The section below on the role of economic instruments sets out how such consultation may be taken forward.
66. In the absence of any mandatory targets, however, consultation to-date has indicated

that the market may benefit from further policy certainty regarding the future fuel and technology mix required in a zero-emission world.

67. To assist in providing some clarity, the Government has commissioned research⁵⁷ to investigate the likely take-up of technologies and alternative fuels, and the associated costs, under a number of different future scenarios. This research does not represent policy decisions. It seeks only to identify possible future technology mixes in different scenarios under changing assumptions about policy and the availability of alternative fuels. Nevertheless, certain conclusions can be drawn from this research. In particular:
- Certain categories of vessel traffic are estimated to be particularly significant contributors to UK shipping emissions. For example, container vessel traffic is estimated to make the highest contribution to UK international shipping GHG emissions, while ro-ro vessel traffic is estimated to be the highest contributor to UK domestic shipping GHG emissions.
 - In order to achieve the reductions in GHGs required by the IMO GHG Strategy, it is estimated that energy efficiency improvements alone will not be sufficient and that the use of alternative fuels (such as hydrogen, ammonia or methanol) will be required.
 - Under the assumptions made in the research, ammonia is estimated to be more cost-effective than methanol or hydrogen for most ship types. However, there is substantial uncertainty around this result, so it is not possible to reach definitive conclusions on this at present. In addition, under these assumptions,

generation of hydrogen, methanol and ammonia is estimated to be more cost-effective using fossil fuels (with carbon capture and storage) rather than via electrolysis⁵⁸.

- LNG is not estimated to be a substantial part of the fuel mix in the future (whether near future, around 2035, or longer-term, around 2050) under any scenarios that achieve the reductions in GHGs required by the IMO GHG Strategy
 - Electricity is estimated to play a much smaller role than that of alternative fuels, with electric propulsion take up limited to vessels that operate short voyages, such as short ferry crossings. Whilst its use is expected to be more significant for the UK domestic fleet than the UK international fleet, it is still estimated to remain relatively small under all scenarios. This conclusion is sensitive, however, to current cost assumptions, such as regarding the capital cost of batteries.
 - Whether or not shipping has access to biofuels is not estimated to result in a significant difference in the costs to business of delivering the reduction in GHGs required by the IMO GHG Strategy.
68. This last point is relevant given the need to ensure, across the economy, the optimal use of limited feedstocks of sustainable bioenergy supply. The most recent advice from Government's independent advisory body, the Committee on Climate Change, suggests that the use of biofuels should be directed towards those sectors which faces the hardest challenges to abate emissions⁵⁹. The extent to which biofuels may play a role in decarbonising the maritime sector will need to be considered



carefully against the needs of these other sectors (such as aviation and heavy goods vehicles) to ensure cost-effective decarbonisation for the whole economy.

69. There are also important considerations regarding hydrogen, ammonia and methanol as alternative fuels. Since none of these fuels are currently widely used for marine propulsion, their uptake will require the development of both safety standards and bunkering infrastructure. It should be noted, however, that the maritime sector already has significant experience working with each of these products, which are already shipped as cargo on a significant global scale⁶⁰ (18.8 million tonnes of ammonia was exported between 2015 and 2017, for use in the fertiliser industry, for instance⁶¹). As such, there already exists global infrastructure and established standards for their handling, storage and transport in bulk form.
70. The adoption of bioenergy or alternative fuels would also need to be done so as to take account of potential air pollution impacts. Ammonia, in particular, is itself an air pollutant, primarily emitted from the agricultural sector during the storage and spreading of manures and slurries, as well as the application of inorganic fertilisers⁶². The Government has adopted a legally-binding international emission reduction target for ammonia. Unintentional releases of ammonia (through leaks or unburnt fuel) would need to be managed, as would the NOx emissions generated by combustion. The latter could be managed using SCR technologies, which are already applied to marine engines in order to comply with IMO Tier III requirements in designated NOx Emission Control Areas (e.g. the North Sea and English Channel).
71. Another important factor to inform Government policy on targets is consideration of how to maximise the benefits for the UK economy from the transition to zero emissions shipping. Government has therefore commissioned research to assess the UK's competitiveness in 11 key maritime emission reduction options⁶³. This research found that "there are significant economic and commercial opportunities for the UK across all abatement options considered", with the UK having the strongest competitive advantage in:
- Hydrogen production technologies;
 - Ammonia production technologies;
 - Onboard batteries; and
 - Electric engines.
72. In addition to this, it is also recognised that the UK has particular strengths in the area of maritime services.
73. Given technology and cost uncertainty at this stage, the need to encourage investment in a range of technological solutions to the zero-emission shipping challenge is evident. In order to support a high level of ambition on emissions reduction, providing enough direction to give improved investment certainty while allowing industry the space to innovate is vital. To assist in providing this certainty, and in line with the recommendations set out in Maritime 2050, we set out the following aspirational ambitions for the UK maritime sector.

74. These Clean Maritime Plan Ambitions are intended to provide aspirational goals for the sector, not mandatory targets. They indicate Government's expectation for the direction of travel necessary if the goal of zero emissions is to be met throughout the sector. Each of these ambitions can only be achieved through collaboration between Government and industry. Mandatory targets will be considered further in relation to economic instruments for zero emission shipping (see "The Role of Incentives" below). The policy commitments identified in this document are intended to support the UK maritime sector in moving to a trajectory for zero emission propulsion uptake consistent with these ambitions. The review of the Clean Maritime Plan published in 2022 will consider these ambitions, progress towards them and the need for further policy commitments.

Ambitions

75. In Maritime 2050, the Government set out its vision for the future of zero emission shipping:

"In 2050, zero emission ships are commonplace globally. The UK has taken a proactive role in driving the transition to zero emission shipping in UK waters and is seen globally as a role model in this field, moving faster than other countries and faster than international standards. As a result, the UK has successfully captured a significant share of the economic, environmental and health benefits associated with this transition."

76. In order to reach this vision

By 2025 we expect that:

- i. All vessels operating in UK waters are maximising the use of energy efficiency options. All new vessels being ordered for use in UK waters are being designed with zero emission propulsion capability.
- ii. Zero emission commercial vessels are in operation in UK waters.
- iii. The UK is building clean maritime clusters focused on innovation and infrastructure associated with zero emission propulsion technologies, including bunkering of low or zero emission fuel.

By 2035 we expect that:

- iv. The UK has built a number of clean maritime clusters. These combine infrastructure and innovation for the use of zero emission propulsion technologies. Low or zero emission marine fuel bunkering options are readily available across the UK.
- v. The UK Ship Register is known as a global leader in clean shipping and the UK is home to a world-leading zero emissions maritime sector, with:
 - a. a strong UK export industry
 - b. cutting-edge research and development activities
 - c. the global centre for investment, insurance and legal services related to clean maritime growth.



The Role of Incentives

Commitment

Government will launch a call for evidence in 2020 on non-tax incentives to support the transition to zero emission shipping.

