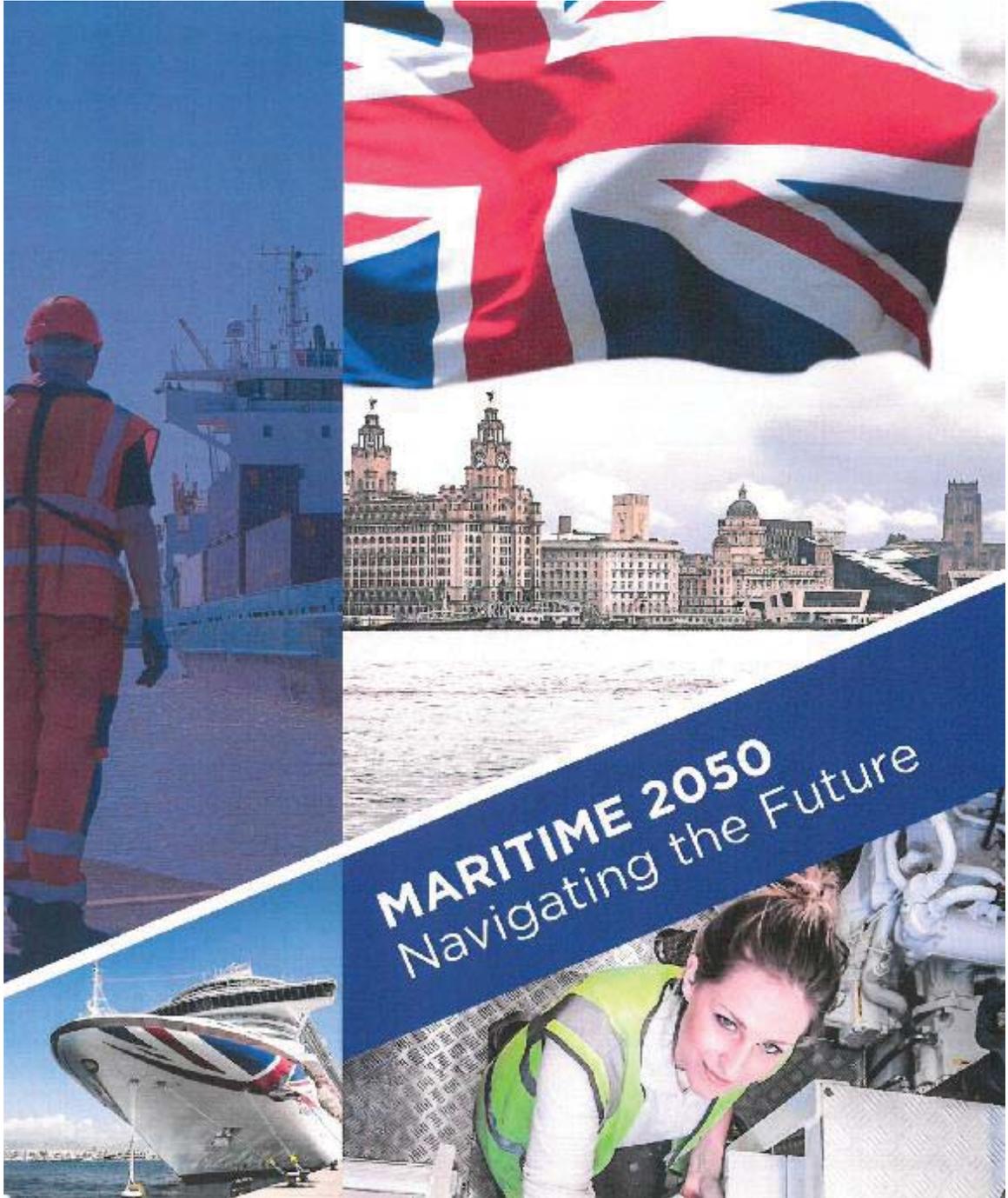




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MARITIME 2050

Navigating the Future

January 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 Secretary of State for Transport



When I launched Maritime 2050 in February 2018, I was confident that with engagement across Whitehall, the full breadth of the maritime sector, and our maritime academic partners, we would produce a truly visionary long term strategy for the UK maritime sector. This document is bold and aspirational, cementing our ambition to be a world leading maritime nation long into the future.

The global economic picture may change and new technologies emerge, but of one thing I am certain - this country will continue to rely upon the maritime sector for its trading success and many of our essential needs, from the clothes we wear to the food we eat.

The maritime sector is the key enabler for UK manufacturers and suppliers to reach out into international markets and I do not envisage that changing through to 2050. However, to remain a competitive maritime nation it is essential that we capitalise on new opportunities, being both innovative and forward thinking in meeting any challenges that arise.

Maritime 2050 is substantial, reflecting our intention to be as wide ranging and comprehensive as possible. It is founded on a number of core ambitions, demonstrating our bold and aspirational objectives as we head towards and beyond the second half of the 21st century. Our desire is for the UK to be a global leader, promoting a liberalised trading regime that delivers maximum

benefit for our maritime sector. In doing so, we must take action now to ensure we are at the forefront of technological advancements, to transform and grow our maritime workforce and be bold and ambitious in progressing clean maritime growth. Underpinning this will be the delivery of maritime infrastructure that matches our future expectations.

Government is committed to working with industry and the wider sector to deliver on our Maritime 2050 commitments and in the development of the route maps. Together we can encourage innovation and investment, collectively shaping and ensuring the success of our UK maritime sector for generations to come.

I am extremely grateful to all those who contributed to the development of Maritime 2050, through an extensive programme of stakeholder engagement and consultation. Your input has been vital, demonstrating real partnership between government and the maritime sector.

A handwritten signature in blue ink, appearing to read 'Chris Grayling', on a light-colored background.

Chris Grayling
Secretary of State for Transport

Foreword by Minister for Maritime



As Minister for Maritime I am proud to have responsibility for our outstanding maritime sector. I have seen first-hand how vital it is to each and every one of our lives and the instrumental role it plays in the UK economy. I know that everyone in the UK who works in our maritime sector, or has an association with it, is proud and passionate about it. I share that passion, and together we are determined to ensure our status as a world-leading maritime centre is undiminished long into the future.

It is clear that the present time is a pivotal period for the sector, one of change and potential. Maritime 2050 charts an ambitious course for the industry that outlines the coming opportunities. Collaboration across the sector will be necessary to achieve these aims, and industry has already demonstrated an admirable willingness to work with government. This strategy is one such result of this cooperation and further partnership will continue to be vital to our ongoing success.

I wish to extend my thanks to all those who contributed to this strategy; those who submitted written evidence, took part in the numerous workshops, and the many individuals who spoke to me directly throughout the year. These thoughts and ideas were heard and contributed to the evidence base that informs Maritime 2050. The strategy and its recommendations are all the richer for them. I am passionate about this strategy

because it sets out our ambition to strengthen our status as a global maritime leader. In taking action in crucial areas like the environment, security and trade, the UK will be a standard bearer on the international stage. This will also be seen in one of the areas closest to my heart: the welfare and talent of our maritime people. Without them, their dedication and high-quality skills, the maritime industry simply would not function. This workforce is, however, not suitably diverse. We therefore have an opportunity to improve our maritime offer by addressing this challenge, attracting a full breadth of skilled individuals who will be needed in the coming decades. Through Maritime 2050 I hope the good work that has begun in the Women in Maritime Taskforce can gather pace and broaden out to look at wider diversity issues.

Maritime 2050 is a hugely ambitious undertaking. As champion for the sector, I can assure you that I will provide the leadership in government that the sector rightly expects and deserves. In return, I ask all those wanting to ensure our UK maritime sector strengthens its position as a global leader in the coming years, join with me in our endeavour.

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

Nusrat Ghani
Minister for Maritime

Executive Summary

Introduction

1. The UK is one of the world's leading maritime nations. Its status is built upon a remarkable historical foundation, our geography, and a large and vibrant economy. But leading maritime nations only hold that position because they adapt and plan for the future. So, the UK is looking far ahead, to allow us to support and grow the maritime sector with strength and determination. This is a maritime strategy to take the UK into the second half of the 21st century.
2. The maritime sector¹ has played a critical role for centuries in the growth and development of the UK as a primary facilitator of global trade. Our highly successful commercial ports have constantly evolved, investing billions in their operations to ensure they remain at the fore of new patterns of trade. Today we rely on the sector not only for the import and export of goods, but also the value the wider maritime sector brings to our economy through the likes of businesses services. Its absence would be quickly felt.
3. The government and the maritime industry are clear that maritime has an integral role to play in the future of the UK. The government has not taken a strategic look at the future of the maritime sector for many years. The need to do so was identified in the 2015 Maritime Growth Study (MGS), which recommended the development of a national strategy for the maritime sector "which could send a strong signal to international customers and competitors"².
4. As the UK looks to reframe its relationship with the world, the time is right to set our vision for the future of the maritime sector. We are confident the maritime sector will thrive and strengthen, as it harnesses the opportunities that EU exit brings. We are working with countries across the world to explore the best ways to develop our current trade and investment relationships and ensure that Britain becomes a global leader in free trade upon departure. We also want a positive future relationship with our European neighbours, encompassing both economic and security cooperation, working in the interests of all.
5. Although maritime is largely a reserved policy responsibility in the UK there are some key interests in the devolved areas, with wide involvement in seafaring and coastal industries. Devolved administrations have some direct responsibility for areas such as ports, which themselves have a huge local and regional impact on the economy. The strategy recognises these interests by building on the

¹ In Maritime 2050, the maritime sector is considered to include shipping, ports, services, engineering and leisure marine industries.

² <https://www.gov.uk/government/publications/maritime-growth-study-report> page 57.

strong partnerships between UK government and the devolved administrations.

6. Maritime 2050 is intentionally ambitious. If we do not set the ambition high, we risk limited progress. Maritime is truly global and will move where business is best. Therefore, we must maintain and improve our offering. Maritime 2050 is a recognition that our maritime future will not look like our maritime past. While we will not be world-leaders across the entirety of the sector, the expertise we have honed over generations will allow us to lead in certain areas such as technological and environmental innovation, and in high quality maritime business services.

Maritime 2050 values and ambitions

7. Underpinning our work is a set of five **core values** for UK maritime:
 - A premium brand, not compromising on safety
 - A balanced set of priorities
 - A commitment to the rules-based approach
 - A truly global United Kingdom
 - Real partnership between government and industry

These values are enduring and distinctive core beliefs that guide the activities and goals of this strategy. They establish why we do what we do and what we stand for. They will be crucial in influencing the attitudes and behaviours of all those involved, as we develop the capabilities and capacity to meet future challenges and opportunities within the sector.

8. Our strategy coalesces around a set of **10 core strategic ambitions**. These ambitions provide, in their simplest form, our bold and aspirational objectives as we head towards and beyond the middle of the 21st century.

Maritime 2050 Strategic Ambitions

The UK will....

- Maximise our strength in maritime professional services, retaining and enhancing our **UK competitive advantage** in the provision of maritime law, finance, insurance, management and brokering, and developing our green finance offer.
- Lead the way in taking action on **clean maritime growth** enjoying economic benefits from being an early adopter or fast mover.

- Strengthen our reputation for maritime innovation, maximising benefits to the UK from new **maritime technology** through our world leading universities, maritime small and medium enterprises (SMEs) and global companies.
- Continue to be recognised as the global leader in **maritime safety and security** standards and expertise worldwide.
- Grow our **maritime workforce and transform their diversity** enhancing our reputation as the world leader in the provision of maritime education and training.
- Promote a **liberalised trading regime** that delivers maximum benefit for our maritime sector.
- Support the continued multi-billion pound commercial investment in **maritime infrastructure** that makes the UK a globally attractive destination for all maritime business.
- Strengthen and enhance our reputation as a **leading country in the International Maritime Organization (IMO), International Labour Organization (ILO) and all international fora** working with like-minded countries to take action.
- Promote our **UK wide leading maritime cluster offer** with government, the maritime sector and academia working in partnership to make the UK the place to do maritime business.
- **Showcase our UK maritime offer to the world**, promoting all parts of the maritime sector including shipping, services, ports, engineering and leisure marine, and through London International Shipping Week (LISW) maintaining its status as the leading global maritime event.

9. Maritime 2050 is built on seven high level themes: the UK's competitive advantage, environment, infrastructure, people, security, technology and trade. The themes were chosen because we see them as being of fundamental importance throughout the life of the strategy. These have been further divided into sub-themes which seek to capture a greater level of detail, including on issues which are fundamentally important to the UK, such as safety, where we seek to lead the way.
10. In each thematic chapter there are recommendations which seek to set out our short, medium and long term priorities. Some are for government, some are for the UK maritime sector which includes our social partners, and an overwhelming majority will only be achieved through collective endeavour.

11. This strategy is of course only a starting point and must evolve in the future, as we respond to future challenges and change. A series of route maps will be published in 2019 to clearly define the steps we expect to take over the next ten, twenty and thirty years to deliver on our ambitions. Government will work with the sector to develop these and the first two will cover Trade and Technology and Innovation focussing specifically on maritime autonomy as a case study.

Development of the strategy

12. Maritime 2050 builds upon an extensive body of work already dedicated to the role of the maritime sector in the UK. It sits alongside other government strategies and is supported by specific sectoral plans. It has been developed through an extensive programme of stakeholder engagement and consultation. The appointment of an independent panel of academics, industry leaders, maritime business services providers and promotional bodies - the Maritime 2050 Expert Panel - provided challenge to government and review throughout the development of this strategy.

Implementation

13. Maritime 2050 will only succeed if steps are taken to achieve the vision it sets out. We are clear that achieving these ambitions is not for government or industry alone and that a continued partnership is crucial. We recognise that change will come rapidly in some areas, and incrementally in others, that some steps can be taken quickly while for others the path needs to be paved. That is why the recommendations have been identified across the short (up to 5 years), medium (5 to 15 years) and long term (15 years and beyond). Delivery of the vision and recommendations in Maritime 2050 will be supported by a series of thematic route maps. These will set out in greater detail what steps government and industry will take now and in the coming years to achieve the ambitions of Maritime 2050. Through the route maps, we will review the actions being taken at an appropriate time.

Maritime today

14. For the sector to move forward, we must understand its current position. Today, the global maritime sector remains a key enabler of international trade. Indeed, international trade at current levels is only possible thanks to the maritime sector. Other transport modes have reached the practical limits of scale, yet maritime container ships continue to respond to economic forces, having more than doubled in size within a generation. That said, the maritime sector has not been immune to recent global economic recessions and a decline in global trade significantly damages the shipping sector. The financial crisis which began in 2008 has had a prolonged and adverse impact on the maritime sector with a great decline in some traditional forms of

finance. Yet the importance of maritime in moving goods and commodities around the globe persists.

15. The UK no longer enjoys the unprecedented global pre-eminence it once did, yet it continues to be a significant maritime power. This position is not static or stable and while the country solidified its maritime power over centuries, others have quickly risen to capitalise on geographic location or the ability to compete on price and incentives. Taking the right action now means the UK is well-placed to take a leading role in the new global maritime industry.
16. The shipping industry is a critical element in the UK economy. Around 95% of British imports and exports in goods are moved by sea, including 25% of the UK's energy supply, and 48% of the country's food supplies³. Reliable and timely importation is therefore fundamental to the UK's national security. Maritime business services directly contribute £2 billion Gross Value Added (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 billion⁴. 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 respectively⁵.
17. In addition to trade in goods, the UK 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 revenue⁶. 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 port⁷.
18. The UK has played a leading role, through the IMO, in securing agreement to the target of a 50% greenhouse gas (GHG) emission reduction from the sector by 2050. Investment in maritime infrastructure, aimed at promoting the uptake of carbon neutral fuels and the generation of renewable energy such as using biomass or rotor sails, highlight the UK's commitment to environmental goals and the leading role business can play in achieving these.
19. Macro issues such as the use of data and digitalisation will shape the future of the sector which is why technology is at the heart of this strategy. The UK has a long history of innovation and invention; the light bulb, the telephone, the World Wide Web, the television, and the jet engine are all British born creations. This rich history continues – several British companies are producing early-stage autonomous

³ <https://www.gov.uk/government/publications/maritime-successes-2017-to-2018>

⁴ <https://www.maritimeuk.org/value/maritime-services-industry/>

⁵ <https://www.maritimeuk.org/about/our-sector/maritime-business-services/>

⁶ Maritime UK Annual Review 2018, Section 6, page 111

⁷ Maritime UK Annual Review 2018, Section 6, page 93

vessels such as the SEA-KIT unmanned vessel. The UK maritime sector has a wide range of innovative and ambitious SMEs bringing new products to market that will improve performance and enable better business led decisions to be taken by the global maritime sector.

20. Fundamental to our success is our maritime people, their education and training with world-class universities and institutes providing top-level training for people within the maritime industry. The UK is a world leader in this regard. Moreover, it acts as an important source of thought leadership, setting the benchmark for the promotion of industry standards in safety, regulation, and seafarer welfare. The UK recognises that the statistic that just 4% of the 10,480 UK certified officers active at sea are female⁸, a figure which is poorer still globally. The UK is actively working with Maritime UK and specifically the Women in Maritime Task Force to address this imbalance. This should be a start on a much wider focus on determining the reasons why there is a lack of diversity and implementing policies to attract the best and most diverse talent to the sector both on shore and at sea.

Maritime trends

21. To a greater degree than any other transport sector, maritime is affected by global trends. Attempting to understand the impact of these trends will help the UK sector plan for its place in the global maritime industry and factor in the inherent uncertainty of what the world will look like in 2050.

Key trends influencing the direction of Maritime 2050

- **A long term growth in seaborne trade.** The volume of goods transported by ships and demand for associated maritime services has grown steadily and there is no sign of significant change.
- Maritime is significantly affected by the **changing shape of world population.** Developing countries will see the greatest growth potentially shifting trading patterns and demands for imports and exports. The UK's population and relative importance to other major European countries is expected to increase.
- **Ageing populations** may also influence a decline in some demand whilst creating challenges for the UK workforce both in terms of skillset and fulfilling vital roles in the wider logistics supply chain.

⁸ www.gov.uk/government/statistical-data-sets/seafarer-statistics-sfr

- **The shift in the world economy** eastwards and new emerging markets will have a significant impact on the maritime sector.
- With a potential **shift in political power bases** there could be a change in rules-based discussions in the IMO and other international fora.
- New **disruptive technologies** are likely to emerge and change the maritime sector in ways we may not yet anticipate, including in the areas of artificial intelligence (AI), blockchain and digitisation.
- **Climate change and significant climatic events** will have an impact both on the resilience of the maritime sector and changing patterns of trade whilst also amplifying the need to act to protect the marine ecosystem and environment.

UK competitive advantage

22. The government working in close collaboration with the maritime sector will identify and take the action needed to retain its competitive advantage as a leading maritime nation. Our vision for the UK is to be viewed globally as a top tier place to do maritime business with a number of established strengths and new opportunities to seize.
23. Several of our top Maritime 2050 ambitions are covered in this theme. The UK recognises the importance of being a global leader in the IMO and other international fora to take forward our policy and regulatory ambitions and to bring our thought leadership to bear.

Fiscal competitiveness

24. This section recognises the importance of the UK being viewed globally as a great place to do business and to do it with ease. It also recognises the importance of ship owners, managers and operators to the UK. The City of London and our world leading maritime professional services are highlighted here and their unparalleled expertise in law, arbitration, shipbroking, financial services and consultancy. The sub-theme explores the action that will be needed, and is being taken by the government in close collaboration with the sector, to remain fiscally attractive to the global shipping and maritime community.

The UK's maritime cluster

25. This section explores the wider power of our maritime clusters in London and throughout the UK. This is seen to have a significant

impact on the regional and national economy and on our international attractiveness. Close collaboration in clusters of industry and academia working with government, creates dynamic and innovative synergies. These attract highly skilled and ambitious people, thereby bringing economic opportunities to the global maritime sector.

Thought leadership

26. The UK's thought leadership fosters a dynamic and innovative maritime industry. Moreover, it is demonstrated through negotiations at the IMO and other international fora. This section explores how we translate UK pioneering research and thought leadership into tangible benefits. Attracting the best intellectual talent to the UK, continued support for our universities and hosting renowned international academic conferences play a key part. Beyond research, tighter partnership between the maritime industry, academia and government will maximise transfer of knowledge, and our commitment to retain the IMO in London will consolidate our position as a global thought leader. Creating a blue print for future collaboration with leaders in the maritime educational and training sector will help the UK make the most of future actions.

Strong partnership

27. Ever closer collaboration between the government and the UK maritime sector is seen as fundamental to our competitive advantage. The creation of an increasingly influential Maritime UK has brought a more powerful single voice representing the maritime sector. Maritime UK is able to engage government at the highest levels by demonstrating its global success, and setting out what it needs for the future to enhance our attractiveness to the international maritime community. The merits of a deep and extensive collaborative relationship between government and the sector is recognised as fundamental to future collective success. Government ministers and parliamentarians across parties have never been more cognisant of the importance of the sector to the UK.

A modern approach to UK regulation

28. To be able to deliver on our ambitions for Maritime 2050 the need to have an appropriate and forward looking domestic legislative regime in place is crucial. This sub-theme makes the case for a new framework and a constant evaluation and evolution of the existing regime and its application. The essential role of one of government's leading maritime agencies, the Maritime and Coastguard Agency (MCA), is set out in this theme. The sub-theme also explores the future of registration and the value and importance that we attach to the UK Ship Register (UKSR). It sets out very clearly that the UK seeks to offer a premium level of service that matches modern expectations but remains uncompromising on core values particularly in quality and safety.

Safety

29. The importance that the UK attaches to a safe maritime sector is set out in this section and is vital to our future. There is recognition that globally, maritime safety standards are poor with fatal accident rates in the merchant shipping fleet high, particularly in sectors like fishing. This section explores the steps that are being taken and need to be pursued during the implementation of Maritime 2050.

UK flag

30. Global recognition of the UKSR as a quality brand, and having the capability and flexibility to be at the forefront of world shipping, is the vision for 2050. Capitalising on innovation and the customer experience will be key parts to any future changes. Targeted promotion of the UK offer along with ongoing review to ensure the service remains in a leading position are envisaged. Longer term, horizon scanning and government support through the MCA will help support growth.

Headline UK competitive advantage recommendations

- **Government and industry to work together to maintain and enhance the attractiveness of the UK's regional maritime clusters and London** as a global maritime professional services cluster.
- To ensure that the most innovative companies and ideas are brought to market for the benefit of UK maritime, **government will explore further opportunities to continue to support maritime innovation.**
- The UK, as host of the IMO, will seek to **maximise our leadership role in the organisation.**
- **Government will develop proposals for a new Merchant Shipping Act 1995, in the next 5 years.**

Technology

31. Future changes in technology will change the way in which the maritime sector operates, driving performance enhancements and creating opportunities for maritime businesses to take better decisions. Big data analytics, digitalisation and more advanced communications will lead to better connectivity, efficiency gains and cost savings but also present risks to business continuity such as through cyber-attack. This section sets out the UK's ambition to utilise advancements and

changes in maritime technology to make the sector a cleaner, safer and more efficient place to work with the creation of highly skilled job opportunities at sea and on shore.

Future of shipping

32. The UK is determined to be world leading in the design, manufacture, uptake, and use of smart shipping technologies. To achieve this, we will develop a UK legislative framework for autonomous vessels and lead efforts to establish an international regulatory framework. We will support industry in developing and testing new technologies by funding flagship projects, and learning from other sectors like the automotive industry. The UK will be a vibrant hub of research and development. Shipping companies will benefit from a highly competitive register for technologically advanced and autonomous vessels.

Smart ports

33. As critical maritime and logistics infrastructure, ports will form part of an advanced and integrated supply chain by 2050. By pioneering new business models and realising the benefits of new digital and automated processes they will maximise throughput of goods with seamless onward connections, while continuing to act as a gateway for passengers into and out of the UK. Smart port developments will be led by industry with government support. Joint competitions to develop existing technologies, test new ideas, combined with the establishment of a cross-sector innovation hub at a UK port by 2030, will encourage innovation and the adoption of these technologies. Building on this expertise to further develop a network of regional R&D clusters will benefit local economies into the future.

Digitalisation

34. Digitalisation is crucial to the future of maritime. Replacing paper-based processes and transactions will increase operational and cost efficiency for shipping. Digital documentation for seafarers will reduce the burdens on businesses and individuals, when checking required training and certification. The benefits of new technologies such as distributed ledgers (e.g. blockchain) will be identified along with government's role in supporting and developing their use. UK will lead efforts to set international standards at the IMO and ensure interoperability of systems. Agile UK regulation will allow transparency, competition, and improved efficiency while enabling secure and easy-to-use systems that attract business to the UK flag. By 2050, we anticipate globally harmonised standards governing a transparent data-driven 'digital by default' UK maritime space.

Communication, navigation, and exploration

35. In future years increasing demands are expected on maritime communications and infrastructure, from the development of remotely operated vessels to the need for increased satellite coverage of remote areas like the Arctic. Understanding the potential for 'Future Navigation', what information the sector requires and UK capabilities to provide it will be key to maximising the UK's opportunities. By linking existing UK space manufacturing and R&D capabilities to the maritime sector, cross-sector potential will be unlocked. Mapping the UK's own seabed and Exclusive Economic Zone (EEZ) – the fifth largest in the world - could realise potential economic benefits. Building on expertise gained from mapping UK waters, we anticipate leading a coalition of like-minded nations to substantively map all international waters.

Headline technology recommendations

- **The UK will legislate for a domestic framework for autonomous vessels** to attract international business and allow testing in UK's territorial waters.
- **Government will work with industry to develop a 'Maritime Innovation Hub'** in a UK port as a result of an open competitive process. The hub will bring together expertise, support technology development, and boost regional productivity.
- **UK will be at the forefront of international efforts to chart the international seabed area**, helping us to understand how to sustainably manage and benefit from the global ocean environment and creating exportable hard technology and soft skills.

People

36. The UK's vision for 2050 is a diverse and rewarded workforce with a focus on good maritime welfare that will set a global benchmark for the sector. Inspiring young people to pursue maritime careers and maintaining our world leading training offer in maritime colleges and universities will allow the UK to deliver high quality skills. Future UK seafarers will be expected to transition easily between sea and shore-based roles, using transferable IT based skills, and continuing professional development that allows them to update skills in line with technological advances. Increasingly maritime roles will likely have highly specialised elements and where science, technology, engineering, and mathematics (STEM) skills will come to the fore.

Maritime workforce

37. Embracing change and greater harmonisation of standards with other sectors will ensure that the UK maritime offer for skills and training remains competitive. Aligning ratings training and apprenticeships with industry needs will help boost the number of UK seafarers. Mapping out the variety of career paths including from sea to shore, will help attract the right talent. Increased awareness in schools and taking maritime to the younger generation in a less formal way such as scouts, guides or local sea cadets could reinvigorate the image and appeal of the sector. Future reviews of the UK tonnage tax regime, including considering the training element and exploring greater potential for linkages between the Royal and Merchant Navies to showcase transferable skills, would support our maritime workforce ambitions.

Diversity

38. A limited talent pool has the knock-on impact of limiting important wider skills and risks industry not meeting its full economic potential through a lack of diversity. Building on joint government and industry initiatives like the Women in Maritime Taskforce will be crucial to achieving greater gender balance. Looking to 2050, consideration of diversity as a whole, not just how it relates to women, will be one of the challenges facing the sector. Promoting a maritime culture that encompasses diversity in its broadest sense, will reap wide ranging benefits.

Maritime skills and promotion

39. The skills profile of the maritime sector will change significantly over the next 30 years. The importance of STEM subjects will increase as jobs become more skilled and data driven in response to new technology. Industry roles will be multidisciplinary, potentially requiring the ability to create, operate and maintain autonomous and technological systems. There is an opportunity to build on the UK's existing advantage, developing and expanding our high-quality training programmes to meet new requirements, exploring ways to bolster our offer at home and abroad. Upskilling our workforce to take advantage of emerging technologies such as robotics and artificial intelligence, the agility to adapt training packages in a timely way and regular review of our skills needs will allow the UK to capitalise on its skilled workforce.

Continuous education and training

40. The pace of technological change is expected to continue into future years, requiring workforce skills to keep pace. Without continuous learning the industry risks increased costs from high staff turnover, and individuals could suffer in terms of career progression. Mapping career paths and building professional development into training programmes will allow a proactive approach to career planning and support cross-

sector mobility. Better internet connectivity at sea would remove an existing obstacle to lifelong learning, while the application of technologies such as virtual reality could facilitate retraining in new systems as well as potentially change the way in which traditional training programmes are delivered.

The human in the face of technological change

41. Seafarers suffer a high incidence of mental health conditions, primarily due to the pressures, nature and isolation of working at sea. Changing technology could be utilised to improve sea connectivity. The UK has the opportunity to lead the way in considering the mental health of seafarers and the wider maritime workforce. We would look to develop the concept of a UK social framework, working collaboratively with industry and our social partners to set expectations for the welfare of the UK maritime workforce, while simultaneously leading the push for better standards internationally including a limit on hours per shift to combat seafarer fatigue and eradicating modern day slavery.

Headline people recommendations

- **Government will fund the production of the ‘people like me’ maritime industry project** to help address the image and perception of the industry and demonstrate how we can effectively showcase its value to a wider diversity of people.
- **Government aims to establish a Maritime Skills Commission** bringing existing leading maritime skills experts together, to report on the existing and future skills needs of the industry on a 5-yearly cycle, to inform the maritime training curriculum and keep it up to date with the evolving needs of the sector.
- **UK will develop cutting edge seafarer training** maximising the use of future technologies such as virtual reality and augmented reality.

Environment

42. The scale of goods and people moving around the world is greater than ever before. As evidence mounts for the need to act with urgency to address climate change, it is clear a global transition to a cleaner and greener maritime sector is underway. The UK can use its strengths in areas such as maritime technology and finance, to help deliver its environmental goals and international environment commitments, including the UN Sustainable Development Goals. The vision is for an environmentally sustainable sector, reducing impacts as close to zero as possible, while leading the way on green finance and setting

international standards. Collaborative working with industry and academia will help identify innovative technological solutions and maximise the economic benefits to the UK economy.

Towards zero emission shipping

43. Air pollution is a significant risk to human health in the UK, and as the volume of global trade increases shipping may represent a growing source of GHGs. Regulation has historically been predominantly at the international level with important milestones in recent years such as the introduction of the North Sea Emission Control Area (ECA), the agreement of a global sulphur cap to be implemented by 2020 and the adoption in 2018 of the Initial IMO Strategy on reducing GHG emissions from ships by at least 50% by 2050. These and other developments are sending a strong signal to the sector of the need for a global transition to zero emission shipping.
44. By 2050, the UK will actively drive the transition to zero emission shipping in its waters, moving faster than competitor countries and international standards to capitalise on economic benefits and be seen as a role model in the field. Close collaboration between industry, government and different parts of the supply chain, will enable lessons to be learned from other sectors, ensuring new regulation is appropriate and helping maritime companies realise the benefits of research and investment. Ultimately this will lead to the development and swift uptake of clean technologies.

Minimising wider environmental impacts

45. Maritime 2050 is concerned with the impact on the marine and the immediate coastal environment. In thirty years, the UK maritime sector will have negligible wider environmental impacts, with minimisation integrated into the full ship life cycle from design and construction to operation. The UK's leadership role at the IMO will ensure proportionate global regulation that also enables us to meet high standards domestically. The government will favour an outcome-based approach to environmental legislation where possible. Continued support for the Hong Kong Convention (HKC) will improve standards of ship recycling facilities world-wide. The application of new technologies such as sensors for monitoring compliance with environmental standards will improve enforcement processes, giving greater assurance to the public. The interplay between rate of uptake, cost and unintended consequences will be fully considered when developing and implementing new technology.

Adapting successfully to the impacts of climate change

46. The maritime sector needs to prepare for the uncertain effects of climate change. Increased flooding of ports from tidal surges, more frequent extreme weather events and coastal erosion are predicted.

The flow of goods into and out of the UK as well as connectivity to road and rail infrastructure is therefore at risk of disruption in the coming years. In order to adapt successfully to evolving climate change risks there must be continuing collaboration between industry and agencies like the Environment Agency (EA) and Met Office, supported by government assessment of risks and opportunities. As private entities, ports have a responsibility to plan and respond to their unique vulnerabilities and improve resilience of their estates. In recognition of the potential opportunities presented by opening Arctic trade routes, the government is committed to putting the environment at the centre of maritime trade route discussions.

Achieving our goals through continued international leadership

47. The UK already has strong influence at a number of global fora such as the IMO, and is a leader in the field of international maritime environmental diplomacy. Globally, economic benefits associated with the increasing importance of the blue economy will generate renewed interest in environmental regulation as we move towards 2050. Over this timeframe, the UK will maintain its leading role, ensuring the global sector plays its part in meeting climate change, air quality and wider environmental goals, using its influence or ‘soft power’ to shape an international regulatory framework aligned with our interests.