Government will consult in 2020 on how the Renewable Transport Fuel Obligation could be used to encourage the uptake of low carbon fuels in maritime.

Rationale

77. The Government's Maritime 2050 Strategy contained the following commitments:

- *Government will assess how economic instruments could support the transition to zero emission shipping in the medium to long term.*
- *Government will consider whether and how the Renewable Transport Fuel Obligation (RTFO) could be used to encourage the uptake of low carbon fuels in maritime, taking the availability of sustainable resources, competing uses and the international character of the maritime sector into consideration.*

78. Following publication of Maritime 2050, Government has commissioned research to identify the key barriers to the commercial deployment of emission reduction options⁶⁴. This research identified that one of the key barriers is that the fuel prices do not currently fully reflect the environmental costs (e.g. climate change) that result from the use of these fuels. These environmental costs are known as 'negative externalities'. This reduces the relative cost-effectiveness of emission reductions options and hence means that there is under investment in emission reduction options.

79. This conclusion has been confirmed by extensive consultation with industry, academia and NGOs. At its first meeting, the Clean Maritime Council determined that the economics of zero emission shipping represented a major barrier. The Council established a sub-group, bringing in representatives from outside the permanent Council members, to take forward discussion of economic incentives as a priority issue. The conclusions of this sub-group were discussed with stakeholders at a full-day workshop on the 11th March, and attendees reaffirmed the conclusion that pricing remained the priority barrier preventing the commercialisation of zero emission shipping.

Background

80. While some market actors are proactive and responsible, going beyond regulatory standards for environmental protection, ultimately ship owners, operators and fuel infrastructure owners are commercial entities primarily driven by market pressures. Although they do have commercial incentives to increase fuel efficiency— and such efficiency measures can reduce emissions – this decision making does not account for the full costs of their activities in relation to climate change, or damage to human health from air pollutants.

81. To respond to the evidence of economic barriers preventing the further deployment of zero emission shipping technologies and systems, the government will continue to explore the case for economic instruments to support the transition to zero emissions shipping, beginning with a consultation on the RTFO in 2020 and a Call for Evidence on non-tax incentives.

82. In continuing to explore the case for economic instruments, we will consider

all parts of the maritime sector, and take into account the need to reduce emissions of both greenhouse gases and air quality pollutants by a defined amount, thereby driving emissions toward a domestic medium or long-term reduction target.

83. Government will also consider such factors as:
- The extent to which existing internationally-recognised data collection and monitoring mechanisms can be used
 - How to reduce administrative burden to both regulators and industry
 - The need to avoid perverse incentives or unintended consequences
 - The range of possible low- and zero-emission shipping technologies and fuels
 - Interactions with the UK flag and UK competitiveness
84. Research commissioned by the Government⁶⁵ and consultation suggests that the existing RTFO instrument may provide an opportunity to start to strengthen the incentives for fuel suppliers to provide greater quantities of renewable fuel to the maritime sector.
85. This could be done either by placing an obligation on suppliers of marine fuel to supply a certain percentage of sustainable low-emission fuel or by awarding renewable transport fuel certificates (RTFCs) to suppliers of clean maritime fuel (or both).
86. Government's work on domestic economic instruments will recognise the international nature of the shipping industry and the need to be cognisant of impacts on UK competitiveness. Related to this, Government will continue to play a leading role at the International Maritime Organization (IMO) in advocating for

globally-agreed measures to implement the vision and targets of the IMO GHG Strategy. The UK will continue to advocate for mid- and long-term measures which will ensure a global transition to zero emission propulsion technologies, including new/ innovative emission reduction mechanism(s) to incentivise GHG emission reduction.

The Role of Green Finance

Commitment

Government will launch a 'Greening Finance/ Financing Green' for Maritime Initiative at London International Shipping Week 2019.

Rationale

87. The Government's Maritime 2050 Strategy contained the following commitments:
- *Government will work in partnership with the British banking sector to encourage the provision of finance towards zero emission shipping technology development and manufacturing.*
88. The financial services sector is an important sector nationally. In research commissioned by the Government⁶⁶, the UK's experience in maritime services, including finance, insurance and legal services, has also been recognised as being beneficial to the UK's competitive position across several emission reduction options. However, at present, low- and zero-emission shipping represents only a small part of business for this sector.
89. It has previously been recognised that widespread switching to zero emission propulsion technologies would require significant investment by ship owners alongside ports and bunker fuel suppliers,



presenting both a large investment challenge but also a significant opportunity for maritime service providers⁶⁷. As the global transition to zero emission shipping gathers pace over the coming years, driven by increasing international pressure to tackle emissions of greenhouse gases and air quality pollutants, the UK could build on its existing position as a world leading financial centre to become the global hub for the provision of green finance, insurance and legal services for the clean maritime sector.

Background

90. Maritime business services directly contribute £2 billion GVA to the UK economy. When impacts on the wider economy are accounted for, including the rest of the maritime sector, this rises to nearly £5 billion. The City of London is a global leader in this area; the largest share of worldwide marine insurance premiums and shipbroking transactions occur in

the UK, comprising 35% and 26% of the global market respectively. In a 2015 survey conducted by Norton Rose relating to maritime financial services, 40% of respondents in the shipping sector reported that London was the financial centre most able to meet their financing needs, with other competitors ranked substantially lower (New York at 14%, Singapore at 7%, Frankfurt at 6% and Hong Kong at 5%)⁶⁸.

91. London has also been recognised by the UN Environment Programme as a key location in the landscape of green finance. It has been instrumental in the initial rise of carbon markets, and a leader in the integration of environmental, social and governance factors into institutional investment. Four ‘waves’ of sustainable finance innovation have been recognised as having taken place in the UK, moving from ethical investment, to mainstreaming environmental factors into institutional investment, the surge of post-crisis reform,

Figure 5: Location of Maritime Business Service Providers, 2015



Source: Oxera analysis of World Shipping Register data⁶⁹

to a focus on climate risk⁷⁰. The UK is now home to several schemes to drive green finance broadly, including the Green Finance Initiative⁷¹.

92. However, the direction of green finance and services to zero emission shipping, as a nascent market, presents challenges. Consultation undertaken by Government suggests that the number of financial products available specifically for low emission shipping is relatively low, globally. It includes, for instance, German bank KfW's financing of multiple scrubber projects and the joint European Investment Bank-ING green shipping facility. However, as a rule, the negative externalities associated with zero emission shipping technologies mean that the return on investment for many technologies is not currently sufficient to attract finance at competitive rates. In addition, economic research to inform the Clean Maritime Plan has highlighted that imperfect information presents a significant barrier. There is currently a systemic lack of independent information on the performance of energy efficiency technologies and alternative fuels, leading to high uncertainty, and deterring investment.
93. Consultation has suggested that the definition of relevant standards for maritime green finance which would help reduce these barriers. By providing a framework for assessing and disclosing the climate alignment of ship finance portfolios, lenders and financial guarantors would have a clearer case for supporting technologies and businesses who may traditionally have been viewed as high-risk. The work in this area of organisations such as the Climate Bonds Initiatives and the Global Maritime Forum are likely to be useful examples.

94. In June 2019, The Poseidon Principles were launched, a framework for assessing and disclosing the climate alignment of ship finance portfolios. The principles are designed to align with the policies of the IMO, including the 2018 greenhouse gas target. Signatories commit to four key principles:

- Assessment of climate alignment – that signatories will measure the carbon intensity and alignment of their shipping portfolio annually.
- Accountability – signatories will rely on classification societies or other IMO-recognized organizations to assess and report on climate alignment.
- Enforcement – covenant clauses will be made contractual in new business activities to ensure access to high quality data.
- Transparency – signatories will publish their climate alignment scores annually.

Eleven global banks, jointly representing approximately USD 100 billion in shipping finance, are the initial signatories.

95. To help further address some of these barriers, and recognising the Government's Green Finance Strategy, published in July 2019 and support independent action taken by industry, Government will launch a 'Greening Finance & Financing Green' for Maritime information campaign at London International Shipping Week to begin this work, promoting the UK as a centre of expertise in zero emission maritime business services. This will have a dual approach, both providing information to industry about zero emission funding opportunities, while also promoting opportunities in clean maritime to potential investors.





4. Infrastructure

Infrastructure for Zero Emission Shipping

Commitment

In conjunction with a working group as part of the Clean Maritime Council, Government will undertake a study to identify and support potential UK zero emission shipping clusters.

Rationale

96. The Government's Maritime 2050 Strategy contained the following commitments:
- *Government will work to better understand the capacity of the UK's energy networks to support an increase in demand for green energy from our ports and shipping sectors. It will also*

consider the role the maritime and offshore renewables sectors can play in decentralised energy generation.

- *Government will review the environmental and economic case for coastal shipping, and whether the government should play a greater role in encouraging modal shift.*
97. In line with the commitments in the Clean Air Strategy, the Government will also publish guidelines to advise ports on how to develop effective and targeted Air Quality Strategies.
98. The Government has also commissioned a report on Coastal Shipping and Inland Waterway Transport, to better understand the barriers, challenges and market opportunities of coastal shipping and inland waterways within the current freight landscape. The



report will model different scenarios for freight transport in 2050. Dependent on the outcome of this report, and the Call for Evidence on domestic vessels in UK waters, further research may be necessary to determine the potential emissions savings from short sea shipping if alternative low or zero emission fuels are in use.

- 99. The Clean Maritime Council identified the issue of integration between maritime energy demand and supply as a significant barrier to zero emissions shipping. The Council formed the Energy Systems Integration task and finish group bringing together representatives from outside the Council to consider the subject. Discussions focussed on the emerging

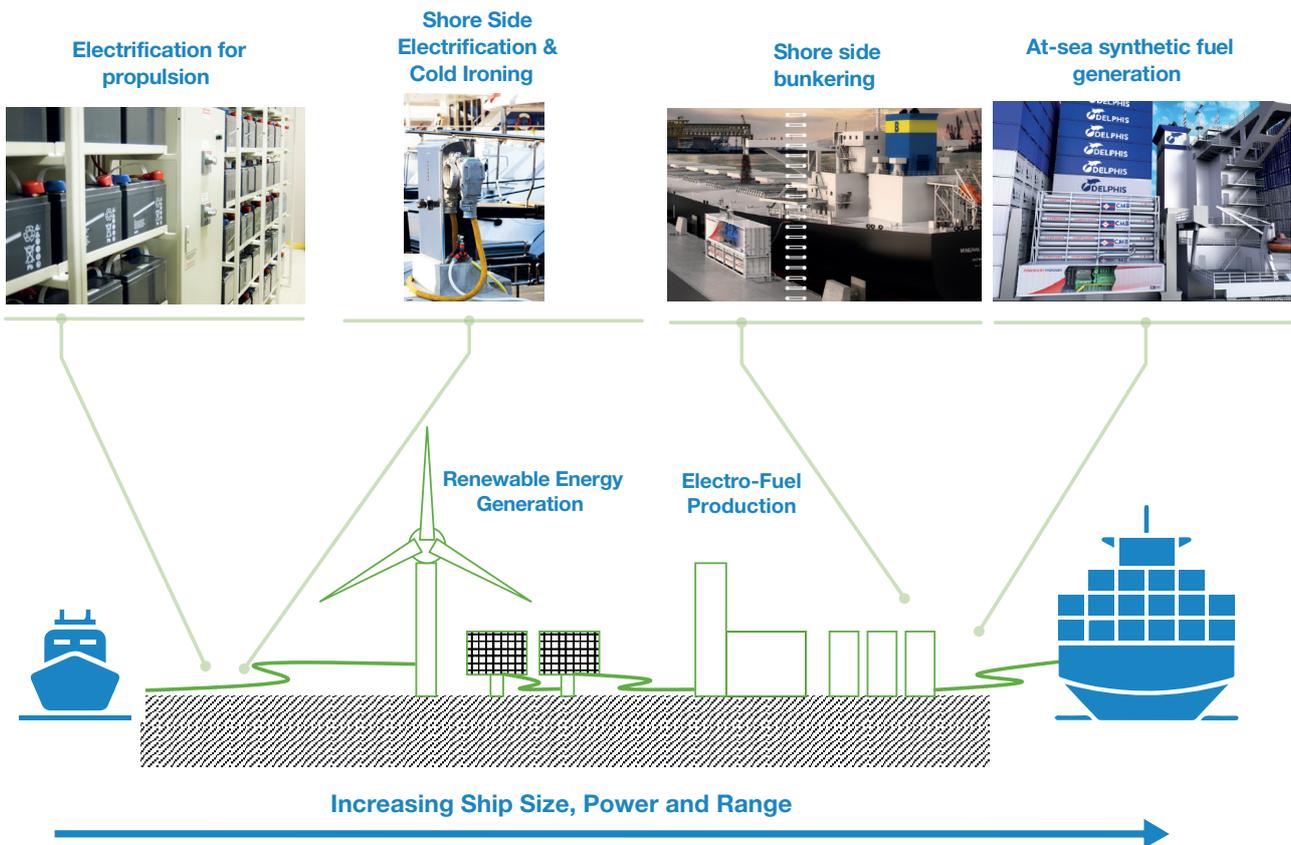
demand scenarios for alternative fuelling in the Maritime sector. It is expected that there is merit in further discussions at a national level on the possible pathways to zero emissions, and the necessary infrastructure to implement them. Government will therefore undertake a study to identify and support the development of zero emission shipping clusters.

Background

Bunkering of alternative fuels

- 100. Figure 6 illustrates how landside infrastructure could operate in a future scenario where vessels operate using zero emissions fuels.