Headline environment recommendations

- **Government will assess how economic instruments could support the transition to zero emission shipping** in the medium to long term.
- In line with the Industrial Strategy, **government aims to launch a number of “zero-emission shipping ambitions”** in the Clean Maritime Plan.
- **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.

Trade

48. Trade is fundamental to the UK maritime sector, which when taking wider impacts into account, supports almost 1 million jobs and contributes around £40bn to UK gross domestic product (GDP⁹). The

⁹ <https://www.maritimeuk.org/value/maritime-sector-all/>

maritime sector both enables our global trading ambitions, being fundamental to our export success, and is a significant trading sector in its own right. This theme also explores in more detail the steps we need to take to maintain and enhance our maritime professional services success in the face of competition.

49. As one of our core Maritime 2050 ambitions, the pursuit of a liberalised global trading regime will have a direct impact on the maritime sector which stands to benefit from increases in trade and frictionless trade flows. Government is committed to working with UK businesses to make trade easier, to remove barriers - whether regulatory, legislative or financial - and to unlock the potential of international exports. We envisage leveraging the UK's experience and reputation to take advantage of opportunities as they arise between now and 2050.

Supply and demand

50. The principle of supply and demand underpins global trade, and the goods we import and export are constantly changing. The UK will need to match the demand in the global maritime sector or risk losses in tax, revenue, employment and GDP. Government has already started consulting on where it should focus efforts in terms of future trade agreements and will complement this by continuing to connect industry to overseas markets and customers.
51. Trade is driven by many factors, including the geo-political situation, transport and production costs, seasonal commodity cycles and external shocks such as war or natural disaster. These are difficult to predict but we can prepare for changes by leading the way in innovation and capitalising on commercial opportunities as they arise worldwide. Our position as world leader in the provision of maritime services is strong and should be capitalised on, in conjunction with marine engineering, technology and innovation and marine science.

Global rules-based trading framework

52. UK trade operates within a global rules-based framework, to date under the auspices of the European Community and the European Union. Following EU exit we will be able to sign bespoke trade deals and align trade policy with national economic interests. Regaining our independence at international fora such as the World Trade Organization (WTO) will allow us to intensify current support for the rules-based system, maximise our influence on shaping the future of the sector and its role in facilitating global trade. Multilateral and bilateral agreements will be used to grow the UK economy and maintain the sector's competitive advantage at a global level. Beyond this, MoUs, bilateral treaties and international engagement by Ministers are additional approaches we can use to unblock barriers and facilitate trade.

Competition in a globalised world

53. Competition in the maritime sector is increasing. The UK must ensure it provides an attractive business environment and offer a competitive package of measures to attract inward investment. The aspiration for London and the UK to remain a world leader of maritime professional services will be achieved through industry and government working in partnership, while focussing on their respective areas of expertise.
54. Online trading platforms, digital transactions and technologies like blockchain are likely to significantly impact the sector and must be harnessed to the UK's benefit. And in other areas, developing new innovative customs arrangements is an example of an area that could be used to encourage investment in the UK's ports and manufacturing hubs, supported as necessary by evidence collected from industry.

New technology and future modes of transportation

55. A complete shift towards a new mode of transport such as hyperloop is probably unlikely by 2050, however increased investment and technological advances could make maritime and other transport modes more competitive. More fundamentally, it could profoundly influence the interconnectivity of transport modes.
56. Technology has the potential to alter trade patterns and demand for goods e.g. 3D printing, as well as affecting the flow of trade by facilitating cheaper or easier access to Arctic routes opened up by climate change and ensuring such routes are used in a sustainable manner. An agile UK maritime sector will be able to seize commercial opportunities arising through technology adoption and enhance its competitiveness. Moreover, the UK must integrate thinking on developing technologies into future trade agreements.

Trade promotion

57. The government is already progressing a five-year implementation strategy in collaboration with Maritime UK, to coordinate international promotional activity and identify how it can best add value. The Department for International Trade (DIT) is looking more closely at developing emerging areas - autonomous vessels, marine science and decarbonisation amongst others – and the GREAT brand will develop supporting material for a high-impact maritime campaign.
58. There is scope for more targeted promotional events internationally where a value for money case can be demonstrated that contributes to the UK's trade ambitions. Better coordination and a whole of government approach is anticipated to prospect for and develop opportunities into future years.

Headline trade recommendations

- Government will work with the maritime services industry, **to commission and deliver a study into the competitiveness of the sector.**
- Government will engage with the ports and the manufacturing industry to **consider the case for free ports in the UK.**
- **Government will collaborate closely with industry to increase UK exports as a proportion of the UK's GDP from 30% to 35%**, supporting the maritime sector in its role as a key facilitator of trade.

Infrastructure

59. Maritime and marine infrastructure varies enormously from vessels and physical structures at ports, to the supply chain and logistics moving freight around, to name a few. The 2050 vision is an agile sector, open to change as technology develops and adoption speeds up, matching levels in comparable industries. Autonomy, interconnected smart systems and big data will bring the shipping, cargo handling and inland logistics elements ever closer together, maximising efficiency, reliability and reducing costs. UK maritime infrastructure already pushes the boundaries of economic and technological advancement. However, future proofing to ensure the interoperability of systems and protection against potential vulnerabilities such as cyber-attack will be key drivers, as will the development of value-added services and new uses for port land. Future trade flows will likely change in line with consumer preferences and the industry must be able to adapt.

Ports and harbour Infrastructure

60. Continued investment and planning ahead to future proof or retrofit infrastructure will ensure ports and harbours are ready to adapt to future changes. This includes the ability to react to disruptors such as severe weather events or potential security threats. Aligning decisions with developments in shared technology platforms and solutions with other parts of the logistics sector, will ensure a seamless supply chain. More specialisation in commodities is expected, with fewer ports handling the majority of goods entering and leaving the UK. Diversification into new activities and business models is also anticipated. The government will incentivise innovation, working with ports to support R&D, foster beneficial partnerships with SMEs and create conditions conducive to testing of new technologies. Stronger links will help leverage the maximum benefits from government and industry investments alike.

Port connectivity, the supply chain and Logistics

61. Ports will adapt toward full supply chain integration, maximising land use for ancillary activities. Enhanced transparency and use of real time data will increase operational efficiencies, while pioneering cutting edge technologies such as 3D printing. Keeping pace with the adoption of technologies in connected sectors, and engaging with manufacturers and technology companies to capitalise on opportunities for value-added services will be crucial. New transport modes and models of use such as drones, autonomous vehicles, platooning of trucks and their impact on the distribution of freight, will need to be incorporated into investment programmes. As evidenced by the 2018 Port Connectivity Study¹⁰ (PCS), positive impacts for ports and the wider economy can be realised through investment to improve hinterland access. The sharing of information and closer links between ports and infrastructure delivery bodies will support systems integration. Coastal and short-sea shipping could potentially support land-based modes, reducing emissions and congestion and government will explore the feasibility of this option.

Sectoral infrastructure

62. The maritime sector directly supports sectoral infrastructure such as renewable energy, marine aggregates, communications, offshore oil and gas, and the marine and leisure industries. By 2050, the sector will make the most of opportunities associated with a predicted increase in offshore wind generation, playing a key role in UK energy supply and generation, and acting as hubs for trialling and developing new fuelling options. The UK will remain a major cruise centre, with domestic and international ferry passenger services playing an important role. Continued industry investment will be required to meet this vision but offset by exploiting opportunities such as the growing offshore wind supply chain, the decommissioning of North Sea offshore installations and emerging markets in ancillary and support technologies such as energy storage. Potential government intervention to establish an ultra-deep-water port in the UK could improve capability. Growing data requirements across all areas will lead to increased development of subsea infrastructure and government is committed to being at the forefront of developing the UK's capacity. The growth in 'blue tourism' offers benefits to the marine and leisure sectors (cruises, passenger ferry services).

Ship building and boat building

63. As outlined in the National Shipbuilding Strategy¹¹ government will work with industry to further develop the UK shipbuilding and maritime

¹⁰ <https://www.gov.uk/government/publications/transport-connectivity-to-ports-review-of-the-current-status-and-future-infrastructure-recommendations>

¹¹ https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/643873/NationalShipbuildingStrategy_lowres.pdf

engineering industry, building on our global reputation for design, innovation and quality. Developing an enhanced export model while continuing to meet UK military needs is the ambition over the coming decades. Maintaining high quality, specialist skills within the maritime sector and focussing on markets in which the UK can successfully compete such as retro fitment, fitting of advanced technology post build and fit-out of luxury and leisure vessels will be crucial. As a major exporter of maritime equipment and systems, the UK has a platform on which to develop more advanced technologies, and exploit wider sectoral opportunities e.g. wind and tidal energy and coastal and short-sea shipping.

64. Closer links with academia, SMEs and maritime colleges will ensure there are the suitably skilled professionals needed for the future. Better use of existing centres of excellence (e.g. National Composite Centre) or development of additional centres if needed, is envisaged. Building on existing successes in the ship and boat building and marine engineering sectors, government will support the industry in developing facilities that maintain the UK's status as a world leader in these areas.

Shipping in the supply chain

65. The UK will continue to be a global shipping destination for both international deep-sea cargo movements and more regional short-sea shipping. The adoption of new technology on vessels and port side, incorporating the latest developments in autonomy, new fuels and supply chain logistics is expected through to 2050. The volume of short-sea shipping and movement of domestic freight between UK ports is likely to increase, potentially becoming a viable alternative to road and rail and boosting opportunities for a wide range of ports. Ports will need to invest to keep pace with technological and environmental advances and vessel types, particularly those involved in short-sea and coastal shipping markets, to ensure increased competitiveness versus land-based freight modes. While there is some uncertainty, it is likely that vessel size will increase requiring upgrades to physical infrastructure such as dredging, quays and cranes to maintain port effectiveness and ensure the UK continues to attract vessel calls on key global shipping routes.

Headline infrastructure recommendations

- **Government will implement a targeted programme of Port Economic Partnerships**, for ports meeting specific scheme and success criteria, leveraging the maximum benefits from both government and industry investments.
- **Government will continue to consider the needs of the maritime sector as part of rail and road infrastructure**

funding to support the onward transportation of freight and passengers from maritime infrastructure.

- **Government will work with the leisure, superyacht and small commercial marine industry to ensure their needs are factored into the strategic growth agenda for the maritime sector**, in the context of government's Industrial Strategy.

Security and resilience

66. Maritime security is without question essential to the UK's national interest. Without the security of our ships, ports and services, our prosperity and resilience are at risk. The sector therefore requires policing and regulation at the national and international levels, the UK is committed to strong global partnerships to enforce these. For the UK maritime sector, its security is about providing business continuity free from interference and disruption.

67. The security of our maritime domain presents additional challenges compared to those on land, with the UK being one of many nations seeking to deploy diplomatic, military and law enforcement powers. Security threats are constantly evolving and the UK is committed to being at the forefront of anticipating and responding to these. Technological advances offer opportunities yet also present some of the greatest security challenges, for example cyber-attack. We will develop our national expertise, sharing this with international and other sectoral partners in the common interest.

Security of UK waters – including Overseas Territories

68. Monitoring and control of UK waters will require an intelligence led, multiagency response capable of covering a large geographical area that encompasses resources such as offshore energy generation. The UK will maximise its use of developments in automated systems and technology to ensure effective surveillance and continue to support a rules-based international system (RBIS), working closely with NATO and European partners. The UK will be world leading in maritime domain awareness with regular review of the threat landscape and the processes in place to deter and counter threat activity.

Security and resilience at ports and on ships

69. Technological advances will drive changes to shipping and port operations in the coming decades. Improved cargo and passenger screening, operational efficiencies and more frequent severe weather events are anticipated. UK trade interests will be protected by leading

efforts to develop internationally accepted standards and regulations in line with these changes. Port infrastructure will be susceptible to flooding, risking onward disruption to connected services such as electricity, road and rail. Industry has a role to play in 'investing to protect' at ports and on ships, using innovative solutions, and government will support this through the provision of information to encourage and enable informed investment.

Global shipping route security

70. Global economic power is shifting eastwards and the balance of power may alter. The UK is heavily reliant on imports of food, fuel and other goods which is anticipated to continue to 2050. Preserving freedom of navigation, in particular strategic choke points, will remain a priority. The UK will proactively work to strengthen existing alliances, work collaboratively to monitor contraventions of international agreements like the United Nations (UN) Convention on the Law of the Sea (UNCLOS), deter acts of aggression and mitigate increasing nationalist agendas by supporting rules-based norms.

Cyber - security of technology

71. The rate of technological change is likely to make critical national infrastructure increasingly vulnerable to cyber-attack. The UK has committed to lead development of appropriate standards, regulations and guidance in these fields. The onus is on industry to protect themselves and ensure resilience to cyber threats across the supply chain. However, this will be in lockstep with government, who will provide threat and risk assessments, regulation and guidance to ensure that collectively, the UK is a centre of excellence for the provision of maritime cyber security solutions.

Terrorism

72. The global terrorist threat is highly likely to persist to 2050 and beyond. Conflict zones, failed states and the internet will provide a platform for terrorist activity. This may involve attacks on shipping where areas and groups are in close proximity to shipping lanes. Attack methodologies may change through exploitation of new or emerging technologies e.g. drones, and the UK must be alive to evolving threats in its maritime domain, both here and in Overseas Territories. A multi-agency, cross departmental response in close collaboration with international partners and industry is needed, including capacity development in vulnerable countries.

Maritime crime and piracy

73. The nature of global maritime trade means it will continue to be exploited by criminal groups, including activities such as smuggling and people trafficking. More complex, connected systems will present

opportunities for interference and theft but conversely, technology may also help monitoring areas of concern worldwide. Conflict, poor economic development and climate change in coming decades may lead to more failed or poorly governed states, increasing conditions conducive to criminal and pirate activity. The UK will continue engagement with foreign partners to improve law enforcement and legislative capability and capacity in those areas that suffer from organised criminality and piracy. Government will work closely with industry to keep guidance under review and remain responsive to changes in maritime criminal activity.

Headline security and resilience recommendations

- **Government will support international efforts to maintain freedom of navigation across shipping routes.** Where nation states ignore rules-based international system norms, or pose threats to the freedom of navigation (such as blocking strategic international chokepoints or making excessive geographic jurisdictional claims) we will affirm the RBIS framework and requirements of international laws.
- **Government will assess the feasibility of undertaking a systems approach to identifying single points of failure for maritime infrastructure** – looking “beyond the fence” to identify interdependencies of connected infrastructure, supply chains and their levels of redundancy.
- **UK will continue to be alive to evolving terrorist threats** – in both their identification and the mitigation options required – working closely with industry to deliver solutions.

1. Introduction

1.1 A maritime strategy for the UK

Maritime 2050 is an exciting initiative setting out a long term strategy and high-level vision for the future of the UK maritime sector through to 2050. It provides a framework that will inform government policy development and industry decision making as well as giving even greater confidence to potential investors in the UK economy.

It is a blueprint to harness the UK's strengths, understand how we can reach our full potential and demonstrate our ambition to continue to be a world maritime leader. It is the opportunity for us to position the industry to meet the challenges ahead and create a sustainable long term future for UK maritime.

The strategy identifies the challenges and opportunities that are likely to emerge over the next 30 years, enabling the UK to take full advantage of the new horizons now opening up and remain in the front rank of leading maritime nations. It also contains a number of measures to follow up on the government's main priorities. The breadth of the UK maritime sector is far reaching, including not only shipping and ports but a range of other activities such as training, business services, engineering, manufacturing, research and development. The sector as a whole is greater than the sum of its many parts. It is also inexorably linked with a much wider set of supply chain logistics and many other sectors which rely on maritime for their success. Only through government and industry working together will we be able to successfully navigate through to 2050.

The UK maritime strategy does not stand alone. Together with other relevant national, and international policies it will ensure that the sector continues to benefit the whole of the UK. Maritime 2050 builds upon the extensive body of work already dedicated to the role of the maritime sector in the UK, including the MGS, the Foresight Future of the Sea report¹² and the PCS¹³. It sits alongside other government strategies and is supported by specific sectoral plans¹⁴.

Through the Maritime 2050 vision and route maps, setting out measures necessary to achieve the ambitions of this strategy, we will continue to position the UK at the forefront of the international maritime community, taking advantage of the drive for innovation, and capturing opportunities for the UK maritime sector.

¹² <https://www.gov.uk/government/publications/future-of-the-sea--2>,

¹³ <https://www.gov.uk/government/publications/transport-connectivity-to-ports-review-of-the-current-status-and-future-infrastructure-recommendations>,

¹⁴ These include the International Ocean Strategy, the [Industrial Strategy](#), the [National Shipbuilding Strategy](#), the [25-year Environment Plan](#), the [Clean Air Strategy](#), the [Clean Growth Strategy](#) and the [Export Strategy](#).

1.2 About this document

This document sets out a cross government and industry set of objectives and priorities against which government and business can plan for the long term. The document includes strengths, opportunities and risks for the future of the sector.

Chapter 2 describes the core values and strategic ambitions that underpin this work and which will be used to guide subsequent actions as part of our future work programme. This is followed by a description of the current baseline for the global and UK maritime sectors. The importance of the relevant social, economic demographic and other trends for these sectors is discussed in chapter 4.

The Maritime 2050 strategy is built on seven high level themes: UK competitive advantage, environment, infrastructure, people, security, technology and trade.

Chapters 5 to 11 discuss each theme in detail and are further divided into sub-themes, exploring the strengths, opportunities and risks for the future of the sector as well as the journey to reaching our 2050 vision. Recommendations are listed against each sub-theme.

An overview of the nation's history is annexed to the strategy. It outlines the development of the global maritime sector, the UK's place within it and what led to the maritime sector we see today. A number of lessons upon which we can build are identified.

2. Values and strategic ambitions

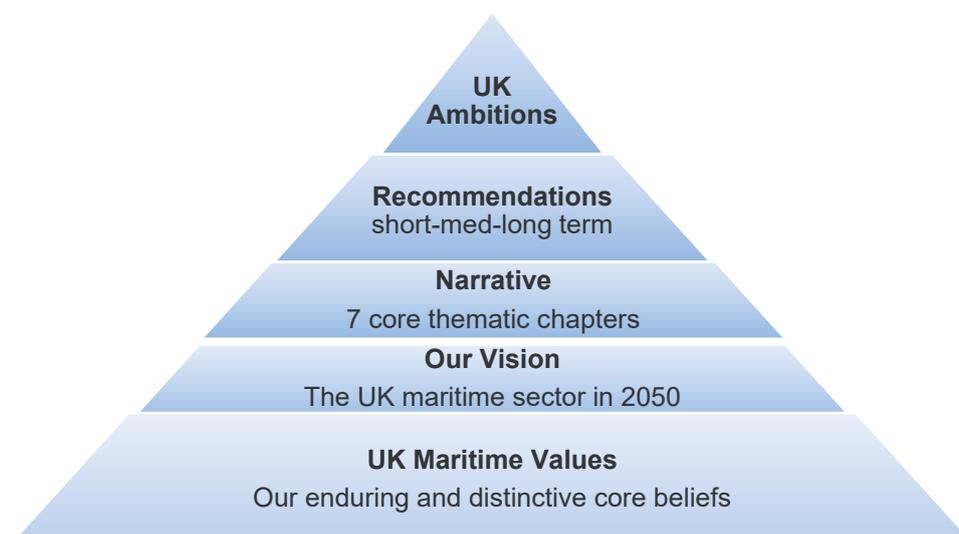
We have developed this strategy around a set of five building blocks which give the report its structure and also define the path ahead to 2050 and beyond. Underpinning our work is a **set of five values**.

Building on this, in each of our seven thematic chapters, we set out bold **visions** for the UK maritime sector of 2050 which define where we expect and want to be. Each chapter has a detailed **narrative** which describes in detail where we as a maritime nation are now, where we want to be in 2050 and how we get there. This is a narrative that has been defined by the call for evidence, the extensive engagement across the maritime sector and beyond throughout the year and with the guidance and challenge of the Expert Panel.

Each thematic chapter includes a comprehensive set of bold and ambitious recommendations. We identify recommendations for the short (1 - 5 years), medium (5 – 15 years) and long (15 years and beyond) term. In a strategy that is as wide-ranging as this we can be confident in our recommendations but the further into the future we go the more there will be new disruptors, unknown challenges and challengers and unpredicted events. Our recommendations define actions for the government and the maritime sector to take, both individually and collectively. The maritime sector encompasses the full breadth of small and large companies, leading representative organisations, social partners, academia and charitable organisations.

And at the top are a set of **10 strategic ambitions** around which our strategy coalesces. These provide, in their simplest form, our bold and aspirational objectives as we head towards and beyond the second half of the 21st century.

A series of thematic route maps will be published in 2019 detailing how these strategic ambitions and values will be embedded into government and industry action in the coming years, helping us to achieve our vision for 2050. The following diagram sets out the building blocks:



2.1 Maritime 2050 strategic ambitions

Our ten strategic ambitions reflect each of the themes in our strategy. While they are not the only focus of our attention, they define some of the very most important aspirational objectives for government and the UK maritime sector. We look to all those involved in driving Maritime 2050 forward to work collectively in the pursuit of them.

Maritime 2050 Strategic Ambitions

- Maximise our strength in maritime professional services, retaining and enhancing our **UK competitive advantage** in the provision of maritime law, finance, insurance, management and brokering, and developing our green finance offer.
- Lead the way in taking action on **clean maritime growth** enjoying economic benefits from being an early adopter or fast mover.
- Strengthen our reputation for maritime innovation, maximising benefits to the UK from new **maritime technology** through our world leading universities, maritime SMEs and global companies.
- Continue to be recognised as the global leader in **maritime safety and security** standards and expertise worldwide.
- Grow our **maritime workforce and transform their diversity** enhancing our reputation as the world leader in the provision of maritime education and training.
- Promote a **liberalised trading regime** that delivers maximum benefit for our maritime sector.
- Support the continued multi-billion pound commercial investment in **maritime infrastructure** that makes the UK a globally attractive destination for all maritime business.
- Strengthen and enhance our reputation as a **leading country in the IMO, ILO and all international fora** working with like-minded countries to take action.
- Promote our **UK wide leading maritime cluster offer** with government, the maritime sector and academia working in partnership to make the UK the place to do maritime business.
- **Showcase our UK maritime offer to the world**, promoting all parts of the maritime sector including shipping, services, ports, engineering

and leisure marine, and through London International Shipping Week maintaining its status as the leading global maritime event.

2.2 Maritime 2050 values

If our strategic ambitions describe what we are seeking to achieve, then our values are enduring and distinctive core beliefs, forming an essential part of developing this strategy. As part of the foundation for Maritime 2050 they will guide the activities and goals of this strategy.

Our values establish why we do what we do and what we stand for. They will be instrumental in influencing the attitudes and behaviours of all those involved as we develop the capabilities and capacity to meet the challenges of the long term future and exploit the opportunities that arise, for the maritime sector. We have set five core values that underpin this work. These are:

- **A premium brand, not compromising on safety:** the UK's global reputation for quality will underpin its offer. The UK is renowned and respected in the maritime world for its unwavering approach to quality services and standards supported by UK expertise; we will not diminish those expectations in the pursuit of market share, and aim to go beyond where appropriate. We will always choose to protect the well-being of crew and other personnel and the safety of life at sea and in ports. We will maintain the highest standards of training.
- **A balanced set of priorities:** we recognise the challenges of and potential conflicts between the demands for prosperity, sustainability and security when growing the economy. We will always work towards a balance between the three, and reject policy and delivery approaches which deliver one at the expense of the others.
- **A commitment to the rules-based approach:** to maintain its place as a global trading nation while maximising its competitive advantage, the UK will play a leading and influential role in the maintenance of a rules-based global system, defending and promoting international organisations and approaches, and supporting the global fight against all kinds of threat¹⁵.
- **A truly global United Kingdom:** we will champion an open international trading environment, to build sustainable global prosperity. We will pursue advantageous partnerships right

¹⁵ The UN Convention on the Law of the Sea sets out the legal framework within which all activities in the oceans and seas must be carried out and is of strategic importance as the basis for national, regional, and global action and cooperation in the marine sector. Its integrity, therefore, needs to be maintained.

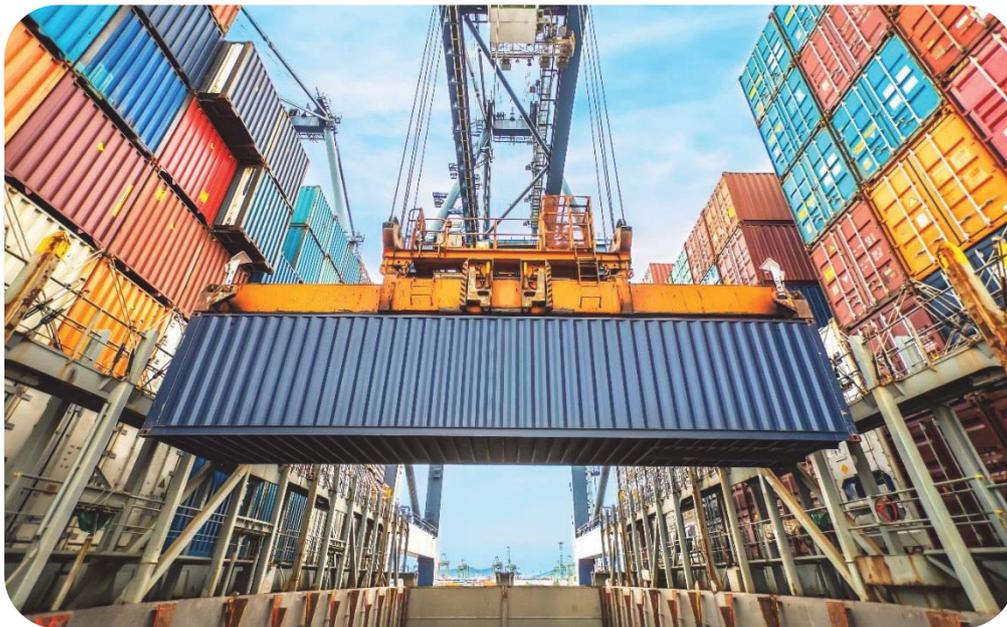
across the world, ensuring the UK's competitiveness, and seek to remove barriers wherever possible. The value we place in our global outlook will be clear in the IMO, ILO and other global fora where we will actively seek to lead and collaborate with like-minded partners.

- **Real partnership between government and industry:** The government and industry partnership is of fundamental importance to ensuring that the UK can be proactive in its response to change, opportunity and challenge. Only by working in full co-operation will the UK reach its full potential.

3. Maritime today

The global maritime industry acts as a key enabler connecting nodal points of the world economy. In recent decades, the near exponential increases in shipping volumes have provided many benefits to the UK, but it has also seen a shift in the industry eastwards, challenging the UK's historical position of strength. In each of the key themes identified in this report, several distinct challenges and opportunities present themselves to the country. These include long-standing, well known issues that the industry is still seeking to tackle effectively, as well as more recent developments, often surrounding new technologies. With the right approach, the UK stands to be at the forefront of the new global maritime industry. Geography, innovation, invention, and foresight; these are the aspects that have made Britain a world leader in the maritime sector, and they are just as present today as they ever have been in the past.

This chapter charts the current state of affairs in the maritime industry, ascertaining the global landscape of the sector today and specifying where the UK sits within this international context. Before it can be understood where the maritime sector is going, it must be understood where it is coming from.



3.1 Global maritime

The worldwide trade of goods at the scale, cost, and ease seen today is only made possible by the maritime industry. The sector is the lifeblood of global trade; it is estimated that over 80% of all trade in goods are transported by seaborne means. In the past ten years global containerised trade has more than tripled to 148 million twenty-foot equivalent units (TEUs)¹⁶. This is a consequence of increasing demand, with several of the largest ships now

¹⁶ <https://unctad.org/en/pages/PublicationWebflyer.aspx?publicationid=2245>

capable of transporting over 21,000 containers at full capacity. At the turn of the millennium, the equivalent figure for the largest ships stood at just 9,000.

These increased trade volumes are also indicative of the eastward shift of manufacturing supply chains, as Asia has continued to grow its manufacturing output. For example, liner trade – the transportation of goods by oceangoing cargo ships following regular routes – is dominated by the export of Chinese goods. The appetite for Chinese exports informs why the volume of liner cargo from China is more than three times that of its nearest rival, the US.

This eastward trend also highlights the causal relationships between the state of the global economy and international seaborne trade flows. In recent years, only global recessions and fluctuating commodity prices have intermittently stymied the growth in shipped goods. However, such are the numerous and interlinking mechanisms between macroeconomic forces and the flow of goods, research has suggested that factors as seemingly disassociated as worldwide interest rates and shipping speeds are interlinked and cargo bought on credit must be shipped faster to minimise costs when rates are high.

Maritime interconnectedness is a key determining factor in any coastal country's economic health. As a result, strategic chokepoints on busy shipping lanes around the Malacca Straits, the Straits of Hormuz and the Suez Canal create a vulnerability in global economic trade, with potential implications for foreign policy decisions. Any understanding of the UK maritime sector today must therefore be made with an awareness of the extent to which the industry informs, is informed by and is vulnerable to, international conditions.

Modernisation of maritime infrastructure is driving the focus of global trade. A notable example of infrastructure upgrades acting as a catalyst for change in the wider industry can be seen in the recent upgrades to the Panama Canal. The widening of the Panama Canal, a project completed in 2016 following a \$5.4 billion investment programme, has enabled an almost tripling in the size of ships capable of traversing the conduit. This has encouraged the design and construction of larger ships, and in turn, the expansion of port facilities capable of servicing these vessels.

Indeed, as much as the expansion in ship size has facilitated increased trade flows, so the ability of ports to efficiently unload, handle, and transfer containers has assumed prime importance in making the shipping supply chain as efficient as possible. In this regard, the upgrading of port connectivity infrastructure – systems to smoothly transfer containers from ship, to rail, to road – have revolutionised the size and scale of the shipping industry.

Despite recent infrastructural advances, further improvements are already underway. Most notably, China is pursuing a “One Belt One Road Strategy”, an initiative which aims to see the upgrading of several facilities on the ‘Maritime Silk Road’ that connects China and Europe. This activity reaffirms China's position as a major player in the shipping industry; any strategic outlooks must by necessity consider China's current plans to accurately appraise coming developments.

This hive of maritime activity witnessed in recent years has come with an environmental footprint. International shipping is responsible for 2.2% of global CO₂ emissions¹⁷ and, unless action is taken, this figure is expected to rise. Furthermore, technological advances in deep sea mining and continued overfishing have raised the question of how the oceans' resources should be managed to the top of policy makers' agendas. Hence, if the sector is to adhere to limiting global average temperature warming to below 2°C, as set out in the Paris Agreement, it has a responsibility to abide by and promote initiatives to reduce environmental impacts. Such actions are not solely constraints on the sector - they are also opportunities. Choosing to ship goods can often be a more environmentally friendly means of transportation than alternatives. In conjunction with emission abatement schemes, the maritime industry can seize upon this fact to champion its offering, aligning business and environmental concerns.

Technological solutions will be key to reducing the maritime sector's ecological impact. Hence, while the environment and technology comprise distinct themes in this report, there is significant crossover between these two areas. For example, improvements in fuel efficiency, introducing greener substitute fuels, and the adoption of exhaust gas cleaning systems, designed to capture emissions at exhaust are all important technological means by which the industry is already moving to mitigate its environmental impact. More radical initiatives underway include moves to integrate hydrogen fuel cells into ships, while companies such as the Japan-based Eco Marine Power are trialling zero emission cargo ships powered by rigid solar sails. This, along with other instances of cutting-edge R&D, are indicative of the leading role Japan and the Scandinavian countries are taking in promoting sustainable shipping. Indeed, fostering an environment where novel technologies can be trialled and first mover advantage is rewarded, is a key challenge to the industry.

Aside from environmental concerns, technological advances are shifting the outlook of the maritime sector more generally. Innovation has transformed the industry in recent decades and all signs suggest further disruptive technology will emerge. Two key areas of recent innovation have garnered attention, focussing upon the digitalisation of ports and shipping, and the introduction of autonomous vehicles.

The former has had a significant impact on the efficiency of port processes where ports such as Rotterdam and Singapore have introduced a spectrum of digital systems designed to ease the transfer of cargo. However, despite these advances, many other ports still rely on analogue, paper-based systems, particularly those that handle bulk goods. Until a critical mass of ports within the global network have fully integrated digital systems, shipping will continue to rely on analogue systems, at the very least as a contingency. Consequently, the global picture is uneven in relation to the digitalisation of ports.

¹⁷ Third Greenhouse Gas Study, IMO

Autonomous technologies are the second area in which disruption is occurring. A prototype of an autonomous ship has been launched by the US Navy, while there are several types of unmanned service vessels already available on the market. This technology is still in its infancy, however, and the current impact of autonomous vessels has been modest to date. This is, in part, explained by the relatively slow uptake of new technology in the sector. The life-cycle of ships is typically 25-30 years, and given these slow fleet turnover rates, ships with the latest designs often take some time to diffuse through the industry. Hence, much of the cutting-edge AI driven technology that captures the headlines remains in the beta-phase, albeit with undoubted potential.