Figure 6: Illustration of potential landside infrastructure associated with zero emission maritime fuels



Source: Frontier Economics for DfT



101. The Clean Maritime Council Task and Finish Group on Energy Systems Integration highlighted the need to consider the challenge of providing infrastructure for alternative fuel transportation and bunkering around the UK. There are a number of challenges to bunkering alternative fuels that need to be addressed. Broadly these fall into three main categories.
- **Regulatory:** the need for the development of, and compliance with, new safety regulations for storage of alternative fuels. In addition, there may be issues associated with planning permission for new bunkering infrastructure.
 - **Investment:** as the upfront capital cost of providing infrastructure associated with alternative fuels may be substantial for an individual port
 - **Market:** a need to co-ordinate across the sector to give ports greater certainty that the ships using its infrastructure will be compatible.
102. Not all these challenges are unique to the maritime sector. Similar challenges will be faced across other transport modes and other economic sectors as the UK moves towards zero emissions. The Government's forthcoming Energy White Paper, due later this year, will take account of such challenges across economic sectors. The investment challenges must also be considered in future work considering economic incentives for the sector (see 'Economics' above).
103. A systems approach to the development of alternative shipping fuel bunkering – whereby maritime needs are integrated within a wider, cross-economy picture of alternative fuelling demand and supply – may help reduce costs and maximise opportunities by aligning signals for investment across various market actors.
104. With this multi-sector approach, it will be possible to identify regional and UK wide areas of specific advantage. There are already projects working on this basis – for instance the case study below outlines the potential for hydrogen production from wind power, and the specific regional advantage this poses to areas of the UK.
105. To assist in the development of a systems approach to the development of alternative fuel bunkering in the UK, the Government in conjunction with the Clean Maritime Council will undertake a study on zero emission shipping clusters. This study will include a detailed assessment of the infrastructure required to enable the uptake of alternative fuelled vessels. This will include consideration of the refuelling requirements of vessels, as well as whether there are particular geographic locations suitable for the production, storage and distribution of alternative fuels for shipping including any dependencies or synergies with other economic sectors such as heating or other transport modes. The study will consider the issues of sustainability of alternative fuel production, noting where clusters have particular advantages in producing fuels with the greatest emission reduction potential (e.g. CCUS opportunities and renewable energy availability). It will also take into account opportunities as well as safety and cost challenges related to, integration with the wider energy system and work ongoing to decarbonise the wider freight system (e.g. with regards to HGV and rail).

106. Table 2 below, for instance, sets out interesting potential hotspots in the UK for clean maritime fuel generation, storage or distribution. It is by no means exhaustive, and many other locations in the UK are expected to have relevant clusters of experience, demand and supply advantages.

107. The Clean Maritime Council will establish a working group to help guide this study, which will be fed into national strategic cross-Government work, for instance, related to the Energy White Paper

Table 2: Potential hotspots in the UK for clean maritime fuel generation, storage or distribution

Location	Activity
Teesside	Tees Valley and North East Hydrogen Economic Study conducted, indicating Teesside as potential hub for hydrogen generation ⁷² .
Liverpool-Manchester	HyNet is a conceptual study by Cadent Gas to develop a practical and economic framework to produce and supply low carbon hydrogen to a core set of major industrial gas users in the North West. The hydrogen would be produced on Merseyside – with the captured carbon stored in the Irish Sea. The study also considers the potential for use in transport and blending hydrogen into the local gas
Orkney Islands	<p>The HyDIME (Hydrogen Diesel Injection in a Marine Environment) project in Orkney will involve the design and integration of a hydrogen diesel dual fuel injection system on board an existing commercial ferry. The ferry operates between Kirkwall and the island of Shapinsay, and will use hydrogen produced from renewable energy by the Orkney-based European Marine Energy Centre (EMEC). The project is led by Ferguson Marine Engineering Ltd and has received funding from Innovate UK⁷³</p> <p>The HySeas III project is led by Ferguson Marine and project managed by the University of St Andrews, and aims to launch by 2020 the world's first zero-emission, sea-going hydrogen-fuelled car and passenger ferry. The vessel is planned to operate in and around Orkney, and use hydrogen which is currently being produced on the islands from renewable energy⁷⁴.</p>
Western Isles	The Scottish Western Isles Ferry Transport using Hydrogen (SWIFTH2) project has studied the possibility of developing new island wind power in the Scottish Western Isles for the purposes of producing 'green' hydrogen instead of grid-connected electricity ⁷⁵ .
Aberdeen	The predominant hub for the UK's offshore oil & gas industry, Aberdeen presents an interesting vessel energy demand cluster, as well as an area with significant existing offshore engineering expertise.
Oxfordshire	Siemens is participating in an all electric ammonia synthesis and energy storage system demonstration programme at Rutherford Appleton Laboratory, near Oxford. The demonstrator is supported by Innovate UK. Collaborators include the University of Oxford, Cardiff University and the Science & Technology Facilities Council ⁷⁶ .



Electrification

108. Electrification in the maritime sector may take the form of:

- Shore-side power (powering vessels' auxiliary systems for vessels at berth, also referred to as cold-ironing)
- Hybrid electric vessels (the use of electric motors & batteries to complement other energy sources such as diesel engines)
- Fully electric vessels (the use of electric motors & batteries)
- Electric charging for port operations (e.g. powering non-road mobile machinery such as cranes).

109. Research commissioned by the Government estimates that alternative fuels will play the most significant role in reducing emissions from UK shipping, with electric propulsion playing a smaller role relatively⁷⁷. In particular, this research suggests that electric propulsion options may be focused predominantly on smaller vessels that operate on shorter routes, such as ferry crossings. However, these conclusions are sensitive to several assumptions about, for instance, the capital costs of batteries.

110. Despite alternative fuels being expected to play a more significant role, research commissioned by the Government estimates that UK ports are still likely to see total electricity demand increase significantly by 2050⁷⁸. Without any further policy intervention, this research estimates that the total annual electricity demand at UK ports could rise from 20 GWh in 2016 to around 250 GWh by around 2050, largely driven by the demand for shore-power from container vessels. In contrast, under a scenario in which there are very ambitious assumptions about maritime electrification, this research estimates that

annual electrical demand at UK major ports could rise to over 4000 GWh by around 2050, predominantly be driven by demand for electric propulsion, but with demand for shore-side power also expected to increase significantly.

111. This research explains that a significant increase in electricity demand in ports would require ports to invest in charging infrastructure and potentially to apply for increased capacity from the electricity network. The scale of connection required to a port will be influenced by the forecasted peak load (maximum energy demand within a certain timeframe that needs to be accommodated)⁷⁹. For an illustration of potential scales of peak total demand, the research estimates that the potential peak load could range from around 9 MW for a small port to around 79 MW for a large port⁸⁰.

112. As demand for electrification is expected to be driven by particular vessel types, demand for electrical capacity in ports is not expected to be uniform across the UK's ports.

113. The research also explored the barriers to port electrification and identified the following potential barriers:

- split incentives to invest and co-ordination failures between ports and the shipping industry;
- imperfect information on abatement options;
- existing infrastructure and onboard technologies;
- the cost of capital; and
- regulatory constraints.

- 114. Consultation indicates that, in particular, constraints on existing local network capacity may be particularly challenging.
- 115. Given the potential role of port electrification for zero emissions shipping, further research on routes to overcoming these barriers will be included in the study undertaken by Government in partnership with the Clean Maritime Council on zero emission shipping clusters. The results of this study will be fed into national strategic cross-Government work, for instance, related to the Energy White Paper.

Public procurement, subsidy and licensing regimes

- 116. The Government's Maritime 2050 Strategy contained the following commitment:

- Government will consider how public procurement, subsidy and licensing regimes can be used to increase the uptake of green technologies e.g. for vessels supporting the offshore energy sectors.

- 117. The publicly-owned civilian fleet is very small, and is largely comprised of highly specialised vessels. Environmental performance is a key part of the assessment criteria during fleet replacement. Over the coming years, Government will continue to ensure that the fleet renewal process takes into account opportunities to embed the reduction of emissions of GHGs and air quality pollutants from new vessels.

Plate 1: NLV Pole Star, a lighthouse tender operated by the Northern Lighthouse Board, due for replacement by 2024



Source: image courtesy of Northern Lighthouse Board



Plate 2: THV Patricia, a multi-functional tender operated by Trinity House, due for renewal by 2022



Source: image courtesy of Trinity House

- 118.** Besides the publicly owned fleet, certain segments of the UK maritime fleet may have certain characteristics which may allow for faster or more extensive reductions in emissions. Vessels associated with the UK's offshore energy sector may be of particular interest. Activities supporting the offshore oil & gas sector tend to be clustered, with a particularly strong cluster of support vessels based out of Aberdeen.
- 119.** The UK also has the world's largest installed capacity of offshore wind. The construction, operation and decommissioning of these installations involves a substantial volume of vessel traffic. This activity is expected to increase as, under the recent agreement of an offshore wind sector deal, this capacity is expected to grow to 30 GW of installed capacity by 2030. The sector itself has launched an initiative aiming to reduce emissions from its support vessels (see case study: Offshore Wind Accelerator Vessel Decarbonisation Programme), including consideration of electric charging of vessels direct from offshore wind turbines.
- 120.** The potential infrastructure development opportunities associated with geographic aggregations of this offshore energy activity will be considered as part of the study undertaken into zero-emission shipping clusters (see above). Synergies with the offshore renewable energy industry will also be taken into account in this study. This may include, for instance, consideration of novel ideas such as the future potential for offshore synthetic-fuel generation fuelled by offshore wind generation alongside the use of empty gas reservoirs, platforms and pipelines for distribution⁸¹.

Case studies

Below are two examples of current projects taking place to further the work of zero emission shipping. They both highlight the need for creative innovative thinking, and highlight ways to utilise geographical and commercial advantages to maximise clean growth opportunities from this transition.

Carbon Trust

The Carbon Trust's Offshore Wind Accelerator (OWA) was launched in 2008, with the focus on commercialising key technologies in the supply chain for offshore wind farms. To date, the OWA has delivered a 15% reduction in the Levelised Cost of Energy. For a 1GW offshore wind project in the North Sea, OWA-supported innovations provide an overall cost saving of £620 million over the project lifetime. This means consumers benefit from cheaper and greener electricity⁸².

The OWA launched the Vessel and Access competition in 2010, with the aim of improving vessel performance to access and maintain offshore wind turbines. Since the competition, there has been a significant evolution of the design and performance of offshore wind vessels, which the OWA continues to support. The evolution of vessel design has been one of the factors enabling the offshore wind industry to reduce costs.

As the industry moves forward, the OWA is looking to support the development and implementation of low emissions vessels. Reducing the emissions and fuel consumption of offshore wind vessels will have a positive effect on the environmental impact of offshore wind energy and will continue to make offshore wind a more commercially viable energy source.

As part of this ongoing work, in January 2019, the Carbon Trust launched a Request for Information (RFI) to inform the scope of a competition which aims to accelerate the development and uptake of new technologies with the potential to reduce emissions and fuel consumption in offshore vessels. The competition will have an estimated funding of circa £400,000, initially focusing on Crew Transfer Vessels, but with consideration to future development of larger Service Operations Vessels⁸³.

Plate 3: A crew-transfer vessel calling at an offshore wind turbine



Case studies

SWIFTH2

The Scottish Western Isles Ferry Transport using Hydrogen (SWIFTH2) project, has studied the possibility of developing new island wind power, in the Scottish Western Isles, for the purposes of producing 'green' hydrogen instead of grid-connected electricity⁸⁴.

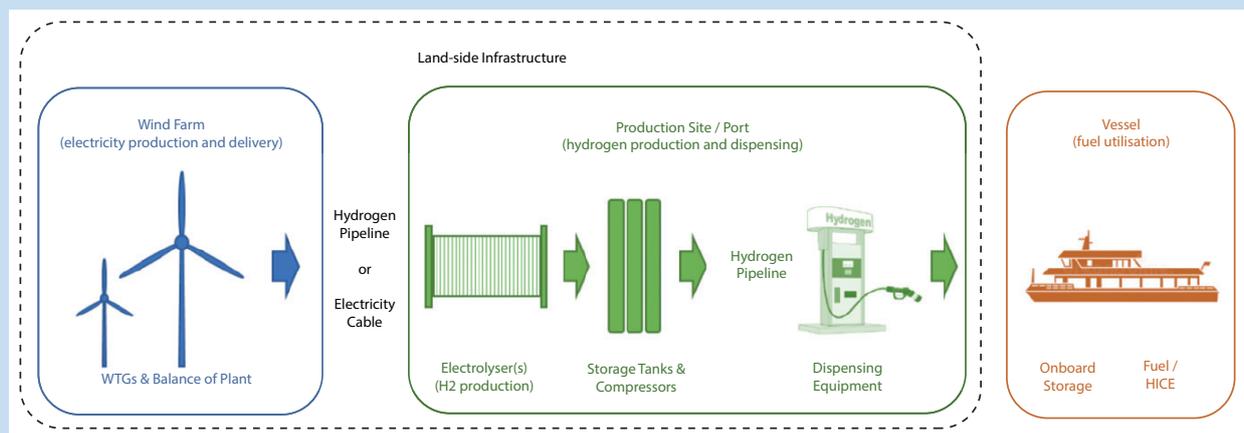
SWIFTH2 aims for 'green' hydrogen, manufactured using a Western Isles community-owned energy wind farm, to power local ferry services. Although hydrogen has previously been used to power small vessels on rivers or coastal routes, SWIFTH2 intends to use it to power larger vessels on 'blue water' or sea-going routes, making them some of the first of their kind.