Each of these changes in the technological stock of the industry will have an impact on those who work in the sector. The maritime industry conjures images of enormous ships, towering cranes, and vast seascapes. It should not be forgotten that underpinning this all are individuals earning their livelihood from the sea, controlling, operating and servicing these colossal machines. There are currently over 1.6 million seafarers worldwide doing so, predominantly originating from China, the Philippines, Indonesia, Russia, and the Ukraine¹⁸. Their work is often dangerous and high levels of worker welfare are typically lacking, with long periods spent at sea for modest remuneration. Indeed, their low level of pay is a principal reason why seafarers from these countries are so attractive to employers. Industry professionals do not only constitute seafarers; the entire ocean economy is directly supported by business and operational support staff. It should not be forgotten, therefore, that the phrase 'the maritime industry' is ultimately used as a short hand for the myriad human stories that comprise the professionals who make up the sector.

Those working in the sector today face several threats, both familiar and new. Piracy, an age-old scourge of life on the seas, has caught media attention in recent years. In 2017, an estimated 19 seafarers were killed in piracy incidents, and research suggests that piracy off the coast of East Africa has had an economic cost of \$29 billion over the period 2010-2017¹⁹.

Encouragingly, the threat of piracy has somewhat abated in the past few years. Conversely, the spectre of international terrorism remains prominent in the global security agenda, and the maritime sector has taken appropriate measures to ensure borders remain secure. Furthermore, while the usage of digital technologies has increased efficiencies, they have exposed a new point of potential vulnerability. Schooners and brigantines were the tools of choice for corsairs in ages gone by. Today those that wish harm upon mariners may do so with a laptop and targeted software. Increasing the resilience of the industry to these threats is a top priority if technological advancements are to become points of celebration and not fear.

¹⁸ BIMCO Manpower Report, 2015

¹⁹ The State of Maritime Piracy 2017, One Earth Future

Together, the above picture is one of a sector in transition, managing the move from west to east and analogue to digital. Despite this shift, Europe will remain a key player in the maritime industry. Likewise, analogue and mechanical technologies will continue to play their part. The sail boat has, after all, not been fundamentally altered for centuries. It is in specifying where innovation will replace existing technologies, and how these will integrate with the larger industry, that the challenges and opportunities exist.

3.2 Britain and maritime today

Within this international context, the maritime sector remains a vital part of the UK economy, and in turn, the UK remains an important player in the international maritime sector. The competitive pressures resultant from the entrance of new international players have already seen significant change to the UK industry in recent years. These developments have challenged the UK's position of dominance in some areas of the sector. In others, the UK remains at the forefront of the industry, most notably in services, although here too pro-activity is required if the UK is to remain a leading light. Across the themes of this report, specific challenges and opportunities are uniquely faced by the UK. To understand how opportunities can become realised long term achievements, the current baseline of the UK maritime industry across the themes of this report must be established.

The shipping industry is a critical element in the UK trade in goods. Around 95% of British imports and exports in goods are moved by sea, including 25% of the UK's energy supply²⁰ and almost half of the country's food supplies²¹. Reliable and timely importation processes therefore constitute not only a bedrock of the national economy, but a foundation to the UK's national security. In total, the industry contributes £14.5 billion to the UK economy, directly supporting an estimated 186,000 jobs - a figure which dwarfs the numbers employed in the defence, aerospace, and motor vehicles sectors²². The UK port sector is the second largest in the European Union, handling around 5% of the world's total maritime freight traffic at some point in its journey.

Moreover, aside from the trade in goods, maritime plays a key role in the tourist and leisure industry with nearly 2 million cruise passengers passing through UK ports in 2016²³. 85% of these passengers passed through Southampton, making it Europe's most popular port for starting cruise liner journeys²⁴. With British cruise line companies including Cunard Line, Carnival Cruise Line and Saga Cruises, the maritime leisure industry is an important strength of the UK economy.

²⁰ <https://www.gov.uk/government/publications/maritime-successes-2017-to-2018>

²¹ Maritime Annual Report 2017-2018, Department for Transport

²² Maritime Sector Report 2017, CEBR

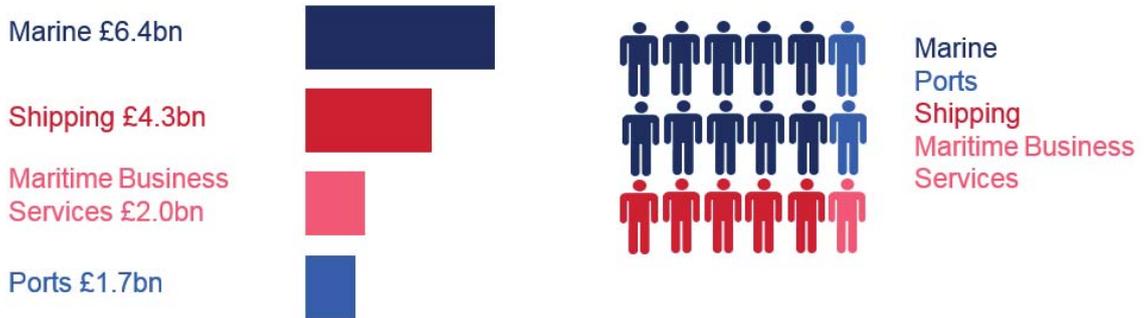
²³ Sea Passenger Statistics, 2018, Department for Transport

²⁴ <https://ec.europa.eu/eurostat/web/products-eurostat-news/-/DDN-20170810-1?inheritRedirect=true>

In 2015, the UK maritime sector directly contributed:

£14.5 billion GVA

186,000 jobs



Including the value generated and jobs supported in industries that supply the maritime sector and from the spending of maritime employees' wages, this rises to:

£37.4 billion GVA

957,000 jobs

Source: The economic contribution of the UK maritime sector, CEBR

Figure 1 - Contribution of the maritime sector to the UK economy

In addition to shipping and leisure, maritime business services constitute a key area of the UK economy, contributing over £2 billion GVA in 2015. The City of London is the global leader in this area; the largest share of worldwide maritime insurance premiums and shipbroking transactions occur in the UK. Important actors in this business sector are based in London – notably Lloyds of London and the Baltic Exchange. Competition from the east has however, affected this part of the industry just as it has shipping. The Baltic Exchange for example while still based in London, was acquired by the Singaporean Exchange in 2016. Recognising and promoting the world class offering British businesses provide will therefore prove vital to ensuring that UK maritime services continue to thrive at the forefront of the industry.

Significant recent investments have been made to the UK's maritime infrastructure to ensure the nation continues to have first class capital assets. The London Gateway, opened in 2013 after a £1.5 billion investment, is the UK's newest port and can now accommodate ultra-large containerships. Moreover, a suite of investment projects have been announced across UK ports: Aberdeen is constructing an additional harbour to boost marine capacity at an expected cost of £350 million; Liverpool has announced half a billion pounds worth of investment in upgrading their container terminal; and Associated British Ports (ABP), who control 21 ports across the UK, are undertaking a £1 billion five-year investment programme across their sites. These are just a selection of the projects British ports are undertaking to ensure that they are fit to handle the demands of 21st-century maritime trade.

The UK has also been forward thinking in its global outlook. The country has played a leading role in promoting the agenda for a reduction in emissions from the maritime industry through international fora, most notably the IMO. The IMO is the only UN body based in the UK, and the UK has continued to press for climate cooperation through this avenue, helping to agree the target of a 50% GHG emission reduction from the maritime sector by 2050.

Closer to home, the UK has invested in maritime infrastructure aimed at promoting the uptake of carbon neutral fuels. Immingham boasts the world's largest dedicated biomass handling facility which recently accommodated the largest ever single shipment of biomass, ultimately destined for the Drax power station. Looking forward, a £100 million investment in biomass silos at the port of Liverpool has been earmarked, further highlighting the UK's commitment to environmental goals and the leading role business can play in achieving these. Wider changes to the nation's energy mix arising from decarbonisation are also affecting the industry. For example, coal shipments passing through UK ports were reduced by 78% in the period 2007 to 2017, while crude oil port traffic fell by 38% over the same period²⁵. Changes in energy commodity flows will surely continue, albeit in uncertain ways, but what can be sure is that the UK maritime sector will have to remain vigilant and agile if it is to take advantage of the global move to decarbonisation.

Technological developments are not only occurring externally to the UK, however. The country has world-class universities and a long history of innovation and invention; the light bulb, the telephone, the World Wide Web, the television, and the jet engine are all British born creations. In the maritime space, the screw propeller and RADAR are two innovations still prevalent today that the UK was instrumental in conceiving. The global technological landscape would not be what it is today but for the UK's contribution.

This rich history continues – several British companies are producing early-stage autonomous vessels, such as the SEA-KIT unmanned vessel that stands to enable long-range oceangoing journeys of over 10,000 nautical miles. This is indicative of the UK's heavyweight ability in the technological sphere, punching above its class in terms of size and funding. Continuing this rich tradition and leveraging the country's outstanding human capital to promote cutting-edge R&D on both port-side and ocean-side projects is therefore a top priority.

The UK's history of innovation is fundamentally based on both the enterprise and education of its people. The UK is a world leader in this regard: providing high-level training for people within the maritime industry; acting as an important source of thought leadership; and setting the benchmark for the promotion of industry standards in safety, regulation and seafarer welfare. In particular, the government have part funded the Support for Maritime Training Programme (SMarT) aimed at boosting the number of seafarers trained in the UK. The UK thus remains one of the largest provider of maritime training in

²⁵ Port Freight Statistics, 2017, Department for Transport

the world and has historically led the way in its quality of British officers and ratings produced from naval training centres.

The number of UK seafarers has declined in recent years, but the impact of the country on providing training remains exceptional. Seafaring is an arduous career involving significant periods of isolation at sea and modest wages suppressed by an international labour supply. This has resulted in a shortage of British seafarers. While the current initiatives have boosted the numbers in training, the latest figures continue to pale in comparison to historical levels. Indeed, this is partly reflective of the wider historical trend of larger ships being staffed by fewer and fewer seafarers. This trend will not be reversed – the impact of autonomous vessels may in the long term further reduce seagoing staff, engendering changes in the desired skillsets of industry professionals. In the nearer term technological advance may change the nature of seafaring and will complement roles. The UK can, therefore, continue to utilise its existing strength in academies and training centres to remain the go to site for the re-education and upskilling of staff.

An additional aspect of the maritime labour market, and one which equally concerns both the UK and the rest of world, relates to the male dominated maritime labour force, just 4% of the 10,480 UK certificated officers active at sea are female²⁶. Today efforts are underway to address this imbalance. An example is the Maritime UK partnership with a number of senior individuals in the industry to convene the Women in Maritime Task Force. This task force seeks to address fairness, equality and inclusion across the sector, and which in turn is expected to boost profitability by increasing the effectiveness and skill pool of the maritime labour force. This gender imbalance, which is mirrored in the global maritime workforce, presents a significant opportunity for the UK. By utilising the workforce more effectively, this issue presents as one in which the UK can be a standard bearer, thereby reaping rewards unclaimed by international competitors.

Protecting these people who work in the industry is an area in which the UK has excelled, continually striving for the highest standards in safety and security. The result is that the UK is one of the safest places in the world to do maritime business, and the country further bears its influence by actively promoting safety and security standards in international fora. Moreover, the emerging threat of cyber-attacks and the continued worry around terrorism are issues the country is tackling head on. Protecting entry points and sharing knowledge of security best practices internationally are two means by which this is being achieved. In prioritising actions against these threats and investing in best-in-class cyber security the UK currently offers a safe and secure place of doing business. Indeed, while the efforts to protect citizens and industry may attest to the threats faced in the current climate they ultimately attest to the UK's ability to provide an environment that is conducive to the protection of business interests, and first and foremost, to the safety of maritime workers.

²⁶ www.gov.uk/government/statistical-data-sets/seafarer-statistics-sfr

3.3 Conclusions

The above developments demonstrate the changing nature of the maritime sector. Competition from the east has impacted the UK's lead in several parts of the sector and in others threatens the UK's still dominant position. However, these changes do not only provide challenges – there are clear opportunities for the UK to leverage its strength in the sector by utilising and combining existing advantages across other parts of the UK economy.

On this broader note, just as the UK maritime industry must be seen in an international context, so the industry must be viewed in relation to the wider UK economy. Indeed, in many ways the maritime industry is a leading indicator – the canary in the coal mine – for the overall health of the UK economy. This relationship is symbiotic; a healthy maritime sector promotes and enables the flourishing of numerous other economic sectors and in turn, a healthy economy increases the demand for maritime services.

The maritime sector is, however, almost uniquely exposed to international macroeconomic forces. Consequently, the industry is likely to feel the effects of changing international conditions before they have fully percolated throughout the national economy. As such, challenges and opportunities present in the maritime sector may only reveal themselves sometime later across the wider economy. For this reason the maritime sector has a unique role to play in acting as a way finder, finding solutions to the coming problems of the day and being at the vanguard of innovation. This chapter has identified the UK's current position relating to the specified themes of the report. The task now is to identify how today's challenges are addressed in the future and to anticipate new challenges that are likely to arise on the long term strategic horizon.

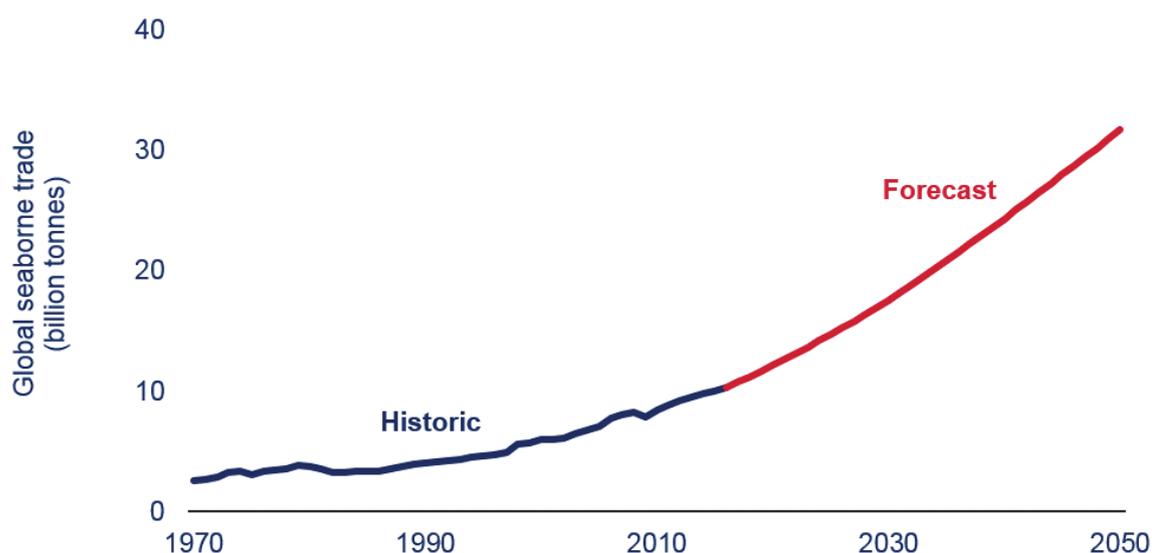
4. Maritime trends

4.1 Future trends

The maritime sector operates at an international level, and is affected by global shifts and trends. The world in 2050 will look very different to how it does today and the maritime sector will need to react to those changes. Examining future trends can help us to plan for an uncertain future. Shifts in the shape of the global population, economy, and environment could affect how and where it operates, and present a range of challenges and new opportunities.

Growth in seaborne trade

The main opportunity is the continuing growth in seaborne trade and with it, the demand for maritime services and products. There is currently no sign of a decisive shift away from shipping as the dominant mode of transporting large volumes of cargo over long distances. At a global level, the volume of goods transported by sea has historically grown more quickly than the economy. Applying this relationship to Organisation for Economic Co-operation and Development (OECD) forecasts of world GDP growth, implies that the demand for cargo to be transported by sea will more than triple by 2050. Although this forecast is simplistic, the message is clear: that by 2050 the global maritime sector will be handling a lot more cargo than it does at the moment. This is a major commercial opportunity for the maritime sector as a whole, and gives the UK an opportunity, as a major maritime nation, to benefit from, and help drive that growth.



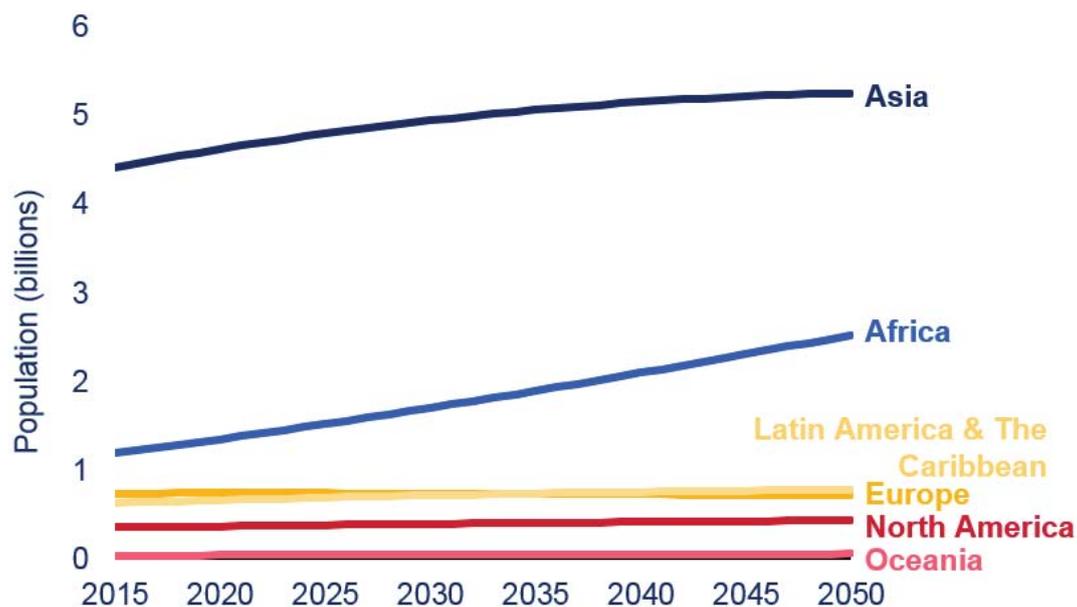
Source: UNCTAD, OECD, DfT Calculations

Figure 2 - Projections of global seaborne trade

4.2 Shifting shape of the world population

Africa's youth bulge

Over the coming decades, an important trend is expected to emerge in the world's population: the African Youth Bulge. Although Asia is the most populous region and has seen a huge increase over recent decades, it is Africa where population is expected to grow most over the coming decades. Infant and child mortality has been falling and fertility rates have remained high: the average woman in Sub-Saharan Africa is expected to have 4.8 children in her lifetime, while the average woman in China or in Europe is expected to have 1.6²⁷.



Source: UN World Population Prospects 2017

Figure 3 - Global population projections

Nigeria is expected to see its population more than double by 2050, increasing in number by more than 200 million people. In contrast, Europe as a whole is anticipated to shrink by 25 million people, or about 3%, and the population of China is anticipated to shrink by over 30 million people or 2%, and be replaced as the most populous country by India. Conversely, the population of the UK itself is anticipated to grow by about 10 million people, equivalent to about 15%. This has the potential to increase the UK's importance relative to other major European countries.

Africa has massive economic potential. As one of the key drivers of economic growth, a rapidly expanding population in Africa could lead to a large increase in imports and exports, feeding demand for logistics provision, shipping

²⁷ <http://blogs.worldbank.org/developmenttalk/youth-bulge-a-demographic-dividend-or-a-demographic-bomb-in-developing-countries>

services, port infrastructure and so on. There is also uncertainty over whether enough good jobs can be created to meet the needs of the rapidly growing population²⁸.

Africa's future prosperity and stability largely rely on ensuring that good economic governance and institutions are in place, along with processes and infrastructure that facilitate trade. In some countries this will require significant effort and is far from guaranteed. Nevertheless, important structural economic reforms have supported improvements in productivity and economic growth in some countries, and there has been significant new investment in African infrastructure in recent years. For example, the Addis Ababa – Djibouti Railway provides an efficient freight link between Ethiopia, where the government has an ambition to become the leading manufacturing nation in Africa, with the Port of Djibouti, located at the edge of the Red Sea and home to a new free trade zone.

With political stability and good management, Africa could be on the cusp of a period of rapid economic change. If ports and their hinterlands open up more areas of Africa to participate in international trade, they can support new jobs and play an important role in African economies taking advantage of the opportunities that its demographics could bring. As wages increase and the population gets smaller in China, manufacturers may find it cheaper to move their factories to African countries, where labour and raw materials are plentiful. One crucial factor that would underpin their decision is the ease with which they can export the finished goods from the factories around the world.

The UK is well placed to support and also benefit from growth in African economies in several ways. Geographically, we are well placed to trade with rapidly growing economies in West Africa such as Côte d'Ivoire, Senegal and Ghana as well as Nigeria, already one of the UK's largest trade partners in Africa. Politically, the UK is already reaching out to economies across Africa, expanding investment and UK government presence, as well as focussing UK aid spending to support both economic development and the Prime Minister's ambition for the UK to be the G7's largest investor in Africa by 2022.

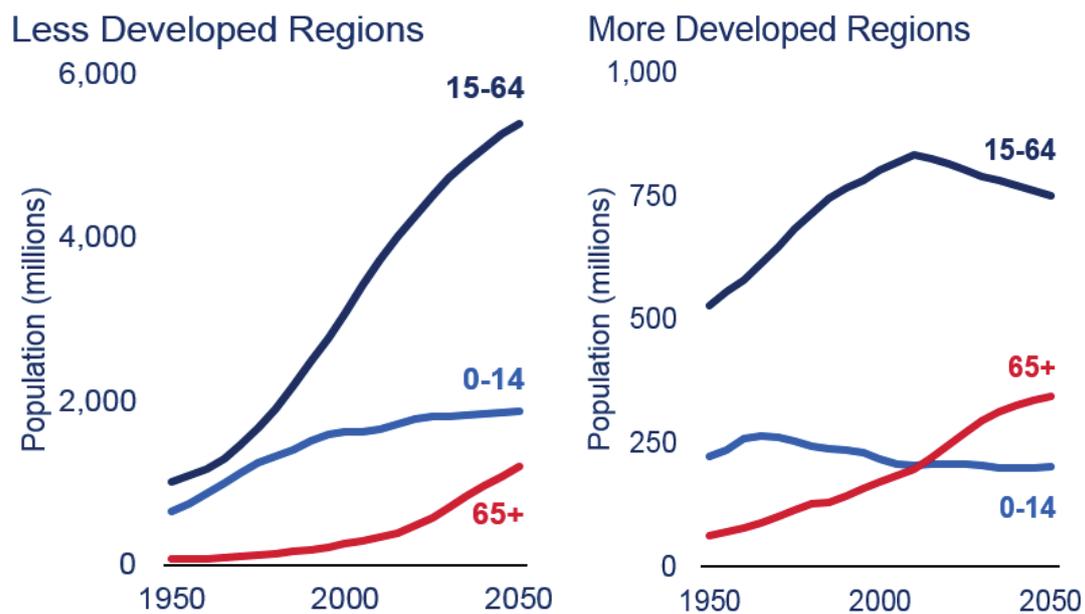
Ageing populations

Conversely, in advanced countries the population is ageing rapidly. People born in the few years following World War 2 are now entering their 70s, but the next few decades will see the much larger Baby Boom generation, born in the 1960s, reach their mid to late 60s, the age when people tend to retire. The number of people over 65 will rapidly grow, while the number of people under 65 will decline.

This demographic shift is likely to lead to changing patterns of consumption, which could impact the maritime sector, through its role in transporting consumer goods. People in older age groups tend to consume less in total than younger age groups, and tend to buy fewer durable products, spending

²⁸https://www.afdb.org/fileadmin/uploads/afdb/Documents/Publications/African_Economic_Outlook_2018_-_EN.pdf

less on items like clothing or cars but more on healthcare. This indicates that in rapidly ageing countries, demand for shipping services could be diluted and countries with younger populations could see an increase in demand for shipping beyond what their economic growth alone would suggest. This also poses a challenge to many industries regarding how they will find enough people to employ at a competitive wage. Industries have historically relied on employing and retaining younger people until they get older and choose to retire. The current model may not work in future, as demographics in more developed regions change.



Source: UN World Population Prospects 2017

Figure 4 - Population projections by age groups

As this challenge becomes more acute, there appear to be three main options to meet the challenges of continuing to operate with fewer people of traditional working age available from economically developed countries, all of which are already being used to some extent:

- Encourage and support older people to continue working later in life.
- Employ more people from, or in, less developed regions, where there is expected to be rapid growth in the population of younger people.
- Use more labour-saving technology.

Parts of the shipping sector face relatively few barriers to recruiting labour from all around the world, so should be well placed to meet the challenge of an ageing population in more developed regions. An encouraging trend for

industries who expect to rely on labour from overseas is that education levels are improving, which will in turn improve the skills available to them from around the world. Globally, the youth literacy rate has increased from 81% in 1986 to 91% in 2016, although there are still regional and gender disparities²⁹. This implies that when maritime companies are recruiting around the world, the necessary basic skills will be increasingly available.

For UK maritime firms, an ageing population makes the challenges they already face in promoting the sector as an attractive career choice amongst young people even more acute. With firms competing to recruit from a relatively smaller pool of young people in future, the maritime sector will have to make itself increasingly attractive if they want to recruit future seafarers from within the UK.

4.3 Shifting shape of the world economy

The economic centre of gravity

This growth in demand for shipping could also be a challenge as it is largely being driven by emerging markets such as China and India. Figure 5 shows how the global economic centre of gravity has moved further and further eastwards, from somewhere in the North Atlantic in 1980 to around Pakistan today, and is expected to move towards the border between India and China by 2050³⁰.

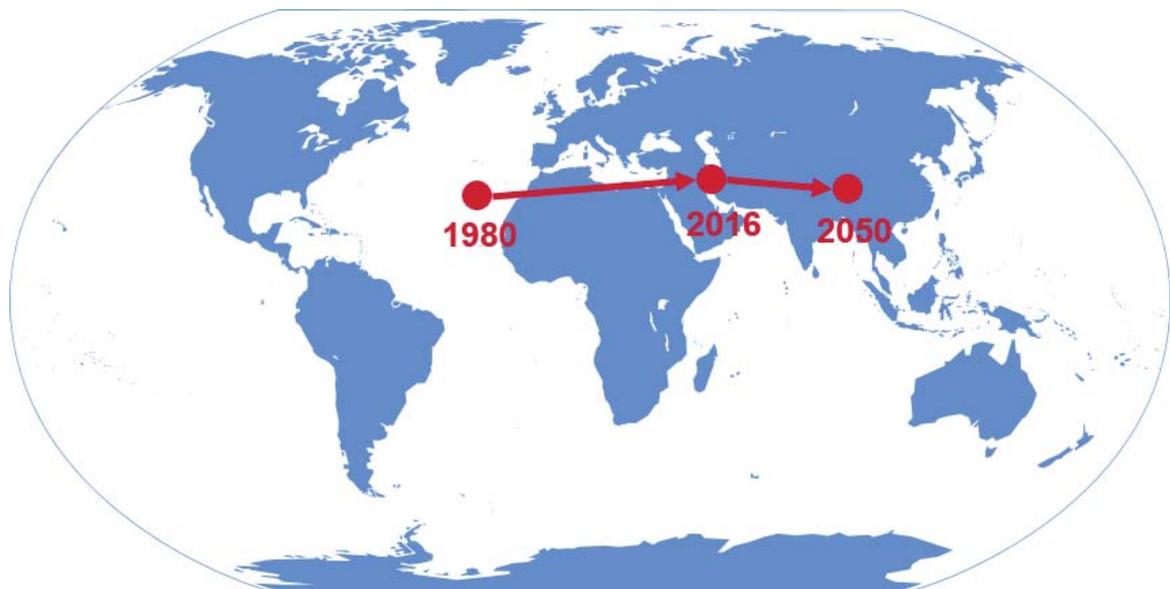


Figure 5 - Global economic centre of gravity, 1980-2050

The centre of the global economy is no longer on the UK's doorstep and it's getting further away each year. Ship ownership in China has been growing

²⁹ <https://data.unicef.org/topic/education/literacy/>

³⁰ <https://onlinelibrary.wiley.com/doi/full/10.1111/j.1758-5899.2010.00066.x>

significantly, and today only Greek ship owners have a larger share of the global merchant fleet than China and Hong Kong when counted together³¹.

The world's emerging markets and developing economies have moved from accounting for a little over a third of the world's economy in the 1980s to almost two thirds today³². China has transformed into an economic superpower - a manufacturing and export hub for the world. India's economy is also developing very rapidly, lifting hundreds of millions of people out of poverty³³ and leading India to play an ever greater role in the world economy.

Middle class spending power

The transformational growth seen over the past few decades in the developing world is leading to more spending power for people who have never had a disposable income before. As shown in Figure 6, it is anticipated that the middle class in Asia will grow by 153% by just 2030, adding two billion more consumers with a disposable income, demanding consumer durables such as televisions, refrigerators, and washing machines, and who are expected to spend around \$30 trillion each year more than they do today³⁴. This is just a suggestion of the huge scale of the opportunity the UK maritime industry can grasp by ensuring that they are prepared for the changes that we will see by 2050.

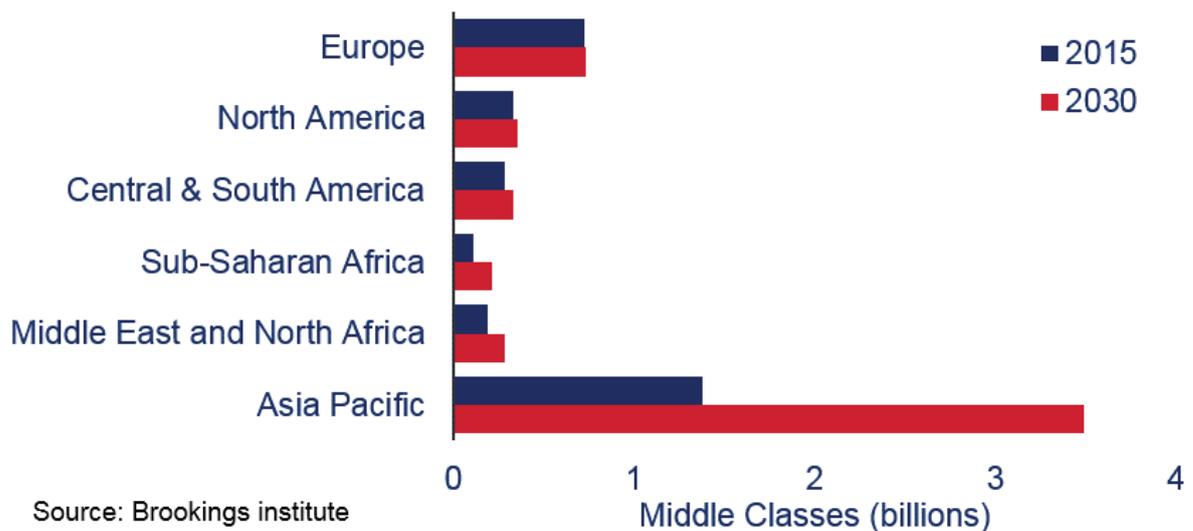


Figure 6 - Growth of the global middle class

The intra-Asia trade routes are already the world's highest volume container shipping routes, which are forecast to continue to grow rapidly. That trade is, at the moment, largely driven by final demand outside Asia, as manufacturers

³¹ https://unctad.org/en/PublicationsLibrary/rmt2017_en.pdf

³² <https://www.imf.org/en/Publications/WEO/Issues/2018/03/20/world-economic-outlook-april-2018>

³³ <https://worldpoverty.io/>

³⁴ <https://www.brookings.edu/research/the-unprecedented-expansion-of-the-global-middle-class-2/>

move components back and forth across complex supply chains before transporting the final products to foreign markets. With rising wealth in Asia, Asian countries will increasingly become the final destination for goods having been predominantly manufactured elsewhere. These producers may be increasingly in Africa, but UK exports of goods to increasingly wealthy countries can reasonably be expected to grow. With current major shipping lines designed around moving goods from Asia to the USA and Europe, in the future companies may focus less on connecting European and American consumers to Asian producers and more on connecting Asian consumers to the producers of the goods they wish to buy. This puts the onus on the UK ports sector to stay ahead of the curve on efficiency and for suppliers to the manufacturing sector to position themselves well for meeting the demands of the sector in the future around the world.

The rules based international system

The shifting shape of global economic power may affect the structure of the rules-based system that allows maritime to operate globally. The IMO and the UN in general, relies on support from around the world, and the most powerful countries in particular. The USA has been the most economically powerful country, with a dominant role in the global trading system since the early 20th century. By 2030, China is expected to become the largest economy in the world, followed by the USA and India.