Comprising both private and public sector organisations, SWIFTH2 was awarded funding by the Scottish Government, through its Low Carbon Infrastructure Transition Programme, for a feasibility study investigating the technical and commercial requirements for a 'green' hydrogen ferry service.

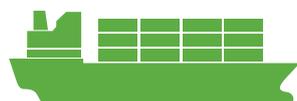
The feasibility study examined the use of wind power in the manufacture of hydrogen, the challenges surround the handling of hydrogen, the transportation and storage of hydrogen in the Western Isles, and whether the design of the ferries and their engines would need to be adapted to run on hydrogen fuel⁸⁵.

The research focussed on nine mainland and inter-island ferry routes, operated by Caledonian MacBrayne ferries. Two routes were highlighted that warranted further detailed study and these are being investigated further in the next phase of the SWIFTH2 project.

Figure 7: Proposed method for creating and utilising 'green' hydrogen for the operation of ferry services in SWIFTH2 project.



Source: Image courtesy of Wood





5. Innovation

Commitment

Government will support clean maritime innovation in the UK, beginning with:

- Providing seed funding to contribute to the establishment of MarRI-UK;
- Funding a competition for innovation in clean maritime in 2019;
- Launching a round of Government grant support for early stage research projects related to clean maritime; and
- Establishing a Clean Maritime Award to celebrate leaders in the field of emissions reductions.

Rationale

121. The Government's Maritime 2050 Strategy contained the following commitments:

- *Government will seek to ensure that measures which tackle the UK's maritime emissions are considered for national grants set aside for dealing with environmental issues.*
- *Government will consider options to support the development of technology which enables monitoring and enforcement of any new regulations governing emissions of GHGs and air quality pollutants.*
- *In line with proposals in the UK Clean Air Strategy, the government has now established the Clean Maritime Council, working closely with research bodies like*



MarRI-UK to ensure strong collaboration between government, industry and academia in this field. Over the next year government will consider the potential role for the Council in directing funding into green technologies for shipping.

122. Research commissioned by the Government has identified a range of key barriers to the commercial deployment of emission reduction options⁸⁶.
123. On top of these challenges, the maritime sector faces particular hurdles related to research and innovation (R&I) spending. Consultation suggests that compared to similar sectors, the global maritime sector invests less of its revenues on R&I activities⁸⁷. Reasons for this relative underspend may be multifaceted. They may include, for instance, the global nature of the sector, its relative maturity and the issue of 'split incentives'⁸⁸.
124. However, it is clear that significant levels of investment in innovation will be required to trigger the scale of emissions reductions required to comply with the challenging international policy objectives on reduction of GHGs and air quality pollutants. To stimulate and support this innovation, there is a need for:
 - Increased cross-sectoral co-ordination of maritime R&D activities
 - Improved information-sharing and transparency around performance of innovative new technologies
125. A nationally co-ordinated approach will be particularly important if the UK is to capitalise on the opening of emerging markets in clean maritime technology. To bolster this approach, we will contribute seed funding to the establishment of MarRI-UK, as well as providing grant

funding for innovation calls. In addition, we will establish a Clean Maritime Award to celebrate leaders in the field of emissions reductions.

Background

126. As set out in Maritime 2050, research organisations such as MarRI-UK⁸⁹ can play an important role in acting as a hub to co-ordinate research and innovation activities in the field of zero emission shipping.
127. Government will help to co-ordinate research across the variety of public and private actors in the field of zero emission shipping e.g. MarRI-UK, Energy Technologies Institute, UK Research & Innovation, Catapults, The Carbon Trust. The Clean Maritime Council will engage closely with research organisations, such as MarRI-UK, to ensure strong collaboration between Government, industry and academia. This will be aimed at encouraging innovation (and, where possible trials or demonstrations) across a spectrum of emissions abatement options (both on board and landside) to enable low-cost movement along the pathway to zero emissions.
128. In addition, Government will support the establishment of MarRI-UK and its workstream around clean maritime activities. The intention of this workstream would be to initially support zero emission projects generally in the early (3 – 7) TRL stages. Where possible, these projects would be aligned with technologies in which the UK has been identified as having a competitive advantage. Research commissioned by the Government⁹⁰ assessed the UK's competitiveness in 11 key clean maritime technologies and found that the UK has the strongest competitive advantage in hydrogen and

ammonia production technologies, on-board batteries and electric engines. This latter area may be a particularly interesting for investment since a number of the low- and zero-emission shipping technologies (battery, fuel-cell, hybrid-electric) rely upon electric propulsion.

- 129. The Government will also support clean maritime projects through its Transport Technology Research Innovation Grant

(T-TRIG) programme. T-TRIG provides seed funding to early-stage science, engineering or technology innovations that have the potential to advance the UK's transport system. T-TRIG is open to any UK organisation, typically micro, small and medium-sized businesses or academia to support research projects which could lead to the development of successful new transport products, processes or services.





6. Regulation

Commitment

The Government will establish the Maritime Emissions Regulation Advisory Service (MERAS) by 2020. Supported by the Maritime and Coastguard Agency, MERAS will provide dedicated support to innovators using zero emission propulsion technologies, assisting them through the regulatory process.

Rationale

- 130.** The Maritime 2050 Strategy made the following commitment:
- *Government will consider options to promote the UK flag as the flag of first choice for vessels adopting low or zero emission technologies.*
- 131.** Currently all new vessels are subject to international safety regulations. All ships using low-flashpoint fuels⁹¹ must conform to the International Code of Safety for Ships Using Gases or Other Low-Flashpoint Fuels (IGF Code)⁹². This code contains mandatory safety provisions for the arrangement, installation, control and monitoring of machinery, equipment and systems using low-flashpoint fuels. The current IGF Code contains detailed requirements for natural gas as a fuel, while other low-flashpoint fuels, including hydrogen, can be approved based on alternative design arrangements.
- 132.** Following the 'alternative design' process of the current IGF code requires each ship design to go through an individual process, which must be approved by the vessel's flag state for operation, adding time, cost and risk to certification.



- 133.** As one of the leading global flag nations, there is a clear opportunity for the UK ship register to attract innovators in clean technology for shipping if membership of the flag gave access to regulatory support to assist the vessel operator through the alternative design process.

Background

- 134.** A sub-group of the Clean Maritime Council focused on Standards and Regulations examined the role of government regulations in encouraging the development and deployment of zero emission vessels. The group concluded that a significant regulatory barrier is the time required and the complexity involved in working through the alternative design process. As such this section is focused on regulatory barriers as they relate to safety and ship standards. There are a number of other regulations which have a bearing on the uptake of zero emission shipping, including, for instance, regulations relating to energy networks and planning permission. Considerations relating to these issues are discussed in the infrastructure section of this document.
- 135.** While future amendments to the IGF Code may be necessary, until more is known about the use of alternative fuels, it would be impractical to create prescriptive safety regulations for these fuels. There is also a danger that a prescriptive code may inhibit innovation if implemented before a fuel or technology is available commercially. The UK would support future amendments to the IGF Code once fuels are sufficiently matured. Government will also work to ensure that the UK plays a role in global standard development for electrification.
- 136.** Government is committed to supporting innovators in the field of clean maritime technology. In order to mitigate this potential regulatory barrier, Government will establish the Maritime Emissions Regulation Advisory Service (MERAS) by 2020. Supported by the Maritime and Coastguard Agency, MERAS will be able to provide dedicated support to innovators using zero emission propulsion technologies, assisting them through the ‘alternative design’ certification process. This will reduce the time, cost and risk associated with certifying vessels using zero emission propulsion technologies.
- 137.** In ‘Technology and Innovation in UK Maritime: the Case of Autonomy’⁹³, published in January 2019 alongside Maritime 2050, Government committed to launching a Maritime Autonomy Regulation lab (MARLab)⁹⁴. MARLab supports maritime innovation in the UK, helping to create an environment which attracts international companies to invest and test autonomous technologies here. The work of MARLab will then be used to develop a domestic regulatory framework for maritime autonomy, allowing the UK to lead negotiations at the IMO to establish international regulations for maritime autonomy. Although regulatory needs for zero emissions technology differ from the requirements for maritime autonomy, there are clear synergies between the work MARLab has already begun, and the future role of MERAS. It is vital to ensure that the two bodies learn from each other, and support industry in tandem.
- 138.** MERAS has the potential to be beneficial for the UK economy, helping to make the UK a destination choice for developers and testers of zero emission fuels and technologies. The support and expertise of MERAS may prove attractive to UK flagged ships, encouraging them to transition to zero emission shipping and with this unique offering, increasing the number of ship owners who choose to register their vessels under the UK flag.



7. Next Steps

139. The Clean Maritime Plan is a route-map to zero emission shipping for the UK, but it is not the final step in supporting this work. It is clear that collaboration between Government and industry is key to ensuring that the UK builds on its unique maritime heritage, and remains a world leading maritime economy. The zero emissions

ambitions outlined at the beginning of this plan highlight that the transition is wide reaching, and will require commitment well into the year 2050. But the actions taken now are vital in helping to reach this goal.

140. In just the next two years, Government will deliver on the following commitments:





Before the end of 2019:

- The Clean Maritime Council will continue to meet, supporting implementation of the Clean Maritime Plan.
- In September 2019, at London International Shipping week, announce a Green Finance/Financing Green initiative for shipping.
- Support the establishment of MarRI-UK, and contribute funding towards its work on clean maritime innovation.
- Issue a public consultation on the further use of Emissions Control Areas to improve UK air quality
- Issue a call for evidence directed at UK domestic shipping seeking information on emissions from the sector and possible approaches to mitigate them
- Issue guidance to support major English ports in producing Air Quality Plans.

In 2020:

- Government will consult on a possible maritime amendment to the Renewable Transport Fuel Obligation
- Government will undertake a study to identify and support potential UK zero emission shipping clusters.
- The Government will establish the Maritime Emissions Regulation Advisory Service (MERAS).
- Act appropriately on the results of the Call for Evidence on Domestic Shipping and the ECA consultation
- Continue leading internationally to deliver the objectives of the IMO GHG Strategy to cut GHG emissions from international shipping by at least by 50% 2050.





Map: The Clean Maritime Plan and Maritime 2050 Zero Emission Shipping Recommendations

ID	Maritime 2050 Recommendation on Zero Emission Shipping	Detail in Clean Maritime Plan
1	Existing Clean Air Strategy commitments	Section 4 – Infrastructure
2	Government will review the existing legislative framework, including the provision of primary powers, to ensure that the UK has the flexibility to respond to public concerns in relation to pollution from the maritime sector.	Section 4 – Infrastructure
3	Government will consider options to promote the UK flag as the flag of first choice for vessels adopting low or zero emission technologies.	Section 3 – Economics Section 6 – Regulation
4	Government will consider options to increase the registration of domestic vessels operating in the UK, as a means to improving our ability to regulate emissions from this sector.	Section 4 – Infrastructure



ID	Maritime 2050 Recommendation on Zero Emission Shipping	Detail in Clean Maritime Plan
5	In parallel with increased international reporting through the IMO Data Collection System and EU Monitoring, Reporting and Verification Regulations, the government will consider domestic options to increase the transparency of emissions data from the maritime sector.	Section 3 – Economics
6	Government will assess how economic instruments could support the transition to zero emission shipping in the medium to long term.	Section 3 – Economics
7	In line with proposals in the UK Clean Air Strategy, the government has now established the Clean Maritime Council, working closely with research bodies like MarRI-UK to ensure strong collaboration between government, industry and academia in this field. Over the next year government will consider the potential role for the Council in directing funding into green technologies for shipping.	Section 5 – Innovation
8	Government will work to better understand the capacity of the UK's energy networks to support an increase in demand for green energy from our ports and shipping sectors. It will also consider the role the maritime and offshore renewables sectors can play in decentralised energy generation.	Section 4 – Infrastructure
9	Government will seek to ensure that measures which tackle the UK's maritime emissions are considered for national grants set aside for dealing with environmental issues.	Section 5 – Innovation.
10	Government will consider options to support the development of technology which enables monitoring and enforcement of any new regulations governing emissions of GHGs and air quality pollutants.	Section 5 – Innovation
11	Government will consider the merits of introducing a medium term target for emissions of GHGs and air quality pollutants from UK shipping. Further detail on this consideration will be set out in the Clean Maritime Plan.	Section 3 – Economics
12	Government will work in partnership with the British banking sector to encourage the provision of finance towards zero emission shipping technology development and manufacturing.	Section 3 – Economics



ID	Maritime 2050 Recommendation on Zero Emission Shipping	Detail in Clean Maritime Plan
13	Government will review the environmental and economic case for coastal shipping, and whether the government should play a greater role in encouraging modal shift.	Section 4 – Infrastructure
14	<p>In line with the Industrial Strategy, government aims to launch a number of “zero-emission shipping ambitions” in the Clean Maritime Plan which could include:</p> <p>A group of hydrogen or ammonia powered domestic vessels in operation</p> <p>At least one major port in the UK to have all ship-side activity zero emission (including non-road mobile machinery like cranes, as well as ships while docked in port).</p>	Section 3 – Economics
15	Government will work to ensure maritime greenhouse gas emissions are appropriately taken into account in national and international emission reporting. The government will carefully consider to the CCC’s advice on the inclusion of international shipping within carbon budgets. Further information on the Government’s plans will be set out in the Clean Maritime Plan.	Section 3 – Economics
16	Government will consider whether and how the Renewable Transport Fuel Obligation (RTFO) could be used to encourage the uptake of low carbon fuels in maritime, taking the availability of sustainable resources, competing uses and the international character of the maritime sector into consideration.	Section 3 – Economics
17	Government will consider how public procurement, subsidy and licensing regimes can be used to increase the uptake of green technologies e.g. for vessels supporting the offshore energy sectors.	Section 4 – Infrastructure
18	Government will consider the introduction of a target to reduce emissions of GHGs and air quality pollutants from UK shipping towards zero. Further details on the government’s long term plans to reduce emissions from UK shipping, will be set out in the Clean Maritime Plan, taking into account the IMO’s 2050 GHG target.	Section 3 – Economics
19	In line with the government’s Industrial Strategy, we aspire to launch a number of “zero-emission shipping ambitions” in the Clean Maritime Plan including an aim to have all domestic ferries zero emission by 2050.	Section 3 – Economics