With their rapidly growing economies, China and India will make larger budget contributions to the UN, where they are already enthusiastic participants in a broad range of initiatives. Larger budget contributions will increase their influence in the UN institutions (including the IMO) and they may become the de-facto standard setters and rule makers of the future. Alternatively, it could lead to a stalemate situation where there is no global agreement on how to proceed and standards become regionalised.

A parallel to this has already been seen in the WTO, where the Doha Round was paralysed by a lack of agreement from India and China to make concessions demanded of them by the most advanced economies. This lack of progress has led to a series of regional and bilateral agreements, establishing a fragmented and overlapping system of rules and standards that fails to include some nations, particularly smaller or less developed countries. The UK should push for an inclusive system for international rulemaking that allows constructive collaboration between a wide range of countries, in order to maintain a rules-based international system that works effectively and is accepted around the world.

There are, of course, many things that can throw these forecasts and predictions off course, but they represent the most likely direction of the changing world economy. Some countries that are expected to emerge as world economic powers in the coming decades will need to significantly restructure their economies to achieve this. Geo-political factors are likely to be the biggest risk to these projections and forecasts, as the systems that

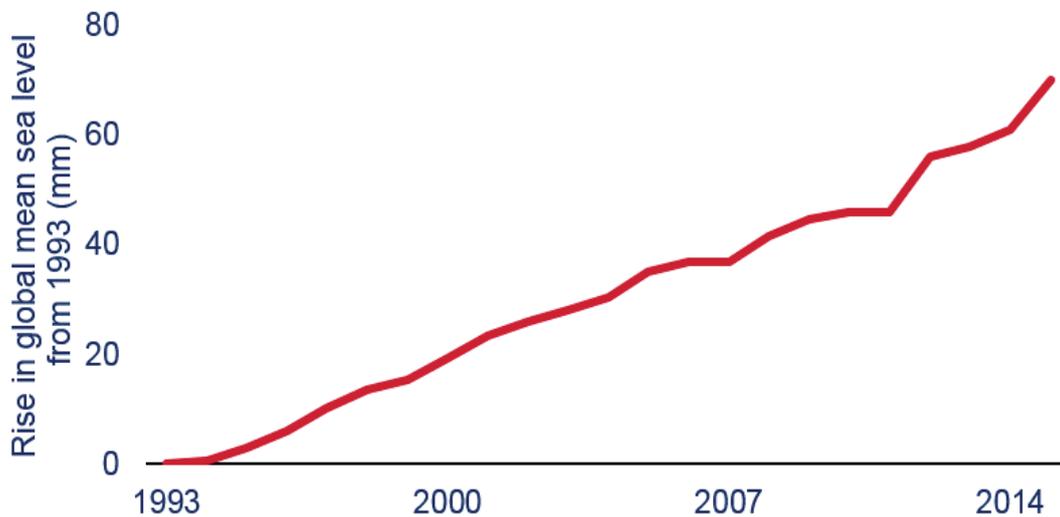
underpin the global economy rely ultimately on the people and authorities in the nations that they take place in.

4.4 Climate change

Sea levels

The global sea level has been rising at a rate of about 3mm per year, driven by the expansion of water volume as the ocean warms, melting of mountain glaciers in most regions of the world, and losses from the Greenland and Antarctic ice sheets³⁵. Projections of how much sea level will rise during the 21st century range from around 26cm to almost 1m³⁶.

Aside from the potentially massive economic impacts of more frequent flooding across the world economy that would have knock on effects for every sector, including maritime and the wider logistics and transport sectors, these projections should be a call to action for maritime organisations in particular. Port operations are, due to their coastal locations, vulnerable to rising sea levels. What is detrimental to ports will be detrimental to all of their customers and clients. Even with increased investment in flood defences or other adaptations, ports rely on other parts of local transport infrastructure for their hinterland connectivity. The sector needs to play a central role in a coordinated effort around the world to prepare for and mitigate practical impacts on the logistics system and coastal communities as a whole.



Source: European Environment Agency (rebased to 1993)

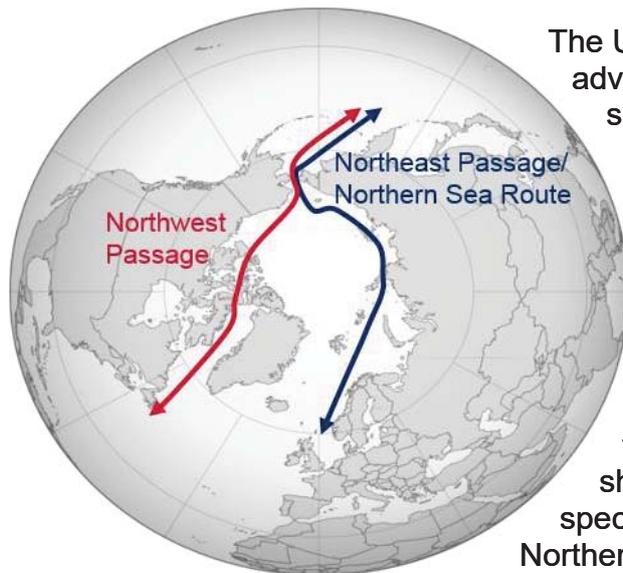
Figure 7 - Sea level rises

³⁵<https://royalsociety.org/topics-policy/projects/climate-change-evidence-causes/question-14/>

³⁶ ³⁶ https://www.ipcc.ch/site/assets/uploads/2018/02/WG1AR5_SPM_FINAL.pdf

Trans-Arctic shipping

The area covered by dense sea ice in the Arctic is shrinking at a rate of 12.8% per decade³⁷. This is exposing areas of Arctic waters previously hard to access, creating potential for new shipping routes. Using these routes could reduce travel time between Asia and northern Europe by 10-12 days. For example, using the Northeast Passage³⁸ could reduce the transit time between a Chinese port and a UK port from around six or seven weeks to around four or five weeks. This could not only save time but also fuel costs and fees paid to transit the Suez Canal.



The UK has a geographical comparative advantage when it comes to Arctic shipping. The ports on the east coast of Scotland and in northeast England are well placed to serve as a key node in Arctic shipping lines of the future. It is conceivable that seasonal maritime routes will open through the Arctic, though it is less clear to what extent year-round routes could open or when. The route is currently used for some oil and gas tankers for a short time each year, and in 2018 a specially built container ship followed the Northern Sea Route along the north coast of

Russia for the first time to collect information about the journey. Arctic shipping routes are currently relatively expensive because of very limited windows when passage is possible, the need for ice breaker escorts, reinforced ships and unpredictable conditions causing delays. A recent Danish study concluded that the Northeast Passage is not expected to be commercially viable for liner shipping until around 2040, taking into account the economic trade off of operating more expensive and smaller vessels through the Northeast Passage for a growing window of time each year with the time and fuel cost savings.³⁹

There are significant environmental considerations around an increasing amount of shipping accessing the Arctic Ocean and adjoining seas. Its unique ecosystems and environment are fragile and vulnerable. Increased shipping and the development of coastal infrastructure to support shipping could negatively impact this ecosystem, as well as the health and livelihoods of local Arctic communities who rely upon it as an important resource⁴⁰. Industry

³⁷ https://insidc.org/cryosphere/sotc/sea_ice.html

³⁸ The Northeast Passage / Northern Sea Route is the sea route between the Pacific and Atlantic oceans through the Arctic Ocean, along the coasts of Norway and Russia. The Northwest Passage is the sea route between the Pacific and Atlantic oceans through the Arctic Ocean, along the northern coast of North America.

³⁹ <https://services-webdav.cbs.dk/doc/CBS.dk/Arctic%20Shipping%20-%20Commercial%20Opportunities%20and%20Challenges.pdf>

⁴⁰ https://www.ipcc.ch/site/assets/uploads/2018/02/WGIAR5-Chap28_FINAL.pdf

practices and international regulations must ensure that the environment is a central concern in current and future plans⁴¹.

New technology will be required in order to meet the challenges of transport via the Arctic and to ensure the safety of crew, cargo and vessel. Alongside this, it is highly likely that there would be implications for insurance, environmental and labour regulation, and international agreement over territorial boundaries. In order to meet these challenges, and to ensure the UK continues to be well placed to benefit from the regular opening of trans-Arctic trade routes, consideration of the technological and regulatory challenges of Arctic shipping, both at a domestic and international level need to be incorporated into plans across a range of government and international institutions. Further, government must monitor the climatic, political and environmental factors involved in a more accessible Arctic. Finally, industry and government must work together to better understand what, if any, new infrastructure would be required to prepare the UK for this new trade route.

Weather

Another impact of man-made climate change is an increase in some extreme weather events. Extreme weather linked to climate change is increasing and likely to increase the risk of disasters in the future around the world. There is a major risk of human catastrophes in the wake of these disasters, which have the potential to cause regional or even global economic shocks⁴². There is also a risk that they will disrupt maritime infrastructure and the ability of affected countries to effectively engage in international trade. Without effective mitigation and adaptation, this will amplify the human and economic cost of extreme weather events, but with the proper preparation the maritime sector can build in resilience and play a positive role in helping disaster hit areas rebuild and recover.

4.5 Conclusion

Global population growth will be driven by countries in Africa, while global economic growth will be driven by countries in Asia. These developments and recognising the effects of climate change will affect the maritime sector are not new findings. They are the general consensus amongst forecasters and analysts. What is new is using these predictions and projections to shape the future of the maritime industry. We are scanning the horizon to ensure that the sector stays ahead of the curve in a changing world remaining competitive, agile and sustainable. If we achieve this together we have shown that there is a huge economic prize to be earned for the UK over coming decades.

The maritime sector is planning for the future, using its centuries of experience of adapting and thriving through change, to ensure that its future is even brighter than its past.

⁴¹ <https://www.gov.uk/government/publications/beyond-the-ice-uk-policy-towards-the-arctic>

⁴² <https://www.bankofengland.co.uk/-/media/boe/files/working-paper/2018/climate-change-and-the-macro-economy-a-critical-review>



5. UK competitive advantage

The UK's vision as the place to do maritime business

Throughout the world maritime will retain its central place as the enabler for global trade as it grows and stimulates global and regional economies. The UK will continue to play a leading role in this market. Many of its strengths will remain in areas such as the business service sector, in its leadership in the IMO and other international fora and in its attention to maintaining quality and strength in underlying principles such as safety. The UK will have additionally positioned itself to take advantage of new areas which develop through the period so that by 2050 the UK is at the forefront of innovation and productivity, academic research and thought leadership.

5.1 Introduction

The UK maritime sector has numerous strengths: in maritime business services; thought leadership; government and industry partnership; in seeking an appropriate and forward-looking regulatory framework; and in our ambition to strive for a safe and responsible maritime sector to name only a few. The purpose of this chapter is to highlight these strengths, ensuring that they are recognised and amplified in the long term. Secondly, this chapter highlights the inextricable linkages across the maritime sector all contributing to our success and our attractiveness globally as the place to do maritime business.

For example, the clustering of UK maritime businesses in hubs across the country creates a critical mass of expertise and knowledge. UK thought leadership draws academia to the country, enhancing the nation's maritime educational programmes. This in turn attracts innovative and ambitious businesses. Partnership between government, our leading representative organisations and social partners and industry creates a policy environment which is pro-business and can help it thrive in the long term whilst also recognising the fundamental need to support the people who make the maritime sector in the UK a success. Likewise, effective regulation and safety standards ensure that businesses can plan for the future knowing that their assets are protected underpinned by a supportive and intelligence led security offer.

This chapter therefore sets out some of the key sub-themes that make the UK maritime sector globally competitive. Many of them are strengths that competitors will struggle to match because they are based on years of expertise and knowledge. As with the MGS, this chapter also reinforces the message that we cannot rest on our laurels and need to take action in the short, medium and long term to retain and strengthen our leading maritime position globally. We can do this by:

- Promoting and enhancing the strengths we see in London but also amplifying the strengths of our regional maritime clusters across the

country, in places like Southampton, Liverpool, the Tyne and in Glasgow and throughout Scotland.

- Continuing and strengthening our role as innovative thought-leaders.
- Ensuring that already highly respected organisations like the MCA, the Marine Accident Investigation Branch (MAIB) and our General Lighthouse Authorities (GLAs) play a leading role long into the future.
- Maximising our role as leaders in the IMO, and having a domestic maritime regulatory regime that is fit for our 21st century maritime ambitions.

Absolutely fundamental to the UK's global competitiveness and attractiveness is the presence of the IMO in London. Throughout this strategy the ambitions in areas such as the environment, technology and safety all require strong and sustained leadership in the IMO and other global maritime bodies.

The UK will step up again its engagement in, and leadership of, the policy and regulatory discussions in the IMO. And the UK will actively collaborate with key partners to pursue an ambitious and responsive global agenda. It is a privilege for the UK to host the IMO, one that we recognise and will seek to maximise.

5.2 Fiscal competitiveness

Having an attractive and competitive fiscal regime is fundamentally important to our maritime success and our long term future. Attracting many ship owners, operators and managers to the UK is crucial. Our global success as a trading nation, and our consistent history as a country open for business underpins this. Competitive financial and tax regimes are critical though. While major ship owners, operators and managers have national origins, all are peripatetic and attracted by the most competitive advantages.



Our maritime cluster is crucial here. Our high performing port operations excel in providing the right commercial operating environment while our

maritime services sector provide world-leading insurance, legal and specialist services, all of which consistently rank at the very top globally. Our tonnage tax system, first introduced in 2000, has been competitive for a number of years and our work seeking to make the UK flag attractive has had some success in reversing a period of decline.

Where we are now

The UK is one of the most attractive countries in the world to do business⁴³. It is the number one country for inward investment in Europe and easier to do business here than any other major European economy. The current rate of corporation tax in the UK is 20% the joint lowest in the G20 comprising the world's largest economies. And in future years, corporation tax will continue to reduce to 17% from the year commencing 1 April 2020. Recognising our desire to be at the cutting edge of innovation and the need to support small and medium enterprises, a range of tax credits are available for research and development and patented innovations. Funding and financial opportunities are available for businesses who are seeking to invest in research, development and to support business growth.

The UK has a workforce of 30 million people, the second largest in the European Union with strong skills, high degrees of training and education but regulations that recognise our responsibilities to our employees. In the coming years we have a range of some of the most ambitious infrastructure projects across major sectors like telecommunications, utilities, energy and science. In transport alone, there is a £120 billion investment programme to improve our transport systems with major infrastructure projects like Crossrail, High Speed Rail and a seven-year investment programme to improve our roads.

These drivers of the UK economy are important to our attractiveness to the maritime sector. However, there are also specific incentives designed to improve our attractiveness to maritime companies. The UK's tonnage tax system, first introduced in the year 2000, has long been competitive and like all taxes, it remains under review by government. Recognising that the cost of training seafarers is high but fundamental to the success of the maritime sector, the government doubled SMarT funding which increased the incentive to companies and incentivised them to train cadets to a higher level. This aspect is explored in greater detail later in the People chapter. And schemes like Enterprise Investment and potentially Export Finance offer opportunities to the maritime sector to grow their business.

Risks, threats and opportunities

For some years our status as a leading global maritime player has been threatened, particularly on the basis of fiscal competitiveness. Eastern economies are noted for their pursuit of shipping operations with wide ranging, low and no tax schemes and other financial incentives. Competition is not solely from the Far East with some of our European counterparts seeking to offer attractive incentives and to modify their tonnage tax regimes.

Working together, both government and the UK maritime sector recognise the need to tackle this competition. Like all taxes, the tonnage tax regime remains

⁴³ <https://www.gov.uk/government/publications/rates-and-allowances-corporation-tax/rates-and-allowances-corporation-tax> and <https://www.gov.uk/government/publications/why-overseas-companies-should-set-up-in-the-uk/why-overseas-companies-should-set-up-in-the-uk>

under review by government, and the government is working in partnership with industry to better promote the strengths of the scheme today.

Government is working closely with the maritime professional services sector to maintain our fiscal competitiveness and this is captured in more detail in the Trade chapter. Throughout this strategy new ideas are put forward for increasing first-mover or early adopter opportunities on environmental, technological and infrastructure development. Strategies covering our role in the international oceans, on shipbuilding and on our industrial future, are all throughout this strategy and demonstrate the need for sustained investment and support for our maritime sector. Together, the government and the sector recognise that there are threats to our status but we are working constantly and determinedly to respond and to identify new opportunities to enhance the UK's maritime attractiveness.

Where we are going

The vision for 2050 is:

The UK will be a fiscally attractive country for the global maritime sector. Government, industry and our social partners will constantly work together to ensure we are competitive and identify first mover and early adopter advantages wherever available. We will work together to promote the UK maritime fiscal offer and encourage all maritime businesses to engage directly with us so we can demonstrate our competitiveness and be responsive to their needs. And where others may be able to demonstrate incentives, we will amplify the whole package that the UK maritime sector offers that makes us a more consistent, open and responsible place to do business.

How we get there

The government and maritime sector will work together to ensure the UK maritime fiscal offer is as attractive as it can be recognising our wider fiscal and tax principles. The role of our leading representative organisations like Maritime UK and Maritime London cannot be underestimated in working with government to respond to competition, identify new opportunities and to challenge government where needed.

More widely government needs to work closely with our leading maritime companies across the sector; our maritime services, our ports, shipyards, shippers and logistics companies and SMEs to ensure we have the best possible regime in place to support them and attract others to the UK. In turn government needs to constantly demonstrate that it is open to maritime business, that it wants to engage directly with all global maritime companies be they innovative small and medium enterprises through to the powerhouse maritime companies that drive much of our global maritime economy.

By 2050, long-standing fiscal and tax incentives may be long forgotten to be replaced by new and more dynamic offerings. Throughout this strategy new ideas will be promoted where the UK has an opportunity to lead the way.

Ambition will need to be coupled with appropriate incentives and the fiscal regime will be crucial. In other sectors we have already demonstrated an entrepreneurial spirit such as our global leadership and the incentivisation of clean and autonomous vehicles. Looking to the future of the maritime sector, there is a need to have that same level of ambition and agility to ensure that the UK maritime sector retains its competitive advantage.

Recommendations

Short term (1-5 years)

- Government and industry to work together to ensure we have the best possible fiscal regime in place, including through taxation and the business environment (see Trade chapter).
- Government and industry to better promote the existing fiscal regime better and to engage directly with international maritime companies.

5.3 The UK's maritime cluster

Clustering is a prime way in which a unique and attractive business environment can be created amongst businesses small and large, academia and government. Clusters create a critical mass of expertise and skills. Their partnership and close working drive innovation and ambition. For global companies considering where to locate their businesses or where doing business will be easy, a cluster is a highly attractive one-stop shop where efficiencies in their operations can also be realised. The cluster has a multiplying effect, the more it fosters innovation and expertise the more that it attracts the brightest and best from the workforce.

The vision for 2050 is:

The UK will retain a diversity of maritime clusters that excel in their respective specialisations. London will remain the leading professional services centre in the world, the leading maritime centre in Europe, and one of the top maritime centres globally. The UK will remain a highly attractive destination for maritime industry leaders and staff to work and live. UK-based maritime schools, colleges and universities will continue providing top-quality programmes and qualifications, providing the technologically advanced skills that will be required in the maritime era. The UK will maximise the benefit of its leading clusters across the country retaining London as the home for maritime business and the global home of the IMO. The UK maritime sector will be consistently recognised for the ease with which business is done and the way in which government and industry work as one to promote the offer.

Where we are now

No other country globally can match the UK's strength in its maritime clusters. These clusters include the maritime business services sector situated in the City of London and a huge and impressive array of maritime clusters based around some of our most important UK ports and shipyards such as Southampton and Liverpool and in Scotland. Then there is the cluster of organisations, often with UK leaders heading them up, that have located around the IMO's London presence, and the educational and energy services clusters that populate several cities across the land. More recent and relatively new clusters include the Scottish Maritime Cluster which has at its core a global strength in ship management and a leading educational offering. These hubs are a key advantage of the UK offer; providing an unparalleled level of expertise, innovation, ambition and an ease of doing business that is unmatched across the globe.

London's maritime business services sector is one key example of this clustering. It is the home of international maritime business. The country retains a plurality of market share in this sector with much of it based in the *Square Mile*. Insurance, shipbroking, legal, financial and accountancy services are all extensively offered in the UK, directly contributing £2 billion to the national economy. These maritime services are embedded within the City's wider financial sector where London continues to be a premier hub. This ensures that maritime business services have a supply of world-leading professionals attracted from across the world, from whom to draw expertise.

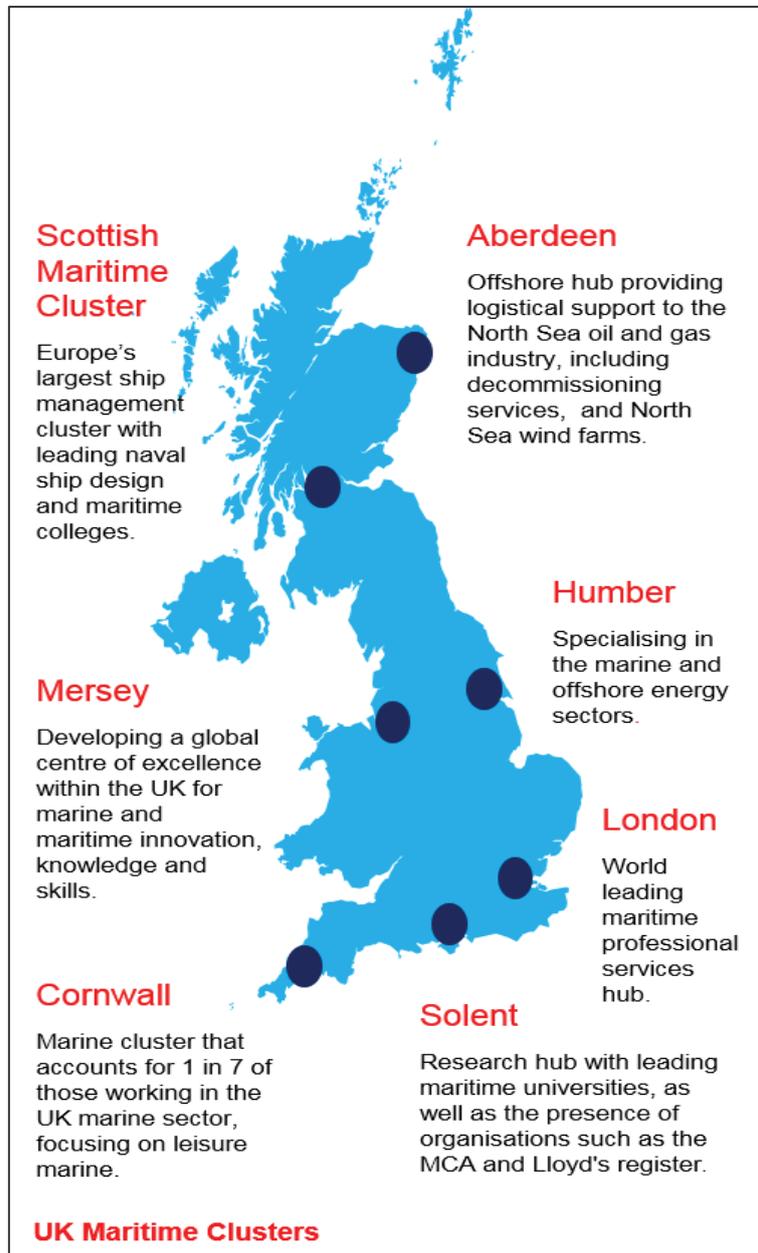
This cluster model is particularly important in maritime business, as face-to-face communication between the parties involved in shipping investment, operational and financing deals remains highly valued. These transactions are heavily based on trust which, in turn, are built on long term personal relationships. Hence, an effective maritime strategy must examine not only shipping, but also its interdependence with trade and finance. After all, the coexistence within a few square miles, of numerous highly significant maritime, trading and finance companies is one of the main reasons that London has historically been the world-leading centre of maritime business services.

The advantages of the cluster model can be clearly illustrated in the specific case of the legal services sector in London. Over 25% of all legal maritime partners practice in the UK, while English law is the preferred jurisdiction worldwide for commercial and shipping contracts. The success of this industry is underpinned by high quality UK universities and law firms producing a steady supply of skilled graduates and trainees. Moreover, the choice of English law as the favoured jurisdiction is predicated upon the trust and stability of the English legal system. London is also the world leader in maritime arbitration with a reputation for quality, speed of resolution and impartiality. A recent study⁴⁴ suggests that over 80% of global arbitrations are handled in London. The presence of other business services in the City of

⁴⁴ <http://www.hfw.com/downloads/HFW-The-maritime-arbitration-universe-in-numbers-March-2018.pdf>

London have aided the attractiveness of British legal services by allowing easy access to maritime consultants, often required as expert witnesses during cases. Each of these outlined elements reinforce one another. For example, just as universities support the legal sector, so universities' attraction to students is bolstered by the close presence of reputable firms. This type of relationship is the fundamental advantage of business clusters, and is a model in which the City of London has excelled.

There are several other, broader factors that underpin the business services cluster. The use of English as the global language of business, as well as its use as the common tongue on board ships, gives the UK a head-start in the industry. Additionally, the UK's geographic position is ideally placed to support the business services sector, being in a favourable time zone between New York and Singapore. Moreover, the UK's educational institutions are the best in the world, while London possesses an active cultural scene that makes it an attractive place to live. No other city in the world can match London's combination of cosmopolitanism, financial service sophistication and maritime history. These factors must therefore be recognised as important elements supporting London's business services cluster.



A second example of this clustering effect can be observed around the presence of the IMO headquarters in London. As the only UN body with its head office in the UK, the location of the IMO is testament to the country's rich maritime history. The result is that several additional organisations and businesses are drawn to London. The Institute of Marine Engineering,

Science and Technology (IMarEST), Intercargo, the International Chamber of Shipping (ICS), the International Mobile Satellite Organization (IMSO), the International Salvage Union (ISU) and the International Oil Pollution Compensation (IOPC) Funds are all industry bodies headquartered or with offices in London, each enjoying frequent interaction with the IMO. Many of these organisations have UK leadership which we have perhaps taken for granted and not maximised as much as we should. The IMO thus represents the keystone within this community of organisations, providing additional soft power to the UK, over and above that which IMO alone contributes.

The clustering within the sector is further observed across a number of domestic geographies, each with distinct specialities. Glasgow and Southampton excel in providing education, training and ship management services. Clyde Marine Training, the UK's largest marine training company, is located in Glasgow, while Solent and Southampton University provide a range of maritime focussed courses. Indeed, Southampton has become a broader hub, with key maritime bodies such as Lloyd's Register, the MAIB and the MCA being located in the city.

More recently the Scottish Maritime Cluster has been created focussed around Europe's largest ship management cluster combined with leading naval ship design and leading maritime universities and academies. Indeed, Aberdeen leads the way as a hub for offshore energy services, providing logistical support for the North Sea oil and gas industry and North Sea wind farms. Ports along the Eastern coastline, including at Aberdeen, have subsequently upgraded to meet the demand for decommissioning services and wind farm construction more about which is set out in the Infrastructure chapter.

Mersey Maritime Cluster

One of the most established and successful clusters is in Liverpool centred on the creation of Mersey Maritime in 2003.

Mersey Maritime is the representative body for the marine and maritime sector in the Liverpool City Region, working with large and small businesses across 33 different sub-sectors of activity to create conditions that will allow business to flourish.

It has successfully worked with a wide variety of maritime SMEs to support their business, create and safeguard jobs and help improve their business performance. Since 2012, it has assisted 93 companies which has resulted in the creation of 324 jobs and the safeguarding of 155 more.

But it is since 2016, in collaboration with key partners, Mersey Maritime and Liverpool John Moores University that it has really pushed open the opportunities for maritime skills.

Its first phase of the Maritime Knowledge Hub was opened in March that year. It is an ambitious new project to develop a global centre of excellence within the UK for marine and maritime innovation, knowledge and skills. This, linked to the colleges around the area, concentrate on delivering a highly skilled workforce for a vibrant and competitive maritime cluster.

These examples evidence the unique offerings various parts of the country have carved for themselves in the maritime sector. There are clusters which have created an attractive business environment whilst also fostering innovation and growth. The business services sector has notably succeeded in providing such an integrated, high quality business offering.

Both government and industry recognise the value in maintaining and enhancing the London offer as fundamental to retaining and growing the UK maritime sector. However, we have leading maritime clusters across the country all of which create a regional dynamism and ambition and contribute to the national significance of the maritime sector to our economy and to our global success.

But this is not the whole story by any means. Looking at the picture across the UK, it is apparent that maritime can play an enormous contribution at a local, regional or country level. This was highlighted by the Centre for Economics and Business Research (Cebr) report for Maritime UK⁴⁵ which highlighted figures for different geographical areas and elements of the sector. Included were:

- Scotland – estimated direct support by the sector of just under £9.3 billion in turnover to Scotland's economy, £3.6 billion in GVA and 39,300 jobs in Scotland in 2015.
- The Welsh maritime sector directly supported just under £940 million in domestic output (through business turnover), £330 million in GVA and 5,960 jobs in Wales in 2015.
- Northern Ireland's maritime sector had a turnover of £430 million last year, directly contributed £180m in gross value added to the economy and supported more than 3,000 jobs.

These figures illustrate the important contribution of the devolved administrations to the UK maritime sector. Another figure from the Cebr report states that Scottish maritime companies account for more than 20% of the UK's total maritime sector on these measures. Much of UK expertise in the oil and gas industries and offshore industries will be based in Scotland as it is so heavily involved in these areas – for example, of the 39.3k jobs, 20.6k are in offshore oil and gas. Future decision-making on maritime issues is therefore of fundamental relevance across the UK, at a UK level. But the decision making is equally very important to more local economies, particularly in those

⁴⁵ <https://www.maritimeuk.org/value/maritime-sector-all/>

areas where communities may be heavily reliant on one industry. Going forward, it is vital that regional strengths are recognised as these are integral to the UK's competitive advantage.

Where we are going

The UK offer will be attractive, promoted widely in the UK and across the world, including by government in embassies and high commissions and through diplomatic missions, demonstrating the benefits of doing business in the UK. It will include a proactive maritime business services sector that has grown its sector share through its command of astute business acumen and integration with the wider financial services sector. The UK maritime services sector will anticipate changes in technology and environmental performance and will create new products and ways of doing business that will ensure London remains the home of global maritime business. New methods of working, such as making use of developments in blockchain and digital technology, will inform the way in which the services sector provides products like insurance and contract management.

Strong, lively clusters across the UK will deliver a breadth of expertise, resilience, and thought exchange, bringing a depth and breadth of maritime resource that can be used to support business and the UK economy and ensure we maintain a strategic advantage. Further enhancing cooperation and linkages between all elements of the maritime sector and with government and its agencies will create an even more powerful and innovative clustering effect. As other chapters identify, additional opportunities will develop. An example of where the UK's clusters will drive our response, is with new technologies. Clusters will be key in identifying where improvements to performance can be made from new digital tools. Equally, the UK will take advantage of other new opportunities, such as the continued drive towards renewable energy where clusters of businesses will support the research, construction, and installation of renewable energy infrastructure at sea.

Risks, threats and opportunities

In recent years the maritime world has seen an eastward shift. China and South Korea have increased their shipbuilding programme. Singapore has a myriad of interests, including becoming a maritime hub. Similarly, India and others are concerted trying to improve their global share of seafarers, alongside the number of people in their industry that are trained and educated domestically. As illustrated above, the UK still has a good story to tell on its share of the global market in many areas. The challenge from the East cannot, however, be dismissed.

How we get there

Both government and the maritime sector must work closely together to ensure that the competitive advantage it gains from regional clusters is maximised. As already identified earlier in this chapter, ensuring that the UK remains fiscally attractive and competitive will be fundamental in maintaining

the strength of London as the home of maritime professional services. Close cooperation between government and our regional clusters will ensure they attract further maritime businesses and people. And increased cooperation between clusters will be crucial, fostering new ideas and innovation. This is a central theme of Maritime UK's Cluster Working Group which seeks to bring together the regional maritime clusters. As later sections explore there is a need to promote our clusters and their importance to our national economy and to global maritime business.

This section also identifies the importance of the IMO and other global institutions such as the ILO covered later in this strategy. The UK sees our role in the global leadership of these organisations as fundamental to our forward-looking ambitions. We will collaborate closely with like-minded maritime countries in developing policy and regulation that matches the needs of the late 21st century maritime sector. The UK recognises that it is in a privileged position to host the IMO, and that it attracts a number of international maritime organisations as a result. We will continue to seek to ensure that the UK is the best host for the IMO, for its staff and for the international community.

The UK already has an impressive geographical spread of maritime clusters. These have been created by a critical mass of expertise rather than any specific activity taken by government or the sector as such.

Nevertheless, in addition to supporting, enhancing and promoting existing maritime clusters close cooperation across government, academia and industry could identify the need for new clusters particularly as a way to respond to the changing needs of the global maritime sector.

Recommendations

Short term (1-5 years)

- The UK, as host of the IMO, will seek to maximise our leadership role in the organisation.
- Government and industry to work together to maintain and enhance the attractiveness of the UK's regional maritime clusters and London as a global maritime professional services cluster.
- Government will support, enhance and promote the strength of all regional clusters in the UK, and their importance to the economy.
- Where appropriate, strengthen the ties between government, industry, and academia to build on existing cluster success and identify new opportunities.

5.4 Thought leadership

The UK's thought leadership stands at the forefront of the industry, both in business and academia. As a centre for innovation and expertise the UK's thought leadership fosters a business landscape that is intellectually dynamic, providing access to not only the best quality employees, but the latest ideas in the field.

The vision for 2050 in this area is:

In 2050 the UK will be widely respected across the world for its maritime thought leadership. UK universities will continue to produce impactful maritime research, and subsequently attract global talent to these institutions. It will have a thorough and constructive approach to progressive and wide-ranging decision making, whether it is regarding cutting-edge innovation, finding solutions to complicated new issues, or settling hard hitting negotiations. Government, maritime sector and academia will work closely together to maximise opportunities to foster innovation. We will explore how dynamic support structures, like the Catapult centres and Innovate UK which exist today to bring cutting edge UK products and services to market, will be utilised to further secure advantages for the UK maritime sector.

Where we are now

UK universities and business consultancies are central to UK thought leadership. They contain invaluable maritime expertise across numerous topics. Solent University has established a reputation for producing impactful research on autonomous vessels⁴⁶, as well as on crewing practices and safety. University College London's Energy Institute produce a body of research focusing upon low carbon shipping⁴⁷. Likewise, CASS Business School, one of the leading lights on shipping and commodity finance and risk management, directly contributes to the primacy of the City's place in the business services sector. In addition, numerous UK based business consultancies produce analysis on the sector, providing strategic intelligence for international companies. The maritime knowledge economy in the UK is thriving.

UK universities do not only impact the industry through the production of research and ideas, they also help to create the thought leaders of the future. Maritime programmes offered by UK-based universities and institutions are considered the highest quality. As a result, the UK has traditionally attracted individuals from every corner of the globe. They come to obtain maritime education and training in a diversity of sub-fields. Apart from direct gains and contributions to the UK economy, this fact ensures that future world shipping experts and maritime leaders establish a strong affinity with the UK.

⁴⁶ <https://www.solent.ac.uk/research-innovation-enterprise/rie-at-solent/projects-and-awards/solace-project>

⁴⁷ <https://www.ucl.ac.uk/bartlett/energy/research/themes/transport/shipping>

The Costas Grammenos International Centre for Shipping, Trade, and Finance

In 1984, Professor Costas Grammenos, founded the International Centre for Shipping, Trade, and Finance at London's Cass Business School with three aims:

- postgraduate teaching
- research
- creation of international dialogue between academia, policy makers, and businesses

Now renamed the Costas Grammenos Centre for Shipping, Trade, and Finance, it is widely considered to have contributed to London's strong position as a hub for the global shipping industry.

The Centre has introduced revolutionary-styled courses - MSc in Shipping, Trade, and Finance and the MSc in Energy, Trade, and Finance. It also introduced finance and trade in shipping studies and thus, created the three interlinked circles of 'Shipping, Trade, and Finance'. By so doing, a new global approach to international business was created with both horizontal and vertical analyses. It introduced shipping finance as a new academic subject - initially in the form of bank finance - and subsequently, the capital markets as sources of external funds for shipping companies. Furthermore, in 1985 commodities and commodity finance were introduced as a new academic topic.

Now with 35 years of ground-breaking research and over 120 published articles in peer-reviewed journals, the Centre has established itself as a leading global authority on shipping finance, financial risk management, commodity, and commodity finance. By encompassing its research in the taught material of both MScs and incorporating the global approach, the Centre has influenced the shipping industry across the world. Finally, the Centre has been offering a forum for international dialogue through its conferences, seminars, and debates.

As of today, the Centre has over 3,700 alumni from 160 countries primarily working in the sectors of shipping, energy, trading, banking, and finance but also in academia in 50 countries around the world – while 20% of those alumni are leaders in their sectors at either an international and/or national

The opportunities that come with this thought leadership have not always been taken advantage of. Translating pioneering research and thought leadership into tangible UK benefits has sometimes been more problematic. For example, despite a wealth of research emanating from leading UK universities and businesses regarding green technology, it has so far been Scandinavian countries that have sought to operationalise these ideas.

Greater encouragement of partnerships between government, business and academia is thus one way in which the UK can help ensure thought leadership transfers into better business outcomes.

The UK has already achieved similar aims through the establishment of nationwide science parks, typically in areas close to leading universities. For example, Southampton Science Park hosts over 100 companies, drawing on expertise from the nearby University. The influence of the University's thought leadership can be seen in businesses such as Renovos, a company that provides orthopaedic regenerative medicine solutions, closely collaborating with the University's experts in this area. Similarly, Tekever, a company which produces an unmanned aerial vehicle used for maritime surveillance is resident in the park. It is ideally situated to utilise the leading maritime research being produced by Southampton's universities. The wealth of intellectual talent in the maritime sector therefore presents as an outstanding opportunity to create deeper linkages between the country's intellectual property and its manufacturing capacity.

UK thought leadership is not solely confined to its research output. The UK's Catapult Programme has created a network of world leading sectors designed to transform the UK's capability for innovation and help drive future economic growth. Catapult centres that are of particular importance and potential benefit to the maritime sector include:

- **Digital** – the UK's leading advanced digital technology innovation centre.
- **Energy systems** – supporting companies and government in developing products and services.
- **High value manufacturing** – the catalyst for the future growth and success of manufacturing in the UK.
- **Offshore renewable energy** – facilitating the development and commercialisation of innovative and technological solutions;
- **Satellite applications** – fostering growth across the economy through the exploitation of space.
- **Transport systems** – seeking to exploit the massive potential market for new products and services.

The work of the Transport Systems Catapult in new maritime technology development is explored further in the Technology chapter.

Government has also sought to demonstrate thought leadership in the maritime sector particularly through the Maritime Autonomy Futures Lab. This work brought together analysts, ethnographers, policy makers and designers from government, industry, academia and unions to consider the government's role in smart shipping. The lab used a range of innovative techniques to develop policy in a collaborative way that was focussed on outcomes. Many of the outcomes of this event are seen in the Technology chapter later in this strategy and in the Technology and Innovation route map.

As highlighted in later chapters of this strategy, the UK has also shown its thought leadership in the IMO. A particular illustration has been on the future ambitious reductions of GHGs in the maritime sector. And led by the MCA, the UK is helping to drive forward the international regulatory agenda that underpins the development and global use of smart shipping. The UK is determined to continue its role as a thought leader in the IMO. We will commit to ensuring we maintain a central presence in the many international fora where maritime issues are negotiated.



We are particularly proud of our history as one of the founding members of the ILO and as one of only ten governments that have a permanent seat on its governing body. A large body of its work has been, and will continue to be, in regard to the welfare and employment conditions of seafarers and fishermen.

UK legislation has often formed the basis on which its conventions, protocols and recommendations have been developed. The Maritime Labour Convention is rightly regarded as one of the principal pillars of maritime law alongside the International Convention for the Prevention of Pollution from Ships (MARPOL), the International Convention on Standards of Training, Certification and Watchkeeping for Seafarers (STCW) and the International Convention for the Safety of Life at Sea (SOLAS). The 'Working in Fishing Convention' provides similar protection to all fishermen.

Given seafarers are operating in a global and mobile market the importance of being able to transit and transfer freely in a foreign country is vital to the maritime sector, as is their fundamental right to access shore leave, the UK was instrumental in driving through changes to the Seafarers Identity Document Convention. The ILO is also looking at modern day slavery and improvements in the supply chain with regard to seafarers and the fishing sector and at promoting more women in the maritime sector – both issues that are of particular interest to the UK.

Where we are going

The UK will have consistently promoted its thought leadership in negotiations and discussions, particularly at the IMO and other global fora. This will have had tangible impacts on environmental and welfare standards across the industry - reaffirming the country's position as setting quality and pace for such standards. The UK will maintain and enhance its status as one of the principal thought leaders in the maritime sector. This is not though just about having ideas but about government, the maritime sector and academia working in partnership to drive innovation and growth. This very strategy demonstrates our thought leadership ambitions taking an extensive, wide ranging and long term view of the maritime sector and ensuring that the UK is ideally placed to benefit from the changing shape and nature of the sector.

Risks, threats and opportunities

The main risks in this area mirror many of those highlighted in the clustering sub-theme. UK thought leadership is supported by the wider maritime offer. Should this weaken, the attractiveness of UK universities and business consultancies will likewise, diminish. Furthermore, educational institutions will have to remain vigilant to competing educational offers, particular those arising in the east to support the growing maritime trade in this area. As noted, the effective transfer of academic research and innovation into business output has not always been fully realised. This does however, present a prime opportunity to improve this situation going forward. Moreover, as new environmental regulations come into force and as the industry continues to change, new opportunities will emerge for businesses to provide technological solutions to the issues of the day. Effectively leveraging the UK's thought leadership can therefore enhance the broader range of maritime goods and services offered in the UK.

How we get there

Maintaining the UK's advantage in thought leadership requires an effort to attract the top intellectual talent to the country. Continuing to support UK universities as sites of academic excellence, across all disciplines, will form a key part of this effort. For the maritime sector, hosting renowned international academic conferences and events such as the Onassis prizes in the City of London, will affirm the country's commitment to supporting and promoting thought leadership in the industry. Additionally, these conferences can serve to draw shipping expertise to the country, connecting academics and businesses within the UK to those across the world. The UK will aim to host in the near future (and for the first time since 2007) the International Association of Maritime Economists conference, considered as the top academic and industry maritime conference in the world. We will also maximise the global maritime recognition of LISW. The next sub-theme exploring the partnership between government, industry and our social partners highlights the particular importance of LISW which is a showcase to the maritime world of UK thought leadership and action.

Encouraging government, maritime industry and academia to form tighter partnerships will aid in the transfer of knowledge between these sectors. This will ensure the UK takes full advantage of its intellectual talent, turning ideas into actions. Initiatives such as secondments between staff of universities, businesses and government to share knowledge and practice will be explored to this end. This openness and crossover will develop greater freedom of thought which should bring innovation and creativity to the sector. Innovation is a key driver underpinning all themes and as such necessitates a number of recommendations which run through many of the elements of Maritime 2050. The process of enhancing innovation will be vital to the whole sector's success.

Commitment to the continued hosting of the IMO in London combined with a determination to be a leading member country in all leading maritime international fora will also consolidate the country's position as a leader in the field, allowing greater influence and soft power to be exerted. Hence, many of the recommendations surrounding the IMO in this chapter, and elsewhere in the report, can both support and enhance the UK's position as a thought leader.

The UK is extremely proud of its leading maritime educational and training sector but we can use it to better effect. As we seek to maximise our place as one of the world's maritime thought leaders, government will work in closer collaboration with our leading maritime educational institutions to ensure we take the right actions to maintain and enhance our status. Through this strategy, the government will explore the opportunity to bring together leading figures from academia together with industry and government to create a blueprint for future collaboration going forwards.

Recommendations

Short term (1-5 years)

- Strengthen the UK profile as the place for maritime thought leadership, through government and industry hosting top academic maritime conferences and shipping events.
- Maximise our leadership role in the IMO and other international bodies through continued and enhanced thought leadership.
- Invite leading figures from the UK maritime academic sector to work with government, industry and social partners to create a blueprint for future maritime thought leadership collaboration.
- To ensure that the most innovative companies and ideas are brought to market for the benefit of UK maritime, government will explore further opportunities to continue to support maritime innovation.

5.5 Strong partnership

Partnership between government and industry is vital to ensuring the UK provides an attractive business environment. And the UK also attaches great importance to our social partners and the third sector in ensuring we recognise the importance of welfare issues. The UK is committed to supplying a regulatory framework in which consideration of the ease of doing business sits at the forefront of decision making. Moreover, opportunities are being sought, and will continue being sought, where government can proactively support the industry. Each of these aims can only be achieved by government working hand-in-hand with business and our wider maritime partners.

The vision for 2050 in this area is:

Government and industry will together provide a strong vibrant leadership for maritime in the UK. Collaborating together we will build on our strengths and identify new opportunities. We will project our close working globally and demonstrate to the world's maritime industries that we are open for business. The UK's strength in its Parliamentary democracy with leading Ministers and Parliamentarians listening and responding to the needs of the maritime sector will continue to be vital. The government will take a proactive stance to ensure that it takes measured, considered, and timely decisions to steer the sector as it seeks to project itself in the global market. Its guidance and advice will be rigorous and timely. This advice will be communicated widely across the sector allowing business to be conducted to the fullest advantage.

Where we are now

Recent initiatives have already made excellent progress in this area. The MGS published in 2015 set out the improvements needed to the current UK maritime sector. The need for a stronger sense of leadership and partnership between government and industry was identified. Consequently, government has established a Ministerial Working Group (MWG) on maritime issues and the Maritime Strategic Committee (MSC), both of which have strong industry participation managed through our relationship with Maritime UK. The MWG in particular recognised the need for the UK maritime sector to be able to engage directly with UK ministers who have an interest in, and impact on, maritime issues. This allows the UK maritime sector to bring to ministerial attention key issues it needs addressing to support its own growth but also the issues that are of importance to the global maritime sector and which attract them to the UK. It is therefore a one-stop shop for the sector to highlight issues of fundamental importance to the maritime sector and to take confidence that they are being heard and acted on in the highest levels of government.

Similarly, industry has set up Maritime UK to represent its views in a unified voice. With around 15 members covering not only the ports, shipping and cruise sectors but also including amongst its membership engineering, leisure marine, a trade union, a charity partner, training and educational institutes and regional organisations, Maritime UK is well able to ensure it understands the

needs of the maritime sector. Government does not look to Maritime UK alone and continues to engage both directly with leading maritime companies of all shapes and sizes as well as a wider range of maritime representative bodies. Engagement between government and the sector is therefore more deeply entwined as never before. Collaboration in this area is therefore a key strength of the wider UK maritime offer. There is a unifying goal towards national success and international competitiveness and attractiveness.

One of the foremost opportunities for joint collaboration between government and industry has been the creation of LISW. First run in 2013, and with its fourth outing in 2019, this week-long conference has showcased not just London but increasingly the whole of the UK maritime sector to the world. It has brought together many of the sub-themes



already identified in this chapter, such as the thought leaders and the strength in our regional clusters. It has attracted to the UK a global audience of leading industry companies and figures, government ministers and officials, academics and social partners. LISW demonstrates the strength of the UK maritime offer, our collaboration and our invitation to the global maritime community to engage with the UK and see what we can do.

Despite these undoubted successes, there remains room for improvement. There continue to be gaps in how individual companies are able to access the information they need from government. This embodied a common theme, particularly from the SMEs, in the call for evidence. A lack of how to engage was one area identified, as was how communications ought to permeate through government departments and across business areas.

Where we are going

Although the UK has made strides in this area over the past few years, there is still room for improvement. With a vision that looks to strong leadership, it vital that both government and industry keep watch and safeguard against complacency in this area. Government will need to be aware of how individual policy areas impact on the sector. There is a role for government to be particularly vigilant when there are a multitude of strategies coming forward to ensure that they do not overlap and efforts are made to get maximum advantage from each initiative. Industry too should seek to reach out to all businesses so that they have full opportunity to make the most of the sharing of knowledge and best practice, the expertise across the sector and connections. By building up the intelligence resources available and presenting timely opportunities to allow ample preparation, the sector can move forward in strength.

Risks, threats and opportunities

There is a risk that the complexity of the industry and the spread of interested government departments makes effective communication difficult. With the complexity of industry supply chains only increasing, these issues could be exacerbated in the future. This could reduce the response time of government to pressing problems. This is an issue that was well recognised in the MGS but requires a renewed and continuous effort to ensure that all government departments are aware of the maritime sector's needs in the UK and the action that is needed to secure future maritime business to the UK. Equally, industry should also take action to ensure that all areas in the sector are comprehensively engaged in maritime decision-making. With government also continuing to engage with as wide a range of actors in the sector as possible, the more that priorities and ambitions are focussed, the greater the chance of success.

The UK has an impressive range of leading maritime companies, both small and large. As emphasised throughout this report the UK continues to be a world-leader in many maritime sectors. In addition, a wide range of sector representative organisations with an ever more coordinated and stronger Maritime UK at its heart, ensure that the issues that matter to the sector are brought to bear and the steps that are needed to attract global maritime businesses to the UK are taken. The UK has a range of social partners in the maritime sector who lead the way in setting the welfare agenda. And the government has a number of leading departments working in ever closer collaboration to support the sector and attract new business to the UK. This work is co-ordinated by the Department for Transport (DfT). There are challenges and complexities but the strength of this collaboration creates confidence that the UK will remain a leading maritime nation long into the future and will work as one to maximise opportunities.

The need to showcase the UK's maritime capability through leading events like LISW and new internationally important opportunities like the Global Maritime Forum will be crucial. Government, industry and all our maritime partners have to work together to promote the strength of the UK offer. Later in this strategy our maritime trade ambitions are considered more fully and events like Maritime UK trade missions to countries including China, Hong Kong and New York are explored. The UK should be confident in its maritime offer and government and industry need to work closely together to project that confidence globally.

How we get there

Government will continue to promote the MWG and MSC as the main meetings to work through cross-government discussions on maritime policy areas. As well as these core overarching groups, the strategy identifies the range of other groups which also exist to ensure continued and strengthened collaboration. Working together, government and the maritime sector will put in place the most appropriate mechanisms for the delivery of Maritime 2050 and its route maps. This is not about creating new institutions but about

creating the right governance arrangements to bring a renewed or enhanced focus to long term maritime issues where they currently do not exist.

The UK maritime industry collaboration is, when it is needed, closer now than ever before. They should be encouraged to continue their cooperative activities and to increase their membership. Ensuring that the sector maximises the strength of its SMEs and champions their dynamism and ambition is crucial. Industry should work for an active membership where each contributes wholeheartedly to create a comprehensive promotional programme of benefit to the whole of the UK sector. Only by a concerted effort and a willing leadership will there be positive national press coverage. More importantly, such activity can help to boost the numbers of companies and people wanting to come to the UK as they see the benefits that could accrue their way.

A wide variety of governance structures already exist to ensure close collaboration between the government and the sector. Indeed, consideration might be given as to whether they are all fit for purpose or whether a simplification or streamlining would put the collaborative effort on a stronger footing. Nevertheless, government and industry should also review whether there is a sufficient long term horizon scanning capability within these structures. There is a need for our governance to be agile, entrepreneurial and responsive to the changing shape of the maritime sector.

Government and industry will continue to work together and to seek ways of enlarging their proactive engagement to promote the UK's maritime offer and to influence government and maritime leaders across the world. More specific information on trade promotion is found in the Trade chapter. Whatever maritime events exist in the long term future, be it LISW 2050, the Global Maritime Forum or new worldwide maritime events, the government and maritime sector will continue to maximise the opportunity to showcase what we offer to the World creating new opportunities and attracting new business to the UK.

Recommendations

Short term (1-5 years)

- Government and the maritime sector will put in place the most appropriate mechanisms for the delivery of Maritime 2050 and its route maps.
- Government will continue to support Maritime UK and its international impact.
- Government will seek to increase its direct interaction with UK maritime companies including both SMEs and large globally successful organisations.

- Government and industry will review the governance structures supporting the UK maritime sector and consider potential rationalisation.

5.6 A modern approach to UK regulation

Domestically the UK maritime sector is governed by regulation set out in the Merchant Shipping Act 1995. This is supported by an extensive and wide-ranging set of secondary legislation which governs international and domestic operations. As already identified earlier in this chapter much of our domestic legislation is taken from international agreements agreed at the IMO and associated international bodies. Standards governing many of the elements of Maritime 2050 such as safety, the environment, future technological applications, the welfare of our seafarers and maritime employees are initially set at a global level.

Alongside having an effective legislative regime is the crucial role of the regulatory bodies which implement, interpret and enforce it. For government, this role is played principally by the MCA. The MCA has the ambition to be the world's best maritime safety organisation. It has a crucial role to play in ensuring that the UK remains recognised globally for its safety activity, such as its leading search and rescue and survey and inspection capabilities, while also providing the levels of customer service that the global maritime sector demands, and being commercially responsive to their needs. This requires an appropriate balance between a modern, safe and secure regulatory environment that also supports the needs of a forward-looking maritime sector.

The vision for 2050 in this area is:

The government will develop proposals for a new Merchant Shipping Act in the next 5 years. We will recognise the importance of internationally agreed legislation and will seek to negotiate and lead appropriate discussions at the IMO and in other international fora. The UK will seek to agree and put in place an effective and proportionate regulatory framework and if opportunities exist to simplify or reduce regulatory burden, we will continue to seek to explore them. The UK will seek to have a regulatory system which is pro-business but is safe, secure and covers the welfare of employees appropriately. The MCA will be recognised as a world-leading regulatory agency that will provide premium levels of customer service combined with implementing an effective and proportionate regulatory regime.

Where we are now

The current Merchant Shipping Act 1995 has been in place for over 20 years but the Merchant Shipping Act has been governing shipping since 1894. Much of this legislation remains extant and fundamental to the application of an

appropriate regulatory environment. Successive government programmes have sought to ensure that UK regulation is proportionate and encourages and supports the needs of our businesses.

The UK has historically led the way on justifiable regulation particularly as a way to ensure safety and security across the maritime sector. It believes that the purpose of any regulation must bring order and a level playing field. This enables society and international agreements to understand clearly and easily what is the established process and can follow it easily.

As consistently recognised throughout this chapter, the UK's domestic legislation is driven by the rules-based approach agreed at the IMO and other international fora. The UK is recognised for its expertise and commitment to negotiating ambitious but deliverable regulation on a wide range of issues.

The call for evidence raised concern from some respondents that the UK over-regulates which on occasion becomes gold-plating. This was particularly apparent on the land-based side of the sector where for example in ports, regulation governing these busy areas covers a multitude of activities requiring a balance between the environment, infrastructure development and safety. There is a continuous and open dialogue between government and the sector to consider whether the regulatory environment is appropriate and whether regulation is sufficiently balanced with the sector's future trading ambitions and supportive of the growth of the national economy.

Where we are going

A review of the Merchant Shipping Act will provide a valuable baseline assessment of UK legislation in this area, and will allow the UK to react quickly to the demands of the sector and the international regulators. From the outcome we will assess the next steps with a view to building a cohort of legislation that hangs together and is easily understood. Along with our work in the discussions at the IMO and other fora we will seek to ensure that our approach to future legislation is evidence based, proportionate and appropriate.

Risks, threats and opportunities

Developing proposals for a new domestic Merchant Shipping Act will be an extensive, comprehensive and significant undertaking. As such it creates a highly significant opportunity to ensure that the UK's domestic maritime legislation matches our policy ambitions and those of the sector while not compromising the core standards to which we adhere. However, to bring a new legislative regime into effect will take time and will require extensive engagement and activity. It will also need significant legislative space in Parliament which has been constrained in recent years. It is therefore an ambition which is absolutely fundamental but will take some time to deliver and even more crucially to get right.

Alongside reviewing our primary legislation ongoing opportunities exist to consider whether the UK's secondary legislation is proportionate and whether any opportunities exist to reduce the regulatory burden. Close collaboration between the government, particularly the MCA and the maritime sector enables informed decisions to be taken on the application of legislation. The MCA must always be able to discharge its regulatory responsibilities effectively and as required by law but that does not preclude an ongoing relationship with the maritime sector to support its growth and ambitions.

How we get there

The government will take the time needed to develop proposals for a new Merchant Shipping Act and to consult appropriately on a new set of primary legislation. That would not be anticipated in the immediate term due to the need for Parliamentary space and legal support working alongside our policy and regulatory experts. That also creates time for government to consult widely across the maritime sector including with our social partners on how best to address and support their needs through effective legislation. The legislation needs to put in place an appropriate and proportionate regime that supports our future ambitions and does not constrain our ability to be bold, innovative and forward thinking. Alongside this though any legislative regime has to ensure that the UK retains its power to impose appropriate penalties and restrictions and to maintain our objective to be a country which offers a premium level of service. Just as the UK believes in the strength of its Parliament and rule of law so our future regulatory system should be proportionate and recognise the needs of business but it should also not be open to abuse.

Alongside our primary legislative powers, the UK will continue to explore its secondary legislation and seek to amend or reduce regulatory burden where appropriate. To do this effectively it requires the full engagement of the maritime sector and clear evidence that demonstrates a need to act. New secondary legislation should similarly be proportionate and match the UK's ambitions whilst again not compromising on fundamental principles. The legislative system that the UK has in place should be supportive of the UK maritime sector and also match our ambitions covered elsewhere throughout this strategy, to encourage global maritime industries to the UK and to do business here.

More widely the government will continue to play its full part in the international regulatory environment most notably through the IMO and other international bodies. The UK places high value on the development of effective and proportionate regulation that sets ambitious targets for the global maritime sector. The UK will continue to seek a leadership role in the policy and regulatory discussions held in international fora. It will pursue agile and responsive regulation that allow the maritime sector to flourish globally and seize the opportunities that new technology and new disruptors will create in the future.

The MCA will continue to be the government's leading maritime agency supported by a wide range of other critical regulatory bodies covering other aspects of the maritime sector. The MCA will be respected as a leading regulatory body, not compromising on its core values. It will implement and enforce a regulatory regime that supports the growth of the UK maritime sector and attracts global maritime businesses to the UK. The MCA will work in close cooperation with the maritime sector where appropriate in considering and reviewing existing regulation and in meeting the needs of its customers. However, the UK will continue to be known as a country that applies regulation in a consistent and trustworthy manner.

Recommendations

Short term (1-5 years)

- Government will develop proposals for a new Merchant Shipping Act 1995, in the next 5 years.
- Government will consider if the existing secondary regulatory regime is fit for purpose on an ongoing basis and explore opportunities to reduce burdens to business.
- Government will play a leading role in setting an appropriate and proportionate global maritime legislative regime through the IMO and other international bodies.
- The MCA is the leading government agency responsible for the development of, implementation of and enforcement of key elements of UK maritime legislation. The Agency will not compromise its safety principles but continue to recognise the need for proportionality and commercial delivery.

5.7 Safety

Safety is a fundamental principle on which the UK will never compromise. No change of emphasis was proposed as part of this strategy but responses to the call for evidence demonstrated that the lack of any specific detail in this area was a cause for concern among stakeholders. There was, in particular, a fear that the UK might be willing to compromise its safety standards to become more competitive on a global stage. This sub-theme restates the UK's continuing commitment to the highest possible safety standards, what we see as the major challenges in this space in the period up to 2050 and what we are already doing, and planning to do, to meet these.

Globally, maritime safety standards are poor⁴⁸ against comparable safety-critical industries such as oil and gas and construction. Fatality rates in the merchant shipping fleet, in particular, are significantly greater than those in the general maritime workforce with performance in some sectors, such as fishing, being perennially far worse⁴⁹. Whilst safety performance in the UK is relatively good by comparison, further action is required to ensure lessons are learned from accidents and incidents and a more consistent safety culture and continuous improvement are embedded into the sector's working practices.

Why is safety so important? Our coasts are a complex environment and the UK has some of the busiest and, potentially, some of the most dangerous waters in the world. As an island nation we rely on ships and ports to deliver the food, fuel and materials we need to prosper and drive economic growth. Other factors such as congestion in our waters has increased significantly. Not only has there been growth in vessel size, particularly in the container sector, but the past decade has seen an increase in offshore wind, wave and tidal installations.

Additionally, restrictions may be placed on shipping that reduce the areas for navigation. For example, there may be restrictions associated with areas designated for marine conservation. The UK's waters are also extensively used by recreational mariners including the most infrequent and inexperienced leisure users. This complex mix of commercial and recreational uses requires an appropriate framework in place that recognises the needs and requirements of this wide spectrum of mariners to ensure that safety can be maintained and enhanced.

The vision for 2050 in this area is:

The UK will remain a world leader on safety matters through its specialist offices⁵⁰, ensuring continuous improvement and developing innovative state of the art technology. The UK will continue to invest in research and development to meet significant new challenges (such as new digitalisation and 6th the introduction of autonomous shipping) and ensure existing systems continue to meet the needs of all forms of professional and recreation mariner, whilst providing sufficient resilience to ensure safety can be maintained under any circumstances.

It is only by being constantly vigilant that the industry's safety record can be transformed and this requires a regulator with the powers to take action where necessary. Should the worst happen, the causes of any accident must be thoroughly investigated to learn lessons and prevent any reoccurrence. The UK is fortunate that it has two world-class bodies in the MCA and the MAIB to deliver these requirements today. They will need to adjust as they meet the challenges leading through to 2050.

⁴⁸ <https://academic.oup.com/occmed/article/64/4/259/1464740>

⁴⁹ <http://www.lrfoundation.org.uk/news/2018/safety-in-the-fishing-industry-providing-insight-into-a-global-safety-challenge.aspx>

⁵⁰ The Maritime and Coastguard Agency, the UK Hydrographic Office, the General Lighthouse Authorities and others.

Where we are now

The safety of shipping, maritime personnel and recreational users on sea and coast is of vital importance but as noted above, safety performance is generally poor when compared to other safety-critical industries.

The UK is already doing a great deal to improve safety performance in its waters through the MCA. It does this by implementing the government's maritime safety policies as they apply to commercial shipping and fishing as well as providing technical and professional advice for both commercial and leisure operators⁵¹ and certifying mariners to serve on ships. It checks safety standards through its audit, survey and inspection roles and can take action against owners, operators and individuals in breach of merchant shipping rules and regulations.

Through Her Majesty's Coastguard, the MCA co-ordinates a 24-hour maritime search and rescue service across a wide area around the UK coast from mid-Atlantic to the middle of the North Sea⁵². It can call on 22 search and rescue helicopters available from 10 sites around the country, as well as around 3,500 coastguard volunteers, the Royal National Lifeboat Institution (RNLI) and numerous responders from a variety of independent organisations who themselves are mainly made up of volunteers.

UK Volunteers in Search and Rescue

The Coastguard Rescue Service (CRS) is a Search and Rescue (SAR) asset which provides a national coastal network of 328 professional Coastguard Rescue Teams (CRTs) made up of 3,500 volunteers and managed by 108 full time staff. The CRTs are available 24/7 for search and rescue purposes operating within the coast and certain designated inland waterways. The CRS responds to nearly 9,000 incidents every year.

The CRS provide the following capability as a declared facility:

- A professional and effective SAR capability, managed, supported and developed by a national cadre of coastal officers, providing specialist procedures, training, equipment and supporting infrastructure.
- A water safety and rescue capability in the coastal environment, including designated waterways and inland of littoral areas if required. This is a shore-based rescue capability which provides an extensive SAR capability to cover water rescue risks within our area of operation.

⁵¹ Through Marine Guidance Notes, Marine Information Notes and Merchant Shipping Notices. See www.gov.uk/topic/ships-cargoes/m-notices

⁵² https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/593127/mca_uksar.pdf

- A technical Rope Rescue capability around the coast, and on adjacent inland cliffs and slopes as required in support of other organisations. This provides a SAR capability to cover natural and urban at height risks in all operational areas.
- A Mud Rescue capability in the coastal environment, including designated waterways and inland of the littoral area if required. This provides a SAR capability to cover unstable coastal surfaces; mud and quicksand in all operational areas.
- In keeping with UKSAR and of the Civil Contingencies Act 2004, volunteer CRT's may respond to requests for mutual aid and can assist other emergency responders inland where practicable, for example the CRS can support the police in search and rescue of persons lost or missing inland or providing a flood response capability.

We also need to recognise the debt owed to other volunteer and independent organisations who undertake SAR activities including the RNLI, independent lifeboat and rescue boat organisations as well as mountain and cave rescue teams who risk their lives to save others. Many of these are declared facilities which meet certain levels of equipment, training and availability and can be tasked by the Coastguard in emergency situations. Government has been supporting these charities through the DfT's Rescue Boat Grant Fund which has provided nearly £5 million in funding since its inception in 2014, in order to maintain and enhance national capability.

Navigation safety has always been fundamental to the delivery of maritime safety and underpins every aspect of the operation of the sector. The vastly differing levels of navigational knowledge, experience and equipment available reflects the wide spectrum of people who use UK waters, from professional mariners to infrequent leisure users, and requires a multi-layered response. The work of the MCA, which has responsibility for implementing the UK's international obligations for navigation safety at sea, is critical to meeting these challenges. This work is done in conjunction with the UK Hydrographic Office (UKHO) and the GLAs⁵³, which operate, maintain and improve all aids to navigation around our coast, as well as respond to new dangers such as wrecks.

The work they do within the International Association of Marine Aids to Navigation and Lighthouse Authorities (IALA), using the UK's long heritage and world leading expertise to further harmonise aids to navigation worldwide, develop and share best practice and encourage cooperation between nations, is equally vital. These efforts will continue as IALA transitions from a non-governmental organisation into an international organisation.

⁵³ Trinity House for England, Wales, the Channel Islands and Gibraltar; the Northern Lighthouse Board for Scotland and the Isle of Man and the Commissioners of Irish Lights for the island of Ireland.

Advances in marine information technology over the past few decades have been substantial and rapid. However, it has also progressed in a piecemeal fashion resulting in a collection of purpose-built systems for vessel and land-based uses that, often, do not operate in an integrated manner. The IMO has recognised this problem and is developing an e-Navigation programme to reduce what it calls the current “confusion of profusion”. This is a significant challenge for the whole sector and the UK is contributing to the solution through participation in IMO working groups.

The industry has already learned lessons from other safety-critical sectors including the introduction of measures such as safety management systems. Many other initiatives have also been introduced to drive continuous improvement. It will take a number of years for these to become fully embedded as best practice across the sector but there is an expectation that similar step changes in safety performance can be realised. Early adopters are already benefitting from the realisation that embedding safety within all aspects of their operations as a core principle also makes good business sense.



However, the best way to stop accidents happening is to prevent the circumstances in which they occur from arising in the first place. Safety management systems are an excellent tool but there is a burgeoning understanding that many of the incidents and accidents which occur and result in fatalities, life changing injuries or catastrophic environmental disasters which can cost billions of pounds in clean-up costs, are eminently avoidable. It is critical that all stakeholders learn lessons from any incident or accident that occurs not only in the UK but internationally.

As a result of the Herald of Free Enterprise tragedy in 1989, the MAIB was established to investigate the causes of marine accidents and make recommendations to prevent reoccurrence, but does not seek to establish blame or liability. Almost 30 years on, it has accumulated a wealth of knowledge and expertise in understanding the chain of actions and decisions

which can lead to major accidents. Assessing trends and similarities can suggest further actions which can be taken to avoid similar issues occurring in future. MAIB does this in its Annual Reports⁵⁴ and Safety Digests⁵⁵

The sector can also learn from the example provided by other industries. In the transport field the UK rail industry has seen a dramatic reduction in the rate of accidents since the establishment (following a major accident) of the RSSB (formerly known as the Rail Safety and Standards Board) in 2003.

RSSB began by researching the critical factors which determine safety performance through an analysis of past accidents can develop. In response to this, the rail industry provides a significant amount of data for the RSSB to collate on its behalf in its Annual Safety Performance Report⁵⁶. If it is to make a similar step change, the maritime industry needs to take the same journey and start recording relevant information.

The UK is a visible advocate of safety in discussions at the IMO. The IMO's role is critical to ensuring that safety measures which must be agreed and implemented at international level are progressed for the benefit of all. Given its long maritime heritage and experience, the UK is well placed, through the MCA, to actively participate to further enhance safety in the industry.

Safety in ports is equally critical to the success of the industry and the UK also leads in this area providing guidance and support through the Health and Safety Executive (HSE)⁵⁷. The MCA works in conjunction with HSE so that safety is covered from both the wet and dry sides of the quay. DfT also publishes the Port Marine Safety Code⁵⁸ (the Code) and related Guide to Good Practice⁵⁹ to assist ports and harbours in understanding the key issues and sharing best practice across the industry. The Code is voluntary but MCA undertakes health checks to assist the sector in making ports and harbours safer.

Port Skills and Safety⁶⁰ is recognised by government as the UK's standard setting body for land-side skills in the ports sector. They work with employers, HSE and the trade unions to promote safety in the workplace and improve the safety culture throughout the industry to develop and maintain a suite of National Occupational Standards for port operatives, harbour masters, marine pilots and vessel traffic services. They also host a number of work and advisory groups and support the development of fit-for-purpose legislation, policy development and guidance. The British Ports Association (BPA) also does valuable work in training for ports on marine safety in compliance with the Port Marine Safety Code.

⁵⁴ www.gov.uk/government/collections/maib-annual-reports.

⁵⁵ www.gov.uk/government/collections/maib-safety-digests.

⁵⁶ www.rssb.co.uk/safety-risk-model/annual-safety-performance-report.

⁵⁷ www.hse.gov.uk/ports/index.htm.

⁵⁸ www.gov.uk/government/publications/port-marine-safety-code.

⁵⁹ www.gov.uk/government/publications/a-guide-to-good-practice-on-port-marine-operations.

⁶⁰ www.portskillsandsafety.co.uk.

Mariner training, both initial and continuous professional development, is critical to delivering operational safety but developments elsewhere have made this increasingly challenging. The human element, which is frequently identified as the root cause of accidents, is a complex and multi-faceted issue that is often forgotten about in the rush to exploit new markets and technologies. These have made the modern mariner's job more complex but the training they receive has not always caught up with the reality of life on a modern ship. This is an area which needs to be addressed by both government and the industry as a matter of urgency.

It was as a result of the 1999 report *Safer Ships, Cleaner Sea* - the review into the Sea Empress disaster where hundreds of tonnes of oil was released into the sea off Milford Haven - that the UK introduced the Secretary of State's representative (the SOSREP). This ground-breaking initiative has proved worthwhile as one of the most innovative steps in casualty management in the UK. In this role the SOSREP oversees the response to accidents at sea. SOSREP is empowered to make crucial and often time-critical decisions, without delay and without recourse to higher authority, where such decisions are in the overriding UK public interest. This independent decision taking removes what otherwise could prove to be intricate and timewasting efforts by the parties involved to safeguard their own interests.

For almost 20 years SOSREP has dealt with many incidents. One of the most high profile came in 2007 when the "MSC Napoli" carrying 2,300 containers and 3,800 tonnes of oil was badly damaged in a storm and forced to come ashore on Dorset's famous Jurassic Coast. The SOSREP used powers to direct the vessel to be beached in Lyme Bay on the English coast with minimal delay and so preventing her from sinking in deeper waters where salvage and pollution control would have been far more difficult.

This demonstrated the wide variety of fantastic work which is already underway to ensure the safety of our seas and respond when the worst does happen within both government, industry and other bodies. We introduced the inaugural Maritime Safety Week in July 2018 to highlight these initiatives, act as a focal point for everything which is being done in this space and to provide visible leadership, direction and support. Parliamentarians too have always demonstrated a strong interest in these issues with input from the Transport Select Committee, as well as individual MPs and Lords, to further raise the profile of maritime safety at government level and engage their support.

The government's role, focus and ambition for maritime safety will be explained in a Safety Action Plan which will underpin delivery of the vision outlined above. Government departments already work in partnership on these issues with a key example being the close working relationship between DfT, MCA and Defra to improve safety in the fishing industry.



Where we are going

By 2050 all avoidable accidents will have been eliminated, making the sea a much safer place to work and to enjoy recreationally. The sea can be a dangerous place and other causal factors in incidents, whether on ship or through human error are all too frequent. A perfect record may be unattainable but the UK has always strived, and will continue to strive, for a place where avoidable accidents are unacceptable, risks have been identified and reduced to the bare minimum and should there be a unavoidable incident, measures are in place to respond quickly and effectively. The UK will continue to be seen as a world leader in navigation safety, research and innovation.

Risks, threats and opportunities

Safety has always been at risk from the constant battle of keeping abreast of transformative change. These developments have the enormous potential for improving safety, efficiency and environmental protection but bring their own challenges, vulnerabilities and risks, such as cyber security, which must be addressed. The pace of that change is only likely to increase in the period running up to 2050 particularly as new technologies are harnessed. An industry playing catch up will always struggle in this respect. This is compounded when small businesses, have pressures on deadlines or competition and there is danger of corners being cut. Care must be taken to ensure that all understand how changes in such areas as new technology could impact on their actions whether they be a major shipping company or port or an individual out for a day on the coast.

A key problem which must be addressed in navigation safety terms is the overwhelming reliance on Global Navigation Satellite Systems (GNSS) with its inherent vulnerabilities to man-made interference and space weather. There are numerous examples of accidents and incidents associated with navigation error. The lack of traditional skills, both navigational and in seamanship, has also exacerbated this problem and has yet to be comprehensively addressed. To stay ahead of the game the UK needs to be proactive in putting in place solutions to these issues and in anticipating emerging requirements whilst remaining flexible in adapting to change. The GLAs have already begun to identify and consider these challenges in relation to their work in “2030 – Navigating the Future” and other strategy documents⁶¹.

This period will also witness the emergence of autonomous and unmanned vessels that are likely to impose new and more stringent performance requirements particularly on navigation services and requirements.

How we get there

Issues remain which will need to be overcome. In particular, the sector as a whole needs to demonstrate more ownership of safety matters. Perhaps by leveraging bodies already in existence, and potentially in establishing new

⁶¹ www.trinityhouse.co.uk/about-us/media-centre/publications.

structures where there are gaps, continuous improvement in performance can be achieved. The industry already has all the necessary expertise and experience to understand what the problems are and how they can be addressed. Safety makes good business sense but it is only by working in partnership between industry bodies and regulators, such as the MCA and wider government that further progress will be made.

Improvements in GNSS will lead to increased accuracy, availability and integrity in what has already become the primary means of navigation for most mariners. The need to mitigate the risks inherent in GNSS vulnerability will undoubtedly see new aids to navigation emerge to provide support and additional resilience within marine navigation. These issues have been considered by government through the Blackett Review⁶². Further work exploring the Review's conclusions is underway involving experts from the GLA's Research and Development (GRAD) team.

The industry will also need to cope with an emerging lack of experienced seafarers, superintendents, surveyors and pilots. The demographic is also changing with rapid advancement and promotion resulting in higher levels of responsibility with less practical experience than in the past.

An increasingly reliance on technology combined with less opportunity to practice and perfect the traditional navigation skills that are critical during system outages and failures will also need to be addressed. Human performance and limitation considerations will need to be incorporated into the development of new technologies. It is only when this is done that the use of new technology can be optimised and lead to safer working practices. Such work will require new research and clear delivery, to roll out practical training so that individuals can be confident they understand the systems, their purposes and how to implement corrective measures should the systems go wrong.

The journey will not be easy and, although 2050 seems a long way away, government and industry will need to start working in partnership now to ensure that the vision outlined above can become a reality. The steps necessary to get us there, and those who will need to work in partnership and offer leadership to deliver this vision, will be outlined in the Safety Action Plan and other documents and initiatives including future Maritime Safety Weeks.

There are, however, already strong foundations for delivery including, for example, the development and evolution of the High Impact/Low Frequency (HiLo) programme (see case study below).

Safety has always been subject to constant and, at times, transformative change but the pace of that change is only likely to increase in the period running up to 2050 particularly as new technologies are harnessed. These developments have the potential for improving safety, efficiency and environmental protection but bring their own challenges, vulnerabilities and

⁶² www.gov.uk/government/publications/satellite-derived-time-and-position-blackett-review.

risks, such as cyber security (considered in more detail in the security chapter) which must be recognised and addressed.

HiLo Project

Founded in 2016 by Shell Shipping and Maritime, Maersk Tankers A/S and Lloyd's Register Consulting and formally launched in 2018, HiLo⁶³ is a predictive model that uses ship data to highlight a pattern of events that could lead to a major incident. The information is used to identify low level accident pre-cursors and flag these in order to prevent high impact incidents before they happen.

The technology has already been used successfully in the air, rail and nuclear industries and can be applied to all ships. The analysis, which is presented in largely visual formats, is anonymised to allow everyone to benefit from the identification of trends and can be used to target the specific areas in which safety should be improved. This, in turn, will facilitate improvements in overall safety performance.

The system makes clear recommendations which can underpin decision-making and delivers safety alerts following reported events, quarterly reports and analysis and deep dives to understand key drivers of risk and

To stay ahead of the game the UK must be proactive in anticipating emerging requirements and flexible in adapting to change. This period will also witness the emergence of autonomous and unmanned vessels that are likely to impose new and more stringent performance requirements particularly on navigation services.

Recommendations

Short term (1-5 years)

- Government will ensure the UK continues to provide a significant contribution to the development of international frameworks on safety measures through the IMO organisations.
- Government will continue to support the GLAs in safeguarding shipping and seafarers, and encourage further improvements at international level through IALA.
- Government will develop a Safety Action Plan to explain what it is doing to improve safety, highlighting future actions and priorities.

⁶³ <https://hilomrm.com>

- Government will continue to develop Maritime Safety Week in partnership with industry and other stakeholders, celebrating work already underway, and encouraging innovation and sharing of best practice.
- Government will provide a significant contribution to the IMO's working groups on the development of a Universal Maritime Data Model.

Medium term (5-15 years)

- Government will support industry to further develop and expand the HiLo system.
- Government will review its mariner training and certification regimes to ensure they are fit for purpose and reflect the realities of roles on modern ships whilst maintaining a basis in traditional mariner skills and facilitating continuous improvement.
- Government will continue to support the GLAs to research innovative e-Navigation solutions and improve resilience where possible, as well as working in the IMO to ensure that regulatory requirements, guidelines and training regimes recognise developments and are continuously improved.

Long term (15 years and beyond)

- Government will consider either through the creation of a body, similar to RSSB, or utilising existing maritime agencies, a dedicated focus can be brought to researching accident precursors, driving continuous improvement and applying lessons learned from other sectors, to safety performance.

5.8 UK flag

International law requires that every merchant ship be registered in a country, called its flag state. A ship is subject to the law of its flag state. It is usual to say that the ship sails under the flag of the country of registration. A ship's flag state exercises regulatory control over the vessel and is required to inspect it regularly, certify the ship's equipment and crew, and issue safety and pollution prevention documents. The organisation which actually registers the ship is known as its registry. Registries may be governmental or private agencies.

In the UK our flag state responsibilities are administered by the UK Ship Register part of the MCA but with significant separate staffing arrangements. The MCA administer the survey and inspection responsibilities through new customer focussed operating standards and practices.



Where we are now

The government is fully committed to supporting the UKSR. It believes that the UKSR should have the capability and flexibility to be at the forefront of global shipping. It also believes the UKSR is one of the most significant indicators to the global shipping community that the UK is synonymous with offering a premium service. A service that is fully commercial and customer focussed but does not diminish on standards or on fundamental principles such as the safety of the global fleet. UK Ministers are closely engaged with the UKSR and provide support where it is needed, such as in the direct interaction with the register's customers when sought. They also give the register flexibility to operate commercially.

The UK flag has long been a byword for a quality and respected flag. It operates in a highly competitive market place with a range of other flags, many of which offer competitive pricing or other incentives to attract ships to their flags. Quality of flags and the service they offer also varies significantly with some flags being priced favourably but offering differing standards.

Despite that high level of competition, the UKSR has made a determined and consistent choice, fully aligned with the government's maritime values covered earlier in this report, to maintain a flag that is recognised for its quality and maintenance of high standards. This is clearly demonstrated by the UKSR's consistently high rankings on both the Paris and Tokyo MoU White lists which are the key indicators of performance of flag states.

The UKSR is continuously evolving and responding to the needs of the shipping sector. So, in recent years recognising that its customer service performance did not match the needs of the industry it has taken a number of significant steps. Examples of this include a now 24/7 operation with Customer Account Managers and Technical Managers available to customers around the clock to make doing business easy. The associated surveyor workforce too is always available with an international presence making it easier than ever before to respond swiftly to customer needs. The UKSR has also introduced far greater flexibility into its offer providing different fee packages, competitive pricing and the delegation of surveys and audits to approved classification societies.

As a result of this activity, the UKSR has grown 18% since 2015 reflecting the strong ambition of the government to grow the flag. However, in such a competitive environment, with a peripatetic shipping sector influenced heavily by price and certainty, there is currently a challenge to keep growing the UKSR.

Where we are going

The vision for 2050 in this area is:

The UK will be one of the top 10 registers in the world in terms of tonnage. The UKSR will be the natural register of choice for quality fleets. It will be one of the leading flags for large yachts and the UKSR will become the natural home as the leading global register authority for autonomous and semi-autonomous vessels. The UKSR brand will continue to be recognised a quality brand. The UKSR will be in the vanguard of any changes to future registration and survey and inspection principles utilising the power of the MCA to ensure a supportive and forward-looking legislative framework is in place. Constantly evolving and improving, the UKSR will be known for the very highest levels of customer service with undiminished standards.

The UK sees its flag as an integral part of its maritime package but that it will require the UKSR to constantly evolve and adapt. Whatever form future registration takes and however standards are maintained the government expects the UKSR to be in the vanguard. The UKSR projects quality UK standards of safety and security principles on the global shipping fleet. It potentially supports the maintenance of the global supply chain into and out of the UK. In the absence of a large domestic shipping fleet it demonstrates the value the UK continues to attach to the global shipping fleet and it provides soft influence in the IMO where we seek to demonstrate global leadership.

Risks, threats and opportunities

As reflected earlier in this section the UKSR operates in a climate of fierce competition with a number of other European and international flag states. It is highly likely that competition will continue and indeed escalate in the coming years. The UKSR is evolving and will continue to do so to match and better the competition. Associated sub-themes already covered in this chapter are crucial here and will have a significant impact on the UKSR's success. For example, this chapter has explored the need to ensure fiscal competitiveness in the long term future.

The UK's flagging system is tonnage tax blind but having an appealing and competitive tonnage tax system is no less important. The UKSR is also a valuable element of the wider clustering effect already covered. The UKSR can be an attractor of maritime businesses and specifically shipping companies to the UK. It can also benefit from the wider cluster effect of companies being attracted by our quality business services, our high performing ports and our collective government and industry ambitions to

grow the maritime sector. So, the UKSR's success is inexorably linked to the wider ability of the UK to remain a competitive and attractive destination for the global maritime sector. Registration may also fundamentally change in the future. Again, with the expertise and thought leadership of the UKSR and the MCA the UK will be alert to making any changes and will lead the way to ensure the UK remains competitive. Regardless of any changes the UK will be determined to maintain and improve the standards of the global shipping fleet and future supply chain security.

The UKSR is determined to be an agile and responsive organisation. It will seek to maximise any opportunities from any changes to its global status. It will be well placed to anticipate changes to the global fleet, as indicated in later chapters on technology and the environment, and provide new products and services that meet the needs of new and existing customers. The UKSR will continue to identify what it needs to grow into the second half of the 21st century and will be able to readily engage with government to ensure it has what it needs.

How we get there

The UKSR has clearly set out its ambition is to innovate at speed. The needs of its customers will be central to future changes. Already the UKSRF has significantly improved its customer accessibility through new staff and a dedicated website. In the short term many of its processes such as registration, certification and verification will be available online making processes simpler and more convenient. The UKSR will have the ability to match customer expectations for responsive and quality survey and inspection both through the MCA's workforce available in the UK or internationally or through approved classification societies.

The UKSR will also promote its offer aggressively worldwide with a clear communications and marketing strategy. This will include a clear targeted plan for attracting particular companies onto the register which match our ambitions for the global shipping fleet. The UKSR will review its existing representation overseas and consider the opportunity to grown and enhance that network to bring its services more closely to its customers. Similarly, the way in which classification societies are used will be kept under regular review to ensure they match customer expectations and offer the benefits expected of them whilst maintaining the quality service levels that the UKSR expects.

As the global shipping fleet changes with different types of vessel or new technologies and environmental performance so the UKSR will provide a flag of choice. Working collectively with government and the maritime sector, the UKSR will take a long term horizon scanning approach to ensure that it is able to attract the future global shipping fleet and match and exceed customer expectations. It will be open to quality vessels in excess of 500GT trading internationally. In addition, fees will be reviewed annually for these vessels.

The government will continue to be highly supportive of the UKSR both directly, and through the MCA. Government will keep under constant review

what the register needs to continue to grow and will support it. This may be through policy and legislative support such as the future reform of the Merchant Shipping Act 1995 and other secondary legislation. As set out earlier government will continue to work with the register to provide the thought leadership necessary to anticipate future changes in the global fleet and to ensure that the UK flag is the flag of choice. Government will work with the UKSR to ensure it has the capability and tools it needs to continue to grow the flag. The UKSR will continue to evolve, innovate and be responsive to customers whilst offering a premium level of service and quality.

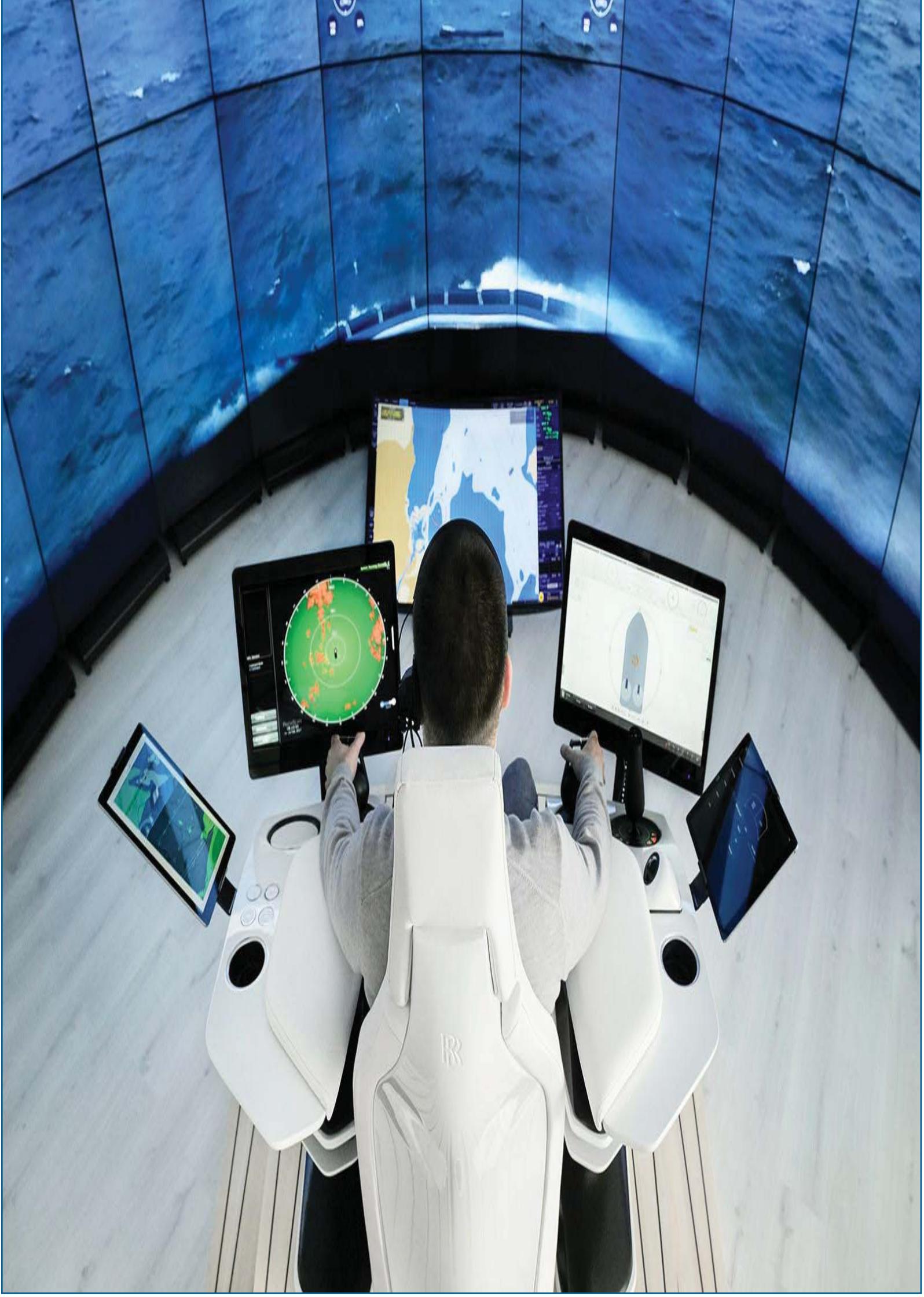
Recommendations

Short term (1-5 years)

- The UKSR will keep under constant review the capability and services it needs to provide a high-quality customer service.
- The UKSR will put in place a communications and marketing strategy to increase its promotion globally and attract companies to the UK flag.
- The UKSR will develop a 'horizon scanning' capability working with the government and maritime sector as appropriate. This will anticipate and lead the way in implementing changes in registration and in the global shipping fleet.

Long term (15 years and beyond)

- Through the MCA, the UK will lead the way in any future changes to the way in which the global shipping fleet is surveyed and inspected and future flag state responsibilities.



6. Technology

UK vision for maritime technology in 2050

Smart shipping and autonomy will make the sector a cleaner, safer, and more efficient place to work. Technology will create new, highly-skilled, job opportunities - helping to make maritime careers more attractive to a more diverse range of people. Digitalisation, big data analytics, and more robust communications will ensure that ships and ports are better connected and improve business decisions. Effective management of huge data-sets by increasingly sophisticated artificial intelligence will realise significant cost savings and ensure more efficient logistics and supply chains. Distributed manufacturing and 3D printing could lead to a 'post-container' society with a correspondingly drastic impact on ship and port design, port location, and the nature of maritime traffic.

6.1 Introduction

One of the most obvious and radical transformations to the world by the middle of the 21st century will be through technology. The maritime sector will not be exempt to this. It will be radically transformed by 2050. Testing of the boundaries and trials of cutting-edge science is already starting in pockets around the world. The UK has to be on board and making a difference quickly. It is only through close collaboration between government, industry and academia that the UK will realise the benefits of a culture of innovation and technology advancement in terms of export opportunities, highly-skilled job creation, and the regeneration of coastal communities.

A wide range of the Maritime 2050 call for evidence responses reflected the importance of technology to the sector. These included support for the commercialisation of technology, support for British SMEs, the importance of capturing the benefits of increased volumes of data and associated digital technologies, and capitalising upon the UK's role as a global 'innovation hub' as well as stressing the economic, regulatory, and legal challenges around introducing new technologies. This chapter outlines some technologies that are key to the future of the maritime sector and considers the benefits they can bring:

- Advanced ship-board technology and autonomous shipping.
- The development of connected 'smart ports', linked seamlessly into digital and physical supply chains.
- The rapid pace of digitalisation and its potential to modernise centuries-old business practices.
- The enabling communications and navigational ecosystem in which these new developments will take place.

Themed sections on these four technology trends outline the current developments in the maritime sector, with particular reference to the UK, and consider risks, threats and opportunities arising from the development of such technologies. The nature of technology means that there is a high degree of inter-connectivity between each of the sections with developments in one topic influencing, enabling and multiplying the effects of the other three. This approach has been deliberately selective to reflect areas where the UK has existing strengths and expertise and consider how best to utilise these strong foundations to realise economic growth and future successes in maritime.

The burgeoning technology sector is delivering very rapid change, far outstripping the capability of existing business practices and models of governance and regulation. With these changes come potentially significant financial impacts, and the UK must harness these benefits as early as possible. However, developing and successfully commercialising new technology can be risky. The House of Commons Select Committee on Science and Technology identified the role government can play in bridging the so-called 'valley of death' between research and commercialisation.⁶⁴ This role has been realised in other sectors with organisations such as the Aerospace Technology Institute (ATI).

The UK is a centre of innovation, with a digital technology sector worth £184bn and employing over 1 million people around the UK.⁶⁵ The UK develops world-class maritime equipment, and is particularly strong in producing navigational and safety devices. But there have been times when the new technology has failed to bring a product successfully to market. Call for evidence responses were conscious of this and called for more support to ensure that the germination of ideas does not falter at an early stage, with the consequence that the ongoing production is realised elsewhere in the world.

Government drives and supports UK innovation through bodies such as Innovate UK, and through the Industrial Strategy^{66,67}. Maritime technological innovation relates to three of the 'Grand Challenges' identified in the Industrial Strategy: clean growth, artificial intelligence and data, and the future of mobility. The development and commercialisation of 'green' maritime technologies will help maximise the advantages for UK industry from the global shift to clean growth (see Environment chapter for more detail). Digitalisation, or the adoption of digital technologies to improve business practices across the sector will help to leverage the UK's existing strengths in AI and the data-driven economy to ensure the UK remains at the forefront of the AI and data revolution.

Finally, new maritime technologies and their applications are a critical element of the future of mobility. New maritime technology will require the development of adaptive regulatory frameworks, help make ships into low

⁶⁴ <https://publications.parliament.uk/pa/cm201213/cmselect/cmsctech/348/348.pdf>

⁶⁵ <https://www.ft.com/content/401955c2-58f1-11e8-bdb7-f6677d2e1ce8>

⁶⁶ <https://www.gov.uk/government/organisations/innovate-uk>

⁶⁷ <https://www.gov.uk/government/topical-events/the-uks-industrial-strategy>

emission vehicles and facilitate the use of data to maximise the benefits of new transport models.

New technology should also be resilient and robust, well-protected against increasing threat of cyber-attack. Government promotes the concept of technology that is 'Secure by Design', with inbuilt security capabilities available as soon as new technology is introduced⁶⁸. The critical importance of cyber security to the maritime sector cuts across almost all types of new technologies explored in this chapter and is also considered as part of the Security chapter.

The sheer scale and global landscape of technological innovation requires the UK to be strategic, identifying and seeking to work with small firms, academia, large UK companies, and international partners who are actively developing maritime technology strategies such as Denmark and the Netherlands. Government and industry must work together to develop international collaborative efforts, sharing information and profitably exporting hard technology and soft skills in the spirit of a free-trading, outward-looking, global Britain.

6.2 Trends affecting the future of technology

Environmental imperatives in global shipping

There is increasing pressure upon the maritime sector to reduce its carbon and pollutant emissions. In 2020 a sulphur cap will come into force. The IMO has recently agreed ambitious global targets for at least 50% carbon reduction by shipping by 2050. The need to meet new environmental targets will require the use of new, innovative technologies. These are addressed in detail in the Environment theme chapter but the recommendations in this chapter are designed to be applicable to the development of all technologies, including green technologies.

Cost reduction

Technology adoption in the maritime sector will be primarily driven by the benefits it can deliver. Low margins, long asset life-cycles, and the problem of split incentives (between ship builders, ship owners, and charterers) means that the maritime sector is not always quick to adopt new technologies. In the maritime sector, the sharing of ideas and technologies between government and industry has historically heralded transformative change. The US military pioneered the first worldwide application of intermodal containers during the Vietnam War. Malcom McLean, a trucking entrepreneur, then developed this idea with Keith Tantlinger to invent the modern shipping container⁶⁹.

⁶⁸https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/686089/Secure_by_Design_Report_.pdf

⁶⁹ 'How the Vietnam War Gave Birth To Container Shipping' at <http://digg.com/2017/containers-episode-1>

Disruptive business models

Technology companies such as Google, Amazon, and Alibaba have already demonstrated their willingness to innovate where business is concerned. New business models could revolutionise the traditional maritime sector, and a willingness to embrace technology and the risks associated with innovation will allow existing industry players to anticipate and adapt to this new environment. Major technological developments, such as fintech⁷⁰, which can transform the maritime sector are as likely to come from outside the sector as they are from within it. Identifying and responding to these developments requires strategic thinking from industry and government, considering the wide range of technological expertise existing in the UK. Government has a key role to play as a facilitator, drawing together this expertise.

6.3 Future of shipping

The 2050 the vision in this area is:

The UK will be a world-leader in the design, manufacture, uptake, and use of maritime autonomy and other innovative ship-board technologies. Having led the development of an international regulatory framework, UK companies will capture the benefits offered through the export, use, and commercialisation of maritime autonomous and innovative technologies. These technologies will be 'secure by design', with vessels displaying resilience towards cyber-security threats.

Where we are now

The global fleet is diverse and contains over 50,000 different vessels, with tens of thousands more operating domestically in the UK. This makes it hard to generalise how technology will be used. Different types of vessel (tankers, roll-on roll-off ferries, wet and dry bulk carriers) move different types of goods (liquids, passengers and vehicles, and materials such as wood, minerals and grain) to different locations⁷¹. The vessels of today already have some degree of digitalisation and automation on board, such as Electronic Chart Display

and Information Systems (ECDIS), which have replaced paper charts as a means for vessels to navigate around the globe.



The future will see an acceleration of these trends as vessels become 'smarter'. Lloyds Register Foundation defines smart ships as 'a manifestation of the utilisation

⁷⁰ A portmanteau of financial technology used describe new technology that seeks to improve and automate the delivery and use of financial services.

⁷¹ <https://www.statista.com/statistics/264024/number-of-merchant-ships-worldwide-by-type/secure>

and exploitation of technology trends'.⁷² 'Smart shipping' refers to the increasing adoption of technologies such as autonomous systems, AI and robotics and sensors.

The materials used to build new vessels may change. The vast majority of the world's merchant fleet is currently constructed from steel, and has been for over a century. New materials, such as composites, could have an impact on safety and efficiency by making new vessels lighter and stronger, improving corrosion resistance, reducing bio-fouling, extending vessel lifetime and reducing maintenance costs. High upfront costs and uncertainty over lifetime benefits, safety and environmental impacts will however lead to slow adoption rates.

A major technological trend currently taking place in the sector is the development of Maritime Autonomous Surface Ships (MASS). These vessels are ones which, to a varying degree, can operate independently of human interaction. Consequently, the technology on board these ships can be used to support how human crews interact with increasingly complicated machinery. It can increase vessel and seafarer efficiency, optimising performance using advanced data analytics and improving safety by reducing human error, which account for the vast majority of marine accidents⁷³. The range of potential benefits and impacts on our maritime workforce are considered more fully in the People chapter.



Autonomous systems help improve operational safety for a wide range of tasks, such as mooring vessels to quays and docks, mine-sweeping operations, long endurance missions in harsh climates, exploring the deep ocean, surveying the world's seas for critical bathymetric and environmental data, and piloting, the practice of guiding a vessel to port using specific routes. The UK currently develops world-class ship-based technology, particularly lifesaving equipment. The British company Survitec is a market leader, producing innovative life-saving equipment on board vessels and B&G Marine Electronics specialise in sail racing and navigational equipment that

⁷² <https://www.lr.org/en/insights/global-marine-trends-2030/global-marine-technology-trends-2030/>

⁷³ <https://www.maritimejournal.com/news101/insurance,-legal-and-finance/human-error-accounts-for-75-of-marine-liability-losses>

has been used on-board every winner of the Volvo Ocean Race (a trans-global yachting race) since it began in 1973⁷⁴.

Other leading maritime nations recognise the importance of technology and innovation to the future of their sectors. In order to not fall behind its major international competitors, the UK should also place technology development at the heart of its future. For example, Scandinavian countries and Singapore are proactive in the development of new maritime technologies, and the Danish government has an ambition to be a world-leader in the field of maritime autonomy. In Norway, the partially state-owned technology company Kongsberg is working with fertiliser provider Yara to build the Yara Birkeland, a fully-autonomous, zero-emission vessel concept which will replace 40,000 road trips⁷⁵.

The UK already enjoys a world-leading position in the development of navigational and safety equipment and there is a real opportunity for the UK to benefit from newer technologies such as those enabling maritime autonomy. The technology to make vessels smarter and advance automation is largely available today and can be brought across from other sectors. Scaling this technology up for the maritime sector should be seen as an opportunity rather than a barrier. New technologies can also help to address large skills gaps in the maritime sector, whilst also creating new, highly-skilled jobs both at sea and on shore.

Risks relating to the future of shipping include the impact of development of new technologies, such as maritime autonomy upon the workforce. Many technologies remain experimental and lack solid business cases, without which the maritime sector (an industry with low margins, split incentives, and long asset life-cycles) will be reluctant to adopt them. Poorly co-ordinated development of discrete but similar technologies risks interoperability issues, which are critical in an international industry such as maritime. A lack of international regulations and legal and insurance frameworks for technologies such as maritime autonomy limits confidence in these technologies and acts as a brake on their wider adoption. The major threat to more connected vessels, with their greater use of sensor and data analytics technologies, is increased vulnerability to cyber-attack. More broadly, cyber-security is an area of major concern to the maritime sector⁷⁶. Research by PEN Test Partners has demonstrated that vessels remain highly vulnerable to cyber-attack, with loopholes in IT systems that were fixed years ago in mainstream IT systems⁷⁷.

Government has an important role to play in the development of new ship-board technologies. UK companies have worked closely with Scandinavian governments in developing technology, requiring the government to take a more active role as it seeks to collaborate with existing international efforts whilst effectively leveraging its own strengths in this area.

⁷⁴ <https://survitecgroup.com/marine/>

⁷⁵ <https://www.kongsberg.com/ks/web/nokbg0240.nsf/AllWeb/4B8113B707A50A4FC125811D00407045?OpenDocument>

⁷⁶ <https://www.marsh.com/uk/insights/research/global-maritime-issues-monitor-2018.html>

⁷⁷ <https://www.pentestpartners.com/security-blog/hacking-tracking-stealing-and-sinking-ships/>

The UK has a major role to play in providing industry with a strategic, long term vision for the future of shipping. Domestically, government will develop a regulatory framework to allow for the safe testing and operation of autonomous vessels in UK waters and will lead international efforts to regulate for new technologies at the IMO. The government (through the MCA) has already adopted a constructive approach to the testing of technologies such as maritime autonomous systems, working closely with innovators to provide advice and support on how and where to test new technologies.

Where we are going

The UK will set an ambitious vision for the use of technology in the maritime sector, and will have provided support and advice to maritime innovators. Autonomous and remotely operated vessels will become more popular, taking humans out of unsafe situations and providing a wide range of new, highly-skilled jobs around the UK. Government and industry will collaborate to bring in expertise from beyond the sector, learning lessons and best practice to help make the UK a pioneer in maritime technology and innovation in shipping. The UK will implement an innovative domestic regulatory framework for maritime autonomy, using the experienced gained to support the development of an international regulatory framework at the IMO.

How we get there

The government already offers financial support to UK innovators through its Transport Technology Research and Innovation Grants (T-TRIG), which have supported a number of innovative projects to develop maritime technology, including smart shipping. Likewise, the government will provide £1 million for the development of an innovation lab through the Regulators Pioneer Fund.

The UK sets out its action plan for smart shipping in the Technology and Innovation route map. This document has been collaboratively developed with industry and identifies policy priorities in five major areas: vision, technology, infrastructure, skills, and regulation. In conjunction with this, government will work with industry, providing regulatory advice for a series of UK-based 'flagship projects'. These projects, initiated by key industrial partners, will provide use cases, business cases, and proofs of concept for smart shipping and maritime autonomous systems ensuring that by 2025, the UK will be a hub of innovation for maritime autonomous systems.

One example of a flagship project is a collaboration between the Transport Systems Catapult, a not-for-profit technology and innovation company dedicated to making the UK a market leader in new technologies, and representatives of government, industry, and academia to develop a proof of concept for maritime mobility as a service, demonstrated by an autonomous electric ferry with the capability to run on-demand services between several key locations on Southampton Water. The aim is that the ferry will address the transport challenges arising from planned developments in the local area, easing congestion on local roads. The system will start fully supervised

(operator on board) and progressively work towards autonomous operation with remote safety supervision.

To ensure the safe, responsible development of new technologies, the government will lead on the development of legislation to enable a domestic regulatory framework for maritime autonomy and smart shipping providing certainty to investors and innovators. The UK will use this experience to lead international efforts to regulate smart shipping at the IMO and create a global framework for the safe and efficient operation of autonomous vessels. A vibrant technological research and development environment, a robust domestic framework for the use of autonomous systems, and a government committed to support an industry willing to innovate will make the UK flag very competitive as the ship register of choice for technologically-advanced and autonomous vessels by 2050.

Recommendations

Short term (1-5 years)

- Government and industry will deliver three flagship projects, developing technological proofs of concept and provide demonstrations of use cases for smart shipping.

Medium term (5-15 years)

- UK will legislate for a domestic framework for autonomous vessels to attract international business and allow testing in UK's territorial waters.
- Government will lead efforts to establish a new proactive and adaptive international regulatory framework for autonomous vessels at the IMO.

Long term (15 years and beyond)

- Government and industry to work together to achieve the first multi-modal autonomous freight movement through a UK port.

6.4 Smart ports

The 2050 vision on this area is:

UK ports will act as part of an advanced supply chain. Digitised, integrated with the wider end-to-end supply chain, and efficient, they will pioneer new business models which may change the national port landscape. This will potentially affect where ports are located, the cargoes they handle, the markets they serve, the skills and experience required to operate port equipment, the capacity to serve different types of vessels, and the size and

number of UK ports. Smart ports, like smart cities, will use a wide range of technologies, using data-driven and automated devices connected together within an 'internet of things', new data collection and analytical technologies and techniques can supply information for more safer and more efficient management of resources.

Where we are now

The UK has over 400 ports, which form a critical part of the country's maritime and logistics infrastructure and are major contributors to their local economies. As busy industrial areas, ports are always seeking improvements in safety and efficiency gains. They actively look for potential to maximise throughput of passengers, goods and containers. Digital technologies, combined with improvements to connecting inland infrastructure - such as cargo storage facilities, roads, and railways - can play a significant role in maximising throughput (for more information see the Infrastructure chapter).

A recent survey of terminal operators revealed that 75% of operators saw landside efficiency as a major concern suggesting a need to introduce technological improvements⁷⁸. Terminal automation, which involves robotics and AI technologies, can improve efficiency and increase safety on the port estate. It is at a relatively early stage but offers potentially lucrative business opportunities for innovators⁷⁹.

One such technology is the 'internet of Things' (IoT) - the network of devices and vehicles which are embedded with sensors and software. In the port context, IoT refers to a system of sensor-equipped machinery (cranes, cargo handlers, vehicles, vessels, etc.) sharing information via internet connections. IoT technologies, in conjunction with other information-sharing technology such as shared data platforms or applications (in which all interested parties



can track the movement of cargo in real-time), can synchronise processes within the port, reducing lorry and vessel waiting and cargo handling times and providing associated cost reductions and environmental benefits.

⁷⁸https://www.porttechnology.org/news/blog_digitally_improving_landside_efficiency_of_ports?utm_source=GatorMail&utm_medium=email&utm_campaign=Newsletter+Daily+15-11-2017&utm_term=%5bPTI+Daily%5d+Grounded+Feeder+Kea+Trader+Breaks+Up...DP+World+to+Test+Remo

⁷⁹ <http://www.portstrategy.com/news101/port-operations/port-services/automated-container-terminal-market-forecast-to-grow> and 'Container Terminal Automation, Pros Cons and Misconceptions', Neil Davidson, Port Technology International.

'Big data' refers to large data sets that can be analysed by computers to reveal patterns, trends and associations. The collection, storage and use of big data will become increasingly important to the effective operation of ports. Enhanced data on tidal patterns could improve the costly process of dredging (the clearing of access routes to ports), whereas better information and predictive algorithms to determine environmental impacts upon wharfs, jetties and piers can enhance the process of upgrading and maintaining port infrastructure by allowing upgrades to be more proactive.

In the UK ports such as DP World London Gateway have embraced automation in cargo handling⁸⁰. At London Gateway intermodal shipping containers are loaded or unloaded by automated cranes, part of a sophisticated tracking and cargo handling system that can locate individual containers amongst the thousands stored on site⁸¹. In the Port of Liverpool, automation of the Canada Dock bulk steel terminal allows two human operators to handle tens of thousands of tons of steel cargo and improve storage capacity by up to 50%⁸². As well as realising the benefits of new digital and automated processes, the UK ports sector has expressed a desire to consider new business models and innovative ways of using port estates, as articulated by the UK Major Ports Group's 'Port 2050' response to the Maritime 2050 call for evidence⁸³.

The Port of Dover uses a system of digital sensors (called BlipTrack) to detect anonymous Wi-Fi and Bluetooth signals from local vehicles and map the flow of traffic across the highway system. BlipTrack also gives traffic controllers in the port valuable real-time data about traffic flows, flagging up trouble spots and preventing time-consuming queues from forming. BlipTrack has helped to reduce bottlenecks outside the port, improving the experience of cross-channel ferry users and also the local community, which has historically been affected by heavy traffic in and around the port⁸⁴.

Globally, Singapore recently showcased a range of new technologies for ports including the use of robotics for container handling, drones to fulfil ship-to-shore deliveries and undertake terminal security, and the use of data analytics to simulate port operations and improve performance⁸⁵. In Rotterdam a mobile phone application (app) called 'Pronto' provides information to shipping companies, agents, terminal operators and other service providers with a joint platform for exchanging information related to port calls. The app provides real-time data on water depths, admission policies and departure times. A trial with Shell and other major shippers in 2017 allowed ships calling at the port to cut waiting times by 20%, reducing costs for shippers and CO₂ emissions at

⁸⁰ <https://www.theguardian.com/artanddesign/architecture-design-blog/2015/sep/15/london-gateway-mega-port-you-didnt-know-existed-docks>

⁸¹ <https://www.bbc.co.uk/news/business-41829864>

⁸² <https://www.portstrategy.com/news101/port-operations/cargo-handling/peels-fully-automated-terminal-bears-fruit>

⁸³ <http://ukmajorports.org.uk/port-2050-what-the-uks-biggest-ports-think-could-shape-the-port-of-tomorrow-and-boost-trade/>

⁸⁴ <https://www.doverport.co.uk/about/news/mobile-technology-helps-streamline-europes-busie/13095/>

⁸⁵ <https://www.maritime-executive.com/article/psa-singapore-showcases-future-port-technologies>

berth. It also allows for co-ordination of services such as bunkering, servicing and maintenance and provisioning⁸⁶.

Where we are going

UK infrastructure will be 'smart' by default. Connected and integrated, UK ports will model the importance of multi-modal logistics, improving efficiency and port hinterlands by reducing congestion and improving air quality. New, highly-skilled jobs and the creation of maritime clusters in UK port estates will help to regenerate Britain's coastal communities.

Risks, threats, and opportunities

New technologies and increased automation can make the port estate a safer place to work, for example potentially reducing injuries associated with cargo handling. And UK ports with the latest technology can be an even more attractive prospect for shippers. Technology can reduce labour costs, whilst also creating new, highly-skilled jobs and improving efficiency in the handling, storage, and onward movement of cargo.

Risks around the introduction of new port technologies include: high initial investments and the long time it takes to see a return on investment in new technologies can discourage innovation in ports. Ports must respond to the demands of their customers, and it is important that technology is interoperable with other systems around the world. Ultimately, smart ports and ships will be integral parts of an end-to-end smart logistics supply chain. The adoption of new digital technologies in UK ports could lead to changes in the work that existing port workforces do.

Outdated systems inside ports can be particularly vulnerable to cyber-threats, and new digital systems create new opportunities for intrusion. In ports, older operational technologies (OT) typically interface with newer information technology (IT) systems, creating a particularly acute risk of cyber-attack⁸⁷. OT are technologies, such as industrial control systems, that interface with the physical world (such as traffic lights).

The UK's range of port ownership models means that any technological development in the UK's ports will be led by industry. Government can play a role in helping the development of early-stage technology in the UK as it currently does with the ATI, a jointly-funded venture established with industry support. More widely where the internet of things is concerned, government is seeking to ensure robust cyber security through an expectation for future technologies to be 'Secure by Design', with cyber security measures built into new technology rather than added later⁸⁸.

⁸⁶ https://www.porttechnology.org/news/europes_largest_port_releases_app_to_optimize_shipping

⁸⁷ <https://www.ncsc.gov.uk/guidance/operational-technologies>

⁸⁸ https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/686089/Secure_by_Design_Report_.pdf

How we get there

Government and industry will collaborate to develop technology and foster innovation in our ports, continuing to encourage and participate in existing projects, such as Rolls Royce, ABP, and Svitzer's joint project to explore new technologies in a British port environment. Government is able to provide regulatory advice and, where beneficial, connect the industry to a range of experts to help the development of new technological solutions to the maritime sector's problems.

Industry has taken a lead in identifying new technologies for use in the UK's ports. Together, government and industry can play a critical role in early-stage technology development. This will help technology to cross the so-called 'valley of death' between initial research and development and commercialisation. Linking the UK's world-class science and engineering expertise to effective commercial opportunities is key to the growth of the UK economy and is being realised in other sectors through organisations such as the ATI⁸⁹. Together, government and industry should explore whether an equivalent body for the maritime sector is needed, or how to ensure that comparable activities to those performed by ATI can be undertaken in existing maritime bodies, by 2025.

The government will work with industry and the devolved administrations to establish a maritime 'innovation hub' in a UK port by 2030. This will become the basis for a network of R&D clusters around the UK. This approach will help attract broader technological talent into the maritime sector.

Smart ports will be a critical part of the smart cities to which they belong, reducing polluting emissions from UK ports, and generating new business opportunities for the UK's port operators. By 2050, ports will be multi-modal, connected intelligent distribution hubs, playing a major role in growing the UK's technological expertise and manufacturing capability alongside their historic role in supply chains.

Recommendations

Short term (1-5 years)

- Industry and government collaboration to find use cases and develop proof of concepts for new and existing technologies.
- Government will work with industry to develop a 'Maritime Innovation Hub' in a UK port as a result of an open competitive process. The hub will bring together expertise, support technology development, and boost regional productivity.

⁸⁹ <https://publications.parliament.uk/pa/cm201213/cmselect/cmsctech/348/348.pdf> and <https://www.ati.org.uk/>

Medium term (5-15 years)

- The UK will consider the need to establish the maritime equivalent of the Aerospace Technology Institute to help commercialise British R&D in the maritime sector or how to ensure the functions that the ATI perform are captured in existing maritime bodies.
- Building upon expertise gained through developing UK's existing Maritime Innovation Hub, develop a network of regional R&D clusters based in UK ports.

6.5 Digitalisation

The 2050 vision on this area is:

The UK maritime sector will be 'digital by default' with accessible, easy-to-use, and secure processes. Paperless maritime governance and e-registration of vessels will make the UK flag an attractive business prospect. Digitised, and standardised means of certifying skill levels will provide a transparent means of ensuring competence requirements. The real-time sharing of open data between all parts of the supply chain will drive efficiencies and generate significant cost savings, with digital seals offering better means of verifying cargo, 'smart contracts' allowing for the real-time calculation and adjustment of insurance premiums, and the throughput of ports and optimisation of routes is achieved through data analytics.

The digitalisation of society that began at the turn of the century started a step-change in the way that data is created, used, shared and stored. This has created huge societal and economic changes as entire industries have emerged, adapted to digitalisation or disappeared entirely. There are now over 11 billion internet connected devices in the world, set to rise to over 20 billion in 2020⁹⁰. The pace of digitalisation is therefore unlikely to reduce over the coming decades.



Digitalisation will be essential for the future of the maritime sector. The adoption of processes

⁹⁰ <https://www.gartner.com/en/newsroom/press-releases/2017-02-07-gartner-says-8-billion-connected-things-will-be-in-use-in-2017-up-31-percent-from-2016>

which both create and make use of existing digital information will generate benefits across the supply chain, reducing costs, improving efficiency, increasing the speed of digital transactions and creating new business opportunities.

The Internet of Things will generate some of this data, as newer vessels are built and new technologies installed which have this capability. Data analytics techniques and AI could be applied to review both new and existing data sets, driving substantial change to processes, identifying patterns and trends that are currently not well understood and leading to greater efficiencies in the maritime sector. Machine learning – using algorithms to create logic based on the evaluation of existing data – could also significantly change the approach that the sector takes towards maintenance, amongst other things. For example, by examining data, the likely failure of components can be forecasted and be used to develop a more predictable maintenance schedule for a vessel, allowing the optimal use of a ship owners assets.

In addition to the digitalisation of existing processes, new technologies such as distributed ledger technology – a decentralised information-sharing technology which could be used to track goods and support customs clearances – could completely change the way that the sector operates. It is estimated that the technology could save up to \$5.4m per shipment on large container ships⁹¹.

Blockchain

An example of a shared distributed ledger, capable of facilitating the process of recording transactions and tracking assets in a business network. The name stems from the fact that it stores data in blocks, interlinked as a chain.

What makes this technology interesting is that the asset can be any storage of value, either tangible such as a vessel, real estate property, a cargo, cash, etc., or intangible such as intellectual property. It is an innovative application of cryptography and information technology to record-keeping. The potential advantages of this technology over other existing transaction systems are: increased operational and cost efficiency since it eliminates the need of intermediaries and duplication of effort; fraud reduction; tighter security; improved auditability; transparency and thus, risk reduction.

Because of these properties, blockchain is able to improve upon traditional databases by ensuring that trust exists throughout a transactional chain, and provides interoperable systems and data for different organisations.

⁹¹<http://www.marineoffshoretechnology.net/features-news/digitalisation-shipping-here-stay>

Where we are now

The maritime sector continues to use a large number of paper-based or analogue processes and transactions, making them time consuming and inefficient. For example, bills of lading which set out the cargo on a vessel and act as proof that the cargo has been physically loaded on-board, are physically handled by the ship's master and handed over to the shipper. Seafarers are still required to prove that they meet training and certification standards through the production of physical documentation. Digitalisation could reduce the burden that these processes place on businesses and individuals.

There are an increasing number of demonstrator projects taking place which show how data analytics and digitalisation could be used to improve business processes across a range of sectors. Both established companies, such as Microsoft and IBM, and SMEs are pursuing these opportunities. \$500m in venture capital and other investment has been raised by US maritime start-ups in the past five years⁹². The UK has introduced a pilot National Maritime Single Window (NMSW) to enable the mandatory pre-arrival data provided by ships (including crew, passenger and cargo manifests), to be submitted to the relevant UK authorities digitally. The aim of the NMSW is to reduce burdens and costs on industry by simplifying and streamlining the submission of this data through a single electronic portal. The project has demonstrated that digitalisation is possible in the maritime environment and can provide significant benefits.

Where we are going

By 2050, a maritime digitalised world means digitalisation of existing processes improves the efficiency of shipping, with the sector broadly paperless by 2050. Globally agreed and harmonised or inter-operable standards mean that repetitive paper-based clearances are replaced by an International Single Window. This drastically cuts clearance times and allows vessels to make time-savings in port, allowing for more efficient use of assets and reducing average shipment times in the sector.

Seafarers use 'digital passports' to prove they have fulfilled their training and certification requirements, and their competence is instantly verifiable by anyone, anywhere in the world. Ports and shipping companies share their data openly, which has resulted in cost savings, increased efficiency, and reduced environmental impact, as routes are optimised and the throughput of ports is improved.

Distributed ledger technologies enable "smart contracts" to be instantly agreed at the lowest cost, and customers use the technology to have full confidence in the provenance of their goods, being able to track their shipments at all times from point of origin to point of arrival. The UK maritime services sector will have consolidated and maintained its world-leading

⁹² https://www.joc.com/technology/ready-or-not-digitalization-its-way_20171230.html

position through the effective exploitation of new digital and data-driven technologies.

How we get there

To realise the cost, environmental, and efficiency benefits of open data, government will work with the maritime sector to encourage the publication and sharing of as much data as possible. Government will consider how it can share more of its own data. For example, we will work with international partners to set standards for the digitalisation of paper-based processes and seafarer training and certification, to enable the take up of digital technologies and reduce the burden on business and seafarers.

Working in partnership with industry, government will support the uptake of new digital technologies, and the supporting ecosystem to create, make use of and analyse data. Innovation hubs located within UK ports will be used to pilot these technologies.

By 2030, all government managed maritime related business processes, such as certification and registration, will be digitalised in the UK with a 'digital by default' maritime business environment. The UKSR will be the world's first paperless registry by 2025.

Recommendations

Short term (1-5 years)

- Government will work with industry to understand the benefits to the maritime sector of innovative new technologies and government's role in supporting their development and use.

Medium term (5-15 years)

- UK will achieve full paperless governance of the maritime sector in the UK by 2030, including creating a fully-digital UK Ship Register by 2025.
- Government will put in place regulations and standards to ensure open data through systems like blockchain, allowing transparency, competition, and improved efficiency.

Long term (15 years and beyond)

- Through to 2050, the UK will lead efforts to set international standards at the IMO for digital technologies in the maritime sector to ensure interoperability.

6.6 Communication, navigation, and exploration

The vision for 2050 in this area is:

The UK will have implemented next-generation communications technologies that can be utilised securely by an increasingly connected and technologically advanced maritime sector. This connectivity will be underpinned by resilient, high-bandwidth satellite technology that provides global coverage and is developed, built and launched from the UK.

Autonomous technology has enabled the high-resolution mapping of the UK's EEZ and the UK has championed an international coalition to map the seabed of international waters, capturing the economic benefits of the deep ocean environment through ecologically responsible use of marine resources, such as seabed mining.

The data that has been gathered has been successfully digitised into 'smart charts', used for the safe navigation of unmanned and autonomous vessels, and the UK remains a world leader in hydrography, exporting this data for global use.

Where we are now

In the marine environment it is essential that vessels and their crew are able to communicate with each other and easily locate themselves at all times. Underpinning this requirement is communications infrastructure and technologies such as satellites, cellular networks and very high frequency (VHF) radio.

Satellite technology also provides location data with a high degree of accuracy through international radio navigation systems with global coverage, known as GNSS such as the US' global positioning system (GPS), the EU's Galileo, and Russia's GLONASS. When combined with marine geospatial data, this allows for safe navigation at sea and on inland waterways. This was considered in more detail in the safety sub-theme including some of the challenges.

The UK is a world-leader in satellite technology and in the collection and use of geospatial data, capturing around 7% of the global market for space technology⁹³. In future, it is likely that the maritime demands placed on our communications infrastructure will increase as vessels become more connected and autonomous. In these circumstances, the requirement for geospatial data in a format that can be used by these vessels, can only grow.

⁹³<https://www.techuk.org/insights/news/item/5256-the-contribution-of-space-and-satellite-industry-to-the-uk-economy>

The UK is also leading the way in the use of drone technology, implementing a regulatory framework which balances safety with innovation. There are several potential



uses in the maritime sphere which are covered in the Environment chapter. Another potential application is in safety. The MCA in partnership with the RNLI and industry have already carried out trials to explore how drones could act as an additional tool in search and rescue.

Communications

Whilst the current coverage, bandwidth and latency available from communications infrastructure is sufficient for today's maritime requirements, as technology evolves demand for bandwidth will only increase. Remotely operated and autonomous vessels could place an increasing strain on capacity if this is not expanded to meet demand. As Arctic trade routes become viable and more attractive to shipping companies, satellite coverage of these remote areas will be essential to ensuring the safety of vessels operating within them. Innovation will support this, with technologies such as CubeSats (miniaturised satellites used for space research) lowering the cost of launching and operating satellites by up to 90%, providing more bandwidth and increased coverage to deliver the communication and data requirements of the maritime sector in future.

Geospatial

Government has supported innovative methods to collect and use geospatial data to aid maritime navigation, particularly of autonomous vessels through the T-TRIG scheme⁹⁴. Projects such as these are essential to understanding what the future maritime requirements of navigational data will be, and enable the establishment of standards for 'smart charts', the format in which geospatial data will be used in future for navigation by vessels which may be unmanned or operating autonomously.

The collection of hydrographic data is also essential to unlocking some of the economic potential of the marine environment. Over 80% of the world's oceans and sea beds are unmapped, and using traditional techniques gathering this data would be costly and uneconomical. Technology can be a force to overcome this obstacle and enable the mapping, in detail, of previously impossible to survey areas. Autonomous and unmanned technologies could reduce the cost of gathering hydrographic data and enable

⁹⁴ <https://www.dft.gov.uk/innovation-grants/>

faster data collection. Seabed mapping is a global priority, as reflected by the Foresight Future of the Sea report and recent G7 commitments⁹⁵.

The UK has the fifth largest EEZ in the world to exploit, at 6,805,586 sq. km spread across the Atlantic, Pacific and Indian Oceans – 28 times the UK's land area. Only 30% of this EEZ is currently mapped, and mapping the remainder could reveal untapped resources and increase the economic return from the UK maritime sector as they participate in realising these opportunities. The Irish government is undertaking a similar exercise (INFOMAR)⁹⁶ and this programme contributed an estimated €24.5 million to the Irish economy in 2016 against annual programme costs of €3-4 million, a return of €6-€8 on every euro invested.

Mapping the EEZ provides data that can be used by offshore industries, including aquaculture and fisheries information, as well as the energy sector. Autonomous technologies and new methods of powering research vessels using battery, solar, wind or wave power will reduce the cost of such an exercise and are a tipping point for their economic viability. Expanding data gathering beyond the UK EEZ, using the world-leading capability of the UKHO, would create new products and services that could be exported globally, maximising the return for the UK.

Where we are going

Deploying highly connected and secure technologies, the UK maritime sector will be at the forefront of international maritime communications. Resilient, high-bandwidth satellite technology developed, built, and launched in the UK will provide better connectivity between sea and shore, but also between maritime and other elements of the supply chain, as well as bringing benefits to seafarer welfare by improving their mental health. Autonomous technology coupled with advanced data analytics will allow the UK to map the seabed of its EEZ and the UK will champion the work of an international coalition to help better understand and sustainably engage with the deep ocean environment and its vital resources. Advanced hydrography has gathered data for 'smart charts', and the UK has maintained its position as a global pioneer in hydrography, exporting this data for use around the world.

How we get there

The government is committed to grow the value of the UK's satellite industry to £19bn by 2020, and capture 10% of the global market by 2030. Government will support industry as they develop standards for maritime data and communications technologies that maximise available bandwidth and enable secure communication between vessels and shore. Innovations such as CubeSat will be used to ensure global coverage for new trade routes, securing safe transit in previously unnavigable waters.

⁹⁵ <https://www.gov.uk/government/news/uk-hydrographic-office-supports-g7-healthy-oceans-commitments>

⁹⁶ <http://www.infomar.ie/>

Government will secure the UK's strong position in hydrography and geospatial data, supporting collaboration between the UKHO, the MCA and experts from industry, academia and government to develop and commercialise the navigation and safety data requirements necessary for unmanned and autonomous vessels.

Government will lead efforts to map the UK EEZ, making use of autonomous vessels to support this aim. The UK will establish a national marine data collection programme which supplements existing geospatial data with that shared by the navigational 'internet of everything' including autonomous vessels and marine infrastructure (such as offshore wind turbines and oil and gas platforms). The expertise developed through this will be used to support international efforts to map the world's sea beds.

Drawing on the work of the Geospatial Commission and the industry-led work, the UK will develop a virtual Marine Geospatial Innovation Centre. This platform will enable partners from across industry, academia and government to access the 'best-view' picture of the UK EEZ and collaborate to develop new applications. The approach will support entrepreneurship, enable the development of new skills and expertise and support the commercialisation of new ideas.

Recommendations

Short term (1-5 years)

- Government will commission a study into the potential for 'Future Navigation', understanding what information the sector requires and UK capabilities to provide it.
- UK to commence charting its own seabed and EEZ seabed using autonomous vessels to understand the potential economic benefits of the seafloor.

Medium term (5-15 years)

- Working together, government and industry will link existing UK space manufacturing and R&D capabilities to the maritime sector, considering how relevant technologies and facilities can be used to unlock cross-sector potential.

Long term (15 years and beyond)

- UK will be at the forefront of international efforts to chart the international seabed area, helping us to understand how to sustainably manage and benefit from the global ocean environment and creating exportable hard technology and soft skills.



7. People

UK vision for people in maritime in 2050

The skills profile of the maritime industry will change as more technology and automation is used in the sector, resulting in more highly skilled and technical roles in the workforce. Some roles will move ashore and workforce diversity will improve. For those at sea, better connectivity will improve conditions, but the opportunities for face to face interaction will decrease as some of the traditionally sea-based roles move ashore.

7.1 Introduction

This chapter demonstrates the opportunities that currently exist for people in the maritime sector and those that will be created in the future as new technologies are embraced. Maritime's success has always been heavily dependent on the people involved in it. That story will not change and it is one which will remain true long into the future. What will change are many of the roles that people will be engaged in, both at sea and on shore.

To attract the interest of the future maritime employee, the sector must engage and inspire them. This includes making sure that school children understand the great number of opportunities that exist on shore and at sea. They also need to recognise that maritime careers do not have to mean heavy, dirty and dangerous careers with many months away from home. Rather, maritime does and will deliver varied and exciting career opportunities. Consequently, employees of the future could be at the centre of shipping or port operations, or using their highly regarded IT skills from within a control centre. Alternatively, they could be highly trained engineers who are at the cutting edge of science, working on the challenges that could transform the sector going into the latter years of the 21st century.

The UK's success in delivering the best quality skills lies in its educational system. Key to this has been the development of the UK's world-leading maritime training programmes in our colleges and universities and in workplaces apprenticeships. There has been and will continue to be a solid partnership between universities, training institutions, government, regulators and directly with UK-based maritime companies. Together, these bodies are capable of providing the training packages needed to maximise the UK maritime workforce's global footprint at sea and on shore, long into the future.

It is not just the newcomers to the sector who will require new skills. Training and education need to be lifelong, giving the workforce the support they need to access new opportunities in emerging maritime roles. In turn, the workforce will need to be adaptable and ready for change. In particular, those who want to make the critical transition into roles on shore will need to attain the skills and training needed to make a successful move into leading roles.

Underpinning the UK maritime skills and training offer is an assurance that the UK is committed to attracting a diverse workforce, all of whom should enjoy a supportive working environment, paying competitive salaries and with a clear framework of employment standards. We want that framework to set a global benchmark that any like-minded nations will envy. Those working at sea should have comparable conditions to those working on land. Currently it is easy for countries to accommodate the international regulatory minimum when it comes to employment practices, pay and reward, mental health and social care. The UK believes that going beyond this minimum, providing high levels of staff care and wellbeing, brings benefits to the productivity of the sector as a whole. As such, the UK will lead the way in addressing maritime welfare issues.

People vision



In 2050 the UK maritime sector will be an increasingly high-tech industry employing a highly skilled and diverse workforce. The focus will have shifted from career specialisation onto attaining a wider range of transferrable skills, supported by continual learning. It will involve working with cutting edge technologies, designing and developing new systems, and creating new software and hardware. There will be a wide range of different jobs across the sector both on shore and at sea, with clear career progression and personal development being considered throughout. While there will be an increase in the use of technology on board, there will still be a requirement for ratings and we envisage UK ratings being at the fore.

Whether someone is building a highly-sophisticated modern ship like the RRS Sir David Attenborough or one of the superyachts (in which the UK excels), or managing the complex transactions which underpin the UK's predominance in international shipbroking or insurance, or taking charge of a vessel at sea, everyone will be making greater use of technology and automation. The more sophisticated the software and hardware that people use, the more we need talented people who can make the most of it. Training will change to

accommodate that both in greater use of simulation and in greater focus on how people, individually and in cross-professional teams, use the hugely increased amount of data they get. That, in turn, is likely to change who is attracted to maritime careers, both at sea and ashore. These are concepts that are also covered in the technology and infrastructure chapters

Seafarers will be supported at all times and high-speed data links will facilitate connections to family and friends while at sea. Continual learning for seafarers, shore-side workers, and the wider maritime workforce will be available and will be supported through virtual reality and other new communication technologies. The maritime industry will be a highly desirable place to work and will see strong collaboration on career development between different parts of the industry, ensuring that there are enough skilled people available to meet the sector's needs.

In addition to this, education in schools will continue to encourage an emphasis on STEM skills and learning. Outreach to a future generation of maritime workers will successfully present an attractive and exciting place to work. The highly diverse maritime workforce will be well-looked after, with health, safety and welfare standards being set globally by the UK.

7.2 Relevant trends and drivers

With people integral to so many, if not all aspects of maritime and maritime decision-making, there are few trends that would not in some way impact their future. This has already been demonstrated in coverage of issues affecting our maritime workforce set out in the last two chapters. However, in addition to what has already been covered, there are a few key drivers that will likely have a particularly significant direct effect, which are addressed below.

Rise of technology

The world has seen many changes in technology in recent years. Despite this, the maritime industry still has many paper-based systems and processes, relying to a large extent on other traditional 20th century ways of working. However, new technologies will undoubtedly become more impactful on the sector as they become more integrated into the supply chain. This will change the skills profile required for the maritime industry and was covered in more detail in the Technology chapter. Technology will enable safer working environments, for example by removing the need for staff to enter confined spaces. Technology can also enable higher productivity. Furthermore, it is expected to bring more jobs ashore, as increasingly automated ships will require smaller crews, as staff will monitor and manage the ships or more of their processes from ashore. That may be in the longer-term future whilst in the nearer term increased use of technology will complement and enhance existing roles.

These new roles will involve interpreting the data being generated, keeping IT networks secure and maintaining and repairing software, hardware and the machinery being used. This could widen the recruitment pool for maritime jobs

by lessening the need to be away from home for extended periods of time. It could also improve the diversity of the sector. With changing job roles, there could also be an increase in interest from those who have previously discounted working in the sector. No longer seen as too physical or too harsh a working environment, the attractiveness of the industry to people will grow. Additionally, the move towards more technology-focussed skills in the industry could result in an increase in higher paying jobs, reflecting the level of study needed to qualify for those jobs.

Rise of other countries' offers on training and people

In such an international industry, the maritime workforce has always been multicultural. In recent years, however, the UK has seen a particular rise of foreign nationals on its UK flagged ships, its UK owned ships, and on ships calling at UK ports. The latest BIMCO report identified the five nations with most seafarers were China, Philippines, Indonesia, Russian Federation and Ukraine (with India being included in the top five nations list for officers)⁹⁷. While this report predicts that seafarer numbers will continue to rise over the next 10 years, there remains a shortage in the supply of officers.

The UK continues to have an excellent reputation for its seafarer education and training, particularly in highly specialised and technical roles. As a result, courses have remained in demand. Nevertheless, competition from other countries providing quality training will only increase, as these countries seek to boost their numbers of cadets capable of supplying their needs.

7.3 Maritime workforce

The vision for the maritime workforce in 2050 is:

The decline in UK seafarers will reverse, supporting the hypothesis that the overall workforce will be in a position of growth. The expectation of greater work-life balance may lead to shorter sea time for those who do go. Technological integration will be well-advanced, meaning highly skilled workers will require timely and effective training. Due to this technological change, it is likely that some roles will become shore based rather than being at sea.

The service and wider industry will be impacted as there will be a narrower base of seafaring experience to draw upon, meaning that those who have been to sea will be highly sought after. For these individuals there will have been better career and professional development programmes from the outset of their career at sea, allowing them to make a smooth transition into the services sector and other shore-based maritime roles.

⁹⁷<http://www.ics-shipping.org/docs/default-source/resources/safety-security-and-operations/manpower-report-2015-executive-summary.pdf?sfvrsn=16>

Where we are now

The maritime workforce spans a breadth of roles. They are generally divided into seafarers and shore-side workers, but even this is a simplistic definition. Working at sea may be as an officer or rating, working in the different disciplines of navigation, engineering, or in on-board services. Crews may be on board a wide range of vessels carrying out numerous activities across the world, around the UK coast and on vessels operating on UK inland waterways.



There are also very varied roles shore-side, such as but far from limited to naval architect, marine engineers, nautical surveyors and shipbuilders, as well as the numerous professionals needed for efficient port operations.

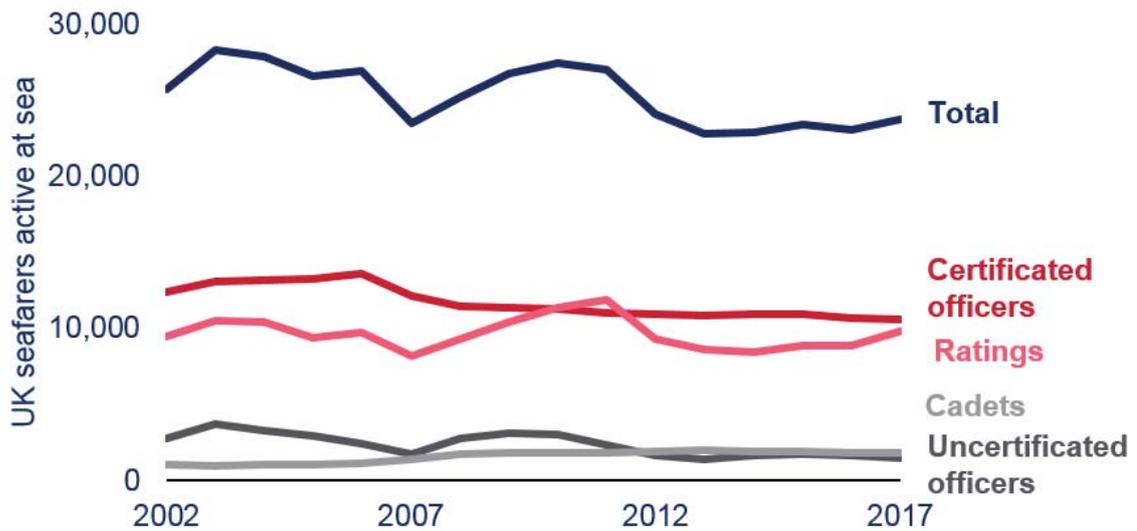
Equally, there are exciting roles in the marine industries and in academia where through innovative research, new ways are found of making the sector work more

efficiently and safely. There are also the roles in the important business services sector supporting the wider maritime industry: shipbroking, insurance, finance and maritime legal services all offer attractive career opportunities.

Historically, the UK has grown much of its own talent and has kept a nucleus of highly trained and highly respected personnel, giving the UK a leading edge in its maritime work both at sea and at home.

Regarding roles at sea, seafaring continues to be an important career of choice in the UK, with an estimated 23,760 UK seafarers in 2017⁹⁸. Just over half of these were officers, with a further 1,830 cadets in training. Numbers appear to have stabilised in recent years but there has been an overall downward trend across the past 15 years.

⁹⁸https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/711537/seafarers-in-uk-shipping-industry-2017.pdf



Source: DfT Seafarer Statistics

Figure 8 - UK seafarers active at sea by type, 2002-2017

Attempts have been made to maximise the number of UK cadets entering the workforce. In particular, the government has sought to provide support to offset some of the costs of maritime training through SMarT funding. SMarT funding in some form has been available to cadets since 1998, helping to improve the take-up of cadet training in the UK.

However, in recent years intake numbers have declined, creating a shortfall against the required number of seafarers. Accordingly, SMarT plus was introduced from April 2018 which will see an increase in funding to £30 million a year in the future⁹⁹. This is aimed at both boosting the number of cadets in training and at enabling those on SMarT Plus placements to fully transition into their careers. The placements do this by providing 12 months sea time experience and progressing cadets to their 2nd Certificate and Competency.

Due to the nature of the maritime sector, it is commonplace for people of different nationalities to work alongside each other. Therefore, the UK competes to have its seafarers on ships with other nationalities. Although UK seafarers particularly the officers and senior ratings, are continuing to be held in high regard, other countries are catching up with their quality training packages and throughput of personnel. In addition, the level of pay differs across the world. Those from countries with a low cost of living command significantly lower wages putting UK personnel, particularly ratings, at a disadvantage in terms of cost if not training and capability.

Overall changes in many ports were seen in the latter part of the 20th century, as containerisation evolved and ports moved to more automated operations for moving freight between ship and shore. This resulting increase in trade

⁹⁹ <https://www.gov.uk/government/speeches/support-for-maritime-training>

has meant that ports still continue to provide employment for a large part of the maritime sector, estimated at almost 24,000 jobs in 2015.

UK maritime business services lead the world. Key to that success are many specialists whose expertise is employed across the world. As a result, these services contributed £2 billion to the UK economy in 2015 and employed over 11,000 people working in the law, accounting, ship-broking, education, and insurance industries¹⁰⁰.

Approximately 60% of these jobs are in insurance, highlighting the UK's particular excellence in this sector. The UK is consistently ranked highly in the global maritime business services sector by benchmarks such as Menon Economics' Leading Maritime Nations 2018 Report¹⁰¹ and the Xinhua-Baltic International Shipping Centre Development Index¹⁰².



Figure 9 - Number of maritime legal experts in selected countries

The people working in the business services sector are hugely important to the reputation of the UK. Moreover, this sector is not divorced from seafaring activity as it relies on a stream of people bringing their wider maritime expertise and knowledge to bear in complex and sometimes technical litigation and discussion. Therefore, it is vitally important that there is a continuous pipeline of skilled UK seafarers coming into the shore based maritime sectors. This highly skilled and productive workforce enables the UK to compete internationally, presenting itself as an attractive place to do business.

¹⁰⁰ <https://www.maritimeuk.org/value/maritime-sector-all/>

¹⁰¹ <https://www.menon.no/the-leading-maritime-nations-of-the-world-2018/>

¹⁰² https://www.maritimelondon.com/wp-content/uploads/2015/09/2015-Xinhua-Baltic-Exchange-Index-report-_English.pdf



The marine industries employed over 99,500 people in 2015¹⁰³. These industries include the leisure marine and marine engineering sectors which encompasses shipbuilding, marine renewable energy, marine oil and gas support, and marine scientific and technical activities. These are areas of growth - the UK's leisure, superyacht and small commercial marine industry have seen an upturn in recent times, with revenues increasing by 3.4% from 2016 to 2017, the sixth consecutive year of increases¹⁰⁴. These marine engineering and manufacturing sectors are good examples of the technical and engineering expertise the UK can provide. They consist of many SMEs keen to expand and, with the right support, to export to the rest of the world. The UK superyacht industry provides a case in point, with Sunseeker, Princess Yachts and Fairline amongst the premier names of the luxury boat market, exporting across the globe.

The UK also possesses strong research institutions and universities. Cardiff University's Seafarers International Research Centre, the University of Southampton and Solent University do important research into the maritime workforce. Additionally, marine research & development centres exist at the University of Southampton, the University of Strathclyde, Portsmouth University and Plymouth University. Their particular research currently excels in such areas as maritime law, sustainable shipping, maritime logistics and maritime cyber threats. Moreover, CASS Business School and its parent organisation City, University of London, excel in offering programmes related to shipping finance and operations. These examples are reflective of the wider contribution British institutions make to our leading position as a 'thought leader' considered earlier in this strategy.

¹⁰³https://www.maritimeuk.org/documents/188/Cebr_Maritime_UK_Marine_finalised.pdf

¹⁰⁴ <https://www.maritimeuk.org/media-centre/publications/annual-review-2018/>

It would also be remiss not to acknowledge the many unwaged individuals who support the functioning of the sector. The RNLI for example, relies upon 7,700 volunteers¹⁰⁵ to staff and operate rescue crews. This volunteering activity is given greater focus in the chapter on the UK's Competitive Advantage, such is its impact.



Similarly, there are numerous national and international maritime charities based in the UK, such as Seafarers UK and Marine Society and Sea Cadets, providing vital support to both current and former maritime workers. Moreover, each member of the maritime workforce is supported by friends and family that enable them to do their job; never is this more pertinent than for the loved ones on shore awaiting the return of seafarers. While this activity may not be financially recognised, the sector must be aware of the vital role such support plays in the effective functioning of the industry.

Where we are going

The UK maritime sector will be a vibrant place of employment. We will have worked collectively to arrest the decline in UK seafarers and the sector will attract technically astute individuals into a range of roles both on land and at sea. The business services sector will continue to thrive, being supported by UK educational institutions providing outstanding learning programmes. The UK will set the example for standards of worker welfare, never compromising safety in a bid to lower costs. Furthermore, career development plans will be prevalent across the industry, communicating future opportunities clearly to the workforce.

Risks, threats and opportunities

Fierce international competition for seafarers leaves the risk that UK training and UK seafarers become costly and uncompetitive in the global market. It

¹⁰⁵ www.rnli.org/support-us/become-a-volunteer/how-you-can-volunteer/be-a-lifeboat-station-volunteer

could be tempting for the UK to compete on cost but this may lead to a reversion to the legal minimum in standards reflective of the values set out at the start of this strategy, encouraging unsustainable business practices, a lack of employment rights and a lack of focus on safety. Instead, the UK intends to retain its reputation for setting high standards and will continue to lead the way on maritime safety and seafarer welfare. This will be achieved by keeping pace with technological change in the industry and anticipating the impact this has on safety, training and welfare needs. The creation of a Maritime Skills Commission will take as one of its core elements, reporting on potential technological development across the sector and the implications resulting from it for our maritime workforce.

As maritime is a global sector and companies can relocate elsewhere, reducing demand for British seafarers, the UK must continue to maintain a competitive tax system that supports growth while ensuring the sector contributes to the costs of public services.

Sea based sectors of the maritime industry currently suffer from a lack of visibility and profile. This lack of exposure creates risks for realising the ambition of creating a maritime workforce ready for the challenges of 2050. For example, the sector has a long and proud tradition but this can risk obscuring the innovation occurring in the industry. Moreover, poor connectivity at sea is an obvious drawback for the current digital generation. Likewise, a perception of shore-side work being dominated by industrial machinery and manual activity can still occur. Heightened awareness of the varied and stimulating career opportunities will therefore be necessary to attract future personnel for roles on sea and shore. Indeed, technological advancement will mean the competition for staff will be fierce not just amongst the maritime sector, but between competing sectors such as the automotive, aviation and space industries. However, we should not just see this as competition but also as providing a way finder for the skills that the maritime sector will need and the roles it will offer. As the greater pool of talent becomes more visible, is perceived as more dynamic and delivering more interesting career paths, the could easily outweigh any challenges.

The lack of seafarers entering the workforce, combined with the current age demographic of existing workers, threatens to both create new skills gaps and exacerbate existing ones. Similar tensions exist in the much wider logistics chain where for example, the age profile of truck drivers who are fundamental to delivery is also increasing not just in the UK but globally creating real concerns over future shortages.

There is also the potential that as the skills profile required for the industry changes and more IT, data and digital skills are needed, the pace of change in the industry may outstrip the pace of change in maritime education. The consequences could negatively impact the UK's position of expertise and innovation if it does not keep up. This would risk companies being unable to source sufficiently skilled UK seafarers to operate their ships or to fill their shore-based vacancies. Companies could, therefore, be tempted to relocate to where they have easier access to a supply of labour.

Any consideration of the impact of technology must acknowledge that some current roles will be modified or be replaced by other roles. Ship systems will become increasingly automated and the industry will take on tools such as distributed ledger technology to open up and deliver a quicker and more effective service. Those with skills in IT will be needed to complement the existing workforce, becoming a vital part of the sector.

Alternatively, changes in the way goods reach and depart the UK may impact on the type of voyage needed and therefore the time away from home for the seafarer. If there is a shift to coastal shipping around the UK, then these feeder services may offer more employment opportunities for UK seafarers. An increase in smaller ships may mean a rise in the overall number of crew needed. Consequently, UK seafarers may become more attractive to employers, being readily available and costing companies minimal travel expenses to get them to port. These feeder services may also be attractive to UK seafarers due to proximity to home and the possibility of not spending long stints at sea without human contact with friends and family.

How we get there

What has been demonstrated already is that there are vast changes foreseen for the personnel in the maritime sector. If the UK is to remain competitive in this international industry, we must embrace these changes and as much as possible anticipate them and their impact. The suggestions below highlight some key actions.

SMarT Plus is already underway. This support for UK maritime training will make UK ship officers more competitive and attractive to employ, reversing the decline in UK officers. Alongside this, ratings training and apprenticeships will be aligned to industry needs, providing the skills required throughout a crew. Career paths will be mapped laying out what skills are needed at what level so it is clear to all how they can progress. This will include the mapping of sea to shore career paths, which will be supported by lifelong learning availability to seafarers, enabled by good connectivity at sea.

Like all taxes, the tonnage tax regime remains under review by government. Government will ensure the regime meets the needs of industry and contributes to the wider economy, including retaining a training link. This will encourage shipping and the wider maritime industry to do business in the UK. This is a topic which is also given focus in the UK Competitive Advantage chapter, which considers tonnage tax from a fiscal perspective.

Britain's maritime sector must continue to attract high-quality, motivated individuals. Greater linkages in both training and careers promotions between the Royal and Merchant Navies could show those that may wish to work in maritime but do not want to be in the forces, that there is an alternative in the Merchant Navy.

The industry will work on its image of being an attractive place to work, aligning with efforts to increase diversity. Moreover, improving working conditions and emphasising the social and environmental efforts that the sector undertakes can appeal to an increasingly globally minded younger generation. Furthermore, industry will continue to work with the education system to raise awareness of the sector and the careers available within it. There will also be opportunities to work with other organisations such as scouts, guides and local sea cadets, bringing maritime to young people in a less formal way. Government will look to task a single industry body to bring greater coherence overall to maritime promotional activity, enacting in-school awareness programmes to promote the sector.

Government will work with industry to understand where unnecessary overlap of certification can be addressed, with one type of accreditation not always being accepted across the entirety of the sector. For example, the MCA approved ENG1 medical certificates for seafarers are often not accepted in the offshore sector, engendering both further costs for industry and inconvenience for the individual. Tackling this issue will ensure the workforce is able to more easily transition across industry sectors. Alongside considering its image, the industry will have a fully supported, cross- industry careers promotion plan where progress and delivery can be shown. This will provide clarity to what is happening in this area for all to see and allow for the pooling of resources to enable the most effective delivery.

Recommendations

Short term (1-5 years)

- Ensure the UK tonnage tax regime has a training element which continues to support UK maritime workforce ambitions while also supporting growth of the UK tonnage tax regime.
- Raise awareness of the maritime sector in schools by having a single industry body overseeing a more coordinated cross-sector in-school awareness and ambassador programme.
- Task a single industry body for bringing greater coherence and coordination to the promotion of maritime careers sector wide.

Medium term (5-15 years)

- Ensure there is greater harmonisation of certification standards within the UK for different maritime sectors.
- Put in place a clear and universally supported careers promotion plan that achieves an outcome of UK employees being listed in the top five maritime nations' listings.

7.4 Diversity in the maritime workforce

The vision for 2050 is about making a change for the better, benefitting both industry personnel and the sector as a whole:

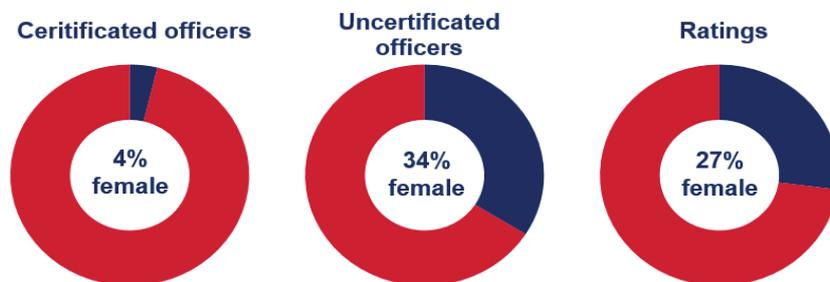
New highly-skilled job opportunities on shore and on connected ships will make maritime careers more attractive to traditionally underrepresented sectors. There will be a more diverse workforce than there is currently, across all characteristics, so that the workforce is more representative of the population and its customer base. An increase in diversity will lead to diversity in thought, alleviating some of the risks that industry faces.

This includes homogeneous thinking, lack of challenge, and slow progression. In turn, diversity and removing the overwhelmingly male dominated perception of the industry will also increase the attractiveness of the sector by showing that it is open to, and welcoming of, the whole population in the UK.

Diversity in a workforce has been proven to lead to better business outcomes. Consequently, there has already been an increased focus on attracting women into the maritime sector. The ambition in the future must be to build upon this work, not only improving gender diversity, but addressing wider diversity issues. Success will be achieved when the maritime sector, regarding both shore-based and sea-based roles, is reflective of UK society, attracting the brightest and best from the broadest possible talent pool.

Where are we now

The UK maritime industry is not diverse. It is typical of the transport sector in the UK, where as a whole only 20% of the workforce are women, compared to a national average of 47%¹⁰⁶. This is the lowest proportion in any sector other than construction. Specifically concerning sea based maritime roles, women make up just 2% of the world's seafarers¹⁰⁷ with figures for UK female certificated officers being just 4%.



Source: DfT seafarer statistics

Figure 10 - Gender distribution of UK seafarers active at sea, 2017

¹⁰⁶ Office of National Statistics (2018) *EMP13: Employment by Industry*. Accessed on 24/07/2018

¹⁰⁷ International Transport Workers' Federation Seafarers, 2018. *Inside the Issues: Women Seafarers*. Accessed on 24/07/2018

Undoubtedly, the traditional and male-oriented nature of the maritime industry has contributed to the lack of women in the sector. The practical impact of long periods away from family endured by a seafarer will also continue to be a factor that impacts on the attractiveness of the sector to all.

Initiatives such as Maritime UK's Women in Maritime Taskforce are working to improve this. The taskforce is looking at several areas: recruitment practices and how they can be improved, how companies can better retain the women that are in the industry and opportunities for progression for women within the sector. The maritime industry has shown intent to tackle the lack of gender balance, with over 80 organisations signing the Women in Maritime Pledge by the end of 2018, committing to building an employment culture that encourages and celebrates gender diversity. The Women in Maritime Charter was also recently launched, looking to build on the show of intent and support organisations in making some practical changes to the way they do things to encourage a better gender balance.

However, the current lack of diversity, especially in age, gender and ethnicity, reduces the attractiveness of the industry to a more diverse audience and to younger individuals, compounding the diversity issue. There is work being done to address the gender balance but there is also an awareness of the need to consider diversity as a whole in the maritime sector, rather than just focusing on women.

Where we are going

It is encouraging that industry and government have together started to make a difference in this area. It will need a significant change of culture within the sector, and as such will take concerted effort and leadership by all involved for that change to filter through and produce an industry that is suitably reflective of UK society. Other factors will support these changes: more shore-based roles may attract different workers; promotional campaigns will appeal to those who would not have previously considered a career in maritime; initiatives such as the Women in Maritime Task Force will have achieved many of their aims; and the service sector will have a diverse workforce across all levels of seniority. The result will be that attitudes will change, bringing unconscious bias into consciousness and changing the way the sector carries out its business.

In 2050 the UK maritime sector will be a diverse workforce with opportunities for all. New highly-skilled job opportunities on shore and on connected ships will make maritime careers more attractive to traditionally underrepresented sectors. The result will be that a lack of workforce diversity is no longer an issue that needs tackling with special initiatives. Our ambition will be for as much more even representational split in diversity that makes up our sector. Moreover, ethnic diversity will be reflective of the population of the UK at all levels in maritime organisations, and disabled representation will similarly improve.

Risks, threats and opportunities

The over-riding risk to this area of work is clear. A sector that only makes use of one part of its talent pool is risking decline, missing out on the wider skills, vitality and enthusiasm that would otherwise be open to it. It is not just the current workforce that is at stake here, but the future one as well. The effect could see the UK maritime industry fail to reach its potential in terms of its contribution to the UK economy. It could also face a higher risk of poor financial performance, losing global market share and be less effective in risk identification and mitigation. With that comes a wider decline in reputation and leadership in the international context.

Good research has already been undertaken on how to attract and appeal to girls and women for industries that have been struggling to achieve a gender balanced workforce. For example, Transport for London (TfL) commissioned research resulted in the 'people like me' guidelines and advice, aimed at attracting more women into the rail industry. This has been effective in improving the gender diversity of applicants and increasing the number of young people interested in careers in the rail industry. The UK has the opportunity to utilise this existing research and tailor it to the maritime industry to good effect.

How we get there

A strong start has already been made with the Women in Maritime Taskforce. This has included the creation of the Women in Maritime Charter, which challenges maritime organisations to set themselves targets for gender diversity, whilst also providing them with the support they need to achieve those targets, moving them from a show of intent to concrete action. The Women in Maritime Charter is at pilot stage - keeping the momentum going and continuing this work is key to improving gender diversity in the industry.



This will be achieved by adding to and implementing the current support the Charter offers, primarily by promoting the industry toolkits that have resulted from the Charter. These toolkits provide information, options and advice on how to implement changes to recruitment practices, attract more young people, improve retention and increase diversity in leadership positions.

Commissioning a 'people like me' information pack that is tailored for the maritime industry as part of these toolkits will guide industry in enabling them to attract a diversity of people. Moreover, this advice can aid businesses with the development of talent pipelines, how they promote themselves as an inclusive organisation and how their recruitment processes including the language they use, can be improved to give them wider appeal.

For these efforts to be effective and to spread the effort to wider diversity groups, there also needs to be further targeted campaigns and drives across the sector, led by a joint industry and government effort.

These campaigns will continue into the future, widening existing initiatives to include not only issues of gender diversity but other underrepresented groups. Gathering and monitoring diversity statistics will be key to testing the success of campaigns, and where new campaigns should be targeted. An initial study to understand the demographics of new entrants into the sector will help provide this information. Achieving the outlined aims will require a cultural change. This will take time, with the existence of barriers to quick progression. Such changes therefore require perseverance but the rewards will be worth it.

Recommendations

Short term (1-5 years)

- Government will fund the production of the 'people like me' maritime industry project to help address the image and perception of the industry and demonstrate how we can effectively showcase its value to a wider diversity of people.
- Joint delivery between government and industry of the Women in Maritime Charter.
- Widening the scope of the Women in Maritime Taskforce to consider diversity as a whole, including undertaking a short study assessing the diversity data of trainees across the UK maritime sector.

7.5 Maritime skills and promotion

The first sub-theme in this chapter looked at the shape of the maritime sector from the roles of the people within it. This sub-theme looks at the skills of the people and the routes they can and will take in the future to acquire them. Changes in technology will require a workforce that is willing and able to adapt with these changes. Personal development and attracting skilled workers will be key factors in keeping the workforce in step with the changing demands of the industry.

The vision for 2050 in this area is:

Over the next 30 years the skills profile across the sector will alter as new technology takes effect. Old skills will not disappear but new skills, particularly in IT, digital and new technology more generally, will be required to complement existing skills. There will be a need for highly qualified personnel with the ability to create, operate, and maintain autonomous and technological systems. This will call for increasing numbers who have studied STEM subjects.

Where are we now

Many sectors now rely on STEM skills as the solid foundation for a wide cross-section of more technical or complex disciplines. The maritime sector faces a skills shortage, especially in STEM subjects, and there is a major shortage of engineers across all UK industries. This only leads to greater competition across many sectors for a relatively small pool of people. Government has already been actively promoting interest in the engineering profession, delivering the Year of the Engineer in 2018. The maritime sector played an active role in this initiative, with partners such as the Institute of Marine Engineering, Science and Technology (IMarEST) and the 1851 Trust showcasing the attractiveness of an engineering career to young people.

Naval Engineering Competition

As part of the Year of Engineering 2018, the Royal Navy, in collaboration with UK Naval Engineering Science and Technology (UKNEST), launched a national Naval Engineering Competition titled as “Design a vessel that can rescue 1,000 people from the sea”. The competition asked school children in Years 1-13 to produce an innovative design of a vessel capable of saving up to 1,000 people from the sea. The main initiative of the challenge was to show young people how rewarding a career in marine engineering can be, while also encouraging creativity and innovative thinking.

As Captain Matt Bolton of the Royal Navy stated “The sea can be a very hostile environment, so the ability to rescue large numbers of people and transport them to safety is a huge challenge. In launching this competition, both the Royal Navy and UKNEST are keen to galvanise school children up and down the country into producing a creative and innovative design whilst applying their understanding of science, technology, engineering and mathematics to solve this real-world problem”.

Students were guided to challenge traditional designs and deliver innovative designs while answering questions such as “How can your design get quickly to the stranded people?”, “How will your design take care of the rescued people?”, “How big does your design need to be to hold 1000 people?”, etc. Participants –who could work individually or in small teams– were typically allowed one month to submit their annotated design along with its description. Accordingly, industry professionals

marked each design in accordance with three age categories (Primary, Secondary, and Further), leading to the award of prizes to the best designs from each group.

More specific activity includes Sea Cadets having a Year of Engineering pop-up at Kidzania in August 2018 as well as a joint venture outreach project between Seafarers UK and Sea Cadets. The latter involves taking six Marine Engineering 'Pods' (trailers) to schools across the UK, helping young people to learn more about marine engineering, career opportunities involved through hands-on experience with real engines and learning activities in the classroom. It is early days but the signs are that the Year of Engineering campaign has had a positive effect and it is imperative that this is built upon in the future.

Engineering graduates in UK

Projected annual demand

101,000

Projected annual supply

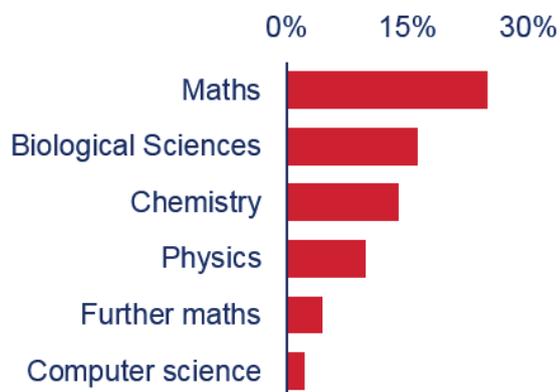
81,000

Shortfall

20,000 

Source: EngineeringUK

Take-up of STEM subjects by A level students (England, 2016/17)



Source: Department for Education

Figure 11 - Engineering and STEM take-up

The seafarer shortfall has been discussed in the maritime workforce sub-theme. Government and industry are working to attract young people into a maritime career through SMarT. Additionally, recognition of the need to boost outreach work to promote seafarer and maritime careers and skills is apparent across the sector. It now needs to gain momentum and roll out across the country. Maritime has to spark with young people so that they are not just aware of the wide breadth of careers but are actually excited by the prospect of being involved in the sector.

As well as the huge number of opportunities available in the maritime industry, there are also a wide variety of skill profiles required across the sector. There are a large variety of seafaring roles that range from the master mariner to on-board catering roles. Added to this are the many roles and differing skills of personnel in the cruise and superyacht sector and, closer to home, the roles needed on inland waterways. On shore, ports concentrate on the delivery of the smooth and quick transfer of goods and people to and from the UK. Skills

to understand logistics and process complex delivery operations are paramount. Business services are well versed in getting to grips with the intricacies of finance, legal issues, ship broking, insurance and accounting. In another direction, the marine industries and academia are using their skills to innovate and improve the machinery and processes that the industry depends upon.

Some people still learn their skills in the workplace, but increasingly they attend specialist educational institutions where they receive appropriate training and qualification. This helps to instil standards across the sector and across the disciplines. The UK is justifiably proud of its maritime education system, offering the comprehensive training necessary for the range of professions available and the diversity of opportunities within each individual career path.

This training can begin in specialist maritime schools such as the London Nautical School, or in the form of apprenticeships available across the sector for people of all ages and skill levels. Similarly, there are opportunities to undergo cadet training at a specialist maritime college, while completing one of the many marine specialised undergraduate or Masters degrees available at UK universities offers access to the industry. Furthermore, evening classes are available where maritime industry skills can be gained at the newly opened London School of Shipping, allowing students to combine work commitments with continued learning.

Some of the training opportunities are still growing. Implementing apprenticeship programmes has been at times, a challenging process due to the specific nature of the maritime environment and the specialisations in the sector. Now the industry is forging ahead with several new apprenticeship standards that have been approved.



The apprenticeship roles are as wide ranging as the maritime industry itself: able seafarer (deck); maritime electrical mechanical mechanic; maritime caterer; workboat crew member; port marine operations officer; boat builder and marine engineer, amongst others. More maritime apprenticeships are in development including boat master tidal inland waterways, marinas and boatyard operative and port agent. More recently