Glossary

- **Bunkering** – refuelling a ship
- **CAS** – Clean Air Strategy
- **CCC** – Committee on Climate Change
- **CC(U)S** – Carbon Capture, (Usage) and Storage
- **CMC** – Clean Maritime Council
- **CO₂** – Carbon Dioxide
- **Domestic Shipping** – Ships which have come from a UK port and are making a call at a different UK port. Domestic shipping for the purposes of the UK GHG inventory is defined as any direct journey from a UK port directly to another UK port. In the case of shipping between the UK and its overseas territories (e.g. Bermuda, Falklands Islands) these are treated as a domestic journey for the sake of international reporting. International shipping emissions are not included in the UK total greenhouse gas emissions, in line with United Nations Framework Convention on Climate Change and Intergovernmental Panel on Climate Change guidelines, however they are reported as a memo item in the UK's GHG inventory⁹⁵.
- **ECA** – Emission Control Areas (ECA)
- **GHG** – Greenhouse Gases
- **GVA** – Gross Value Added
- **H₂** – Hydrogen
- **HGV** – Heavy Goods Vehicle
- **IGF Code** – International Code of Safety for Ships Using Gases or Other Low-Flashpoint Fuels
- **IMO** – International Maritime Organization



- **International Shipping** – Ships calling at a UK port which have come from or are going to an international destination.
- **LNG** – Liquid Natural Gas
- **Maritime 2050** – A strategy setting out the Government’s vision and ambitions for the future of the British maritime sector, published January 2019.
- **MARLab** – Maritime Autonomy Regulation lab
- **MARPOL** – The International Convention for the Prevention of Pollution from Ships 1973 as modified by the Protocol of 1978
- **MarRI-UK** – Maritime Research and Innovation UK, a project aiming to provide a collaborative innovation vehicle for the UK maritime industry.
- **MEPC** – Marine Environment Protection Committee
- **MERAS** – Maritime Emissions Regulatory Advisory Service
- **Negative Externalities** – When the fuel prices do not currently fully reflect the environmental costs that result from the use of these fuels (e.g. climate change)
- **NGO** – Non Governmental Organisation
- **NH₃** – Ammonia
- **NO_x** – Nitrogen oxides
- **NRMM** – Non-road mobile machinery
- **PM_{2.5} & PM₁₀** – Particulate matter
- **R&D** – Research and Development
- **R&I** – Research and Innovation
- **Red Ensign Group** – A group of British Shipping Registers, made up from: the United Kingdom, the Crown Dependencies (Isle of Man, Guernsey and Jersey) and the UK Overseas Territories (Anguilla, Bermuda, British Virgin Islands, Cayman Islands, Falkland Islands, Gibraltar, Montserrat, St Helena and the Turks & Caicos Islands). Any vessel registered in the UK, a Crown Dependency or UK Overseas Territory, is a “British ship” and is entitled to fly the Red Ensign flag.
- **Road to Zero Strategy** – A strategy outlining how Government will support the transition to zero emission road transport and reduce emissions from conventional vehicles during the transition, published July 2018.
- **RTFCs** – Renewable transport fuel certificates
- **RTFO** – Renewable Transport Fuel Obligation
- **SCR** – Selective catalytic reduction
- **Shipping in transit** – Ships which are not calling at a UK port but are passing through UK waters.
- **SO₂** – Sulphur dioxide
- **T-TRIG** – Transport Technology Research Innovation Grant
- **UK international shipping** – Ships calling at UK port which have come from or are going to an international destination
- **UN** – United Nations
- **VOCs** – Volatile organic compounds (VOCs)





Endnotes

- 1 DfT (2019) Maritime 2050 Strategy: <https://www.gov.uk/government/publications/maritime-2050-navigating-the-future>
- 2 DfT (2015) Maritime Growth Study: <https://www.gov.uk/government/publications/maritime-growth-study-report>
- 3 The Environment chapter of Maritime 2050 also discusses a range of other environmental topics, outside of zero emission shipping. Further detail on these topics is monitored through the wider Maritime 2050 reporting process.
- 4 Defra (2019) Clean Air Strategy: <https://www.gov.uk/government/publications/clean-air-strategy-2019>
- 5 The temperature goals of the Paris Agreement aim to “strengthen the global response to the threat of climate change, in the context of sustainable development and efforts to eradicate poverty, including by ...Holding the increase in the global average temperature to well below 2°C above pre-industrial levels and pursuing efforts to limit the temperature increase to 1.5°C above pre-industrial levels, recognizing that this would significantly reduce the risks and impacts of climate change.” https://unfccc.int/sites/default/files/english_paris_agreement.pdf
- 6 IMO (2018) Initial IMO Strategy on the Reduction of GHG from Ships: [http://www.imo.org/en/OurWork/Environment/PollutionPrevention/AirPollution/Documents/Resolution%20MEPC.304\(72\)_E.pdf](http://www.imo.org/en/OurWork/Environment/PollutionPrevention/AirPollution/Documents/Resolution%20MEPC.304(72)_E.pdf)
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- 13 DfT (2018) Port Freight Annual Statistics: 2017 Final Figures: <https://www.gov.uk/government/statistics/port-freight-statistics-2017-final-figures>
- 14 DfT (2019) Sea Passenger Statistics 2018: Short Sea Routes (Provisional): <https://www.gov.uk/government/statistics/sea-passenger-statistics-2018-short-sea-routes-provisional>



- 15 Cebr (2017) The Economic Contribution of the UK Maritime Sector: <https://www.maritimeuk.org/documents/183/Cebr-Maritime-Sector-Report-2017.pdf>
 - 16 A group of British Shipping Registers, made up from: the United Kingdom, the Crown Dependencies (Isle of Man, Guernsey and Jersey) and the UK Overseas Territories (Anguilla, Bermuda, British Virgin Islands, Cayman Islands, Falkland Islands, Gibraltar, Montserrat, St Helena and the Turks & Caicos Islands). Any vessel registered in the UK, a Crown Dependency or UK Overseas Territory, is a “British ship” and is entitled to fly the Red Ensign flag.
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 - 18 Maritime UK (2018) Annual Review: <https://www.maritimeuk.org/media-centre/publications/annual-review-2018>
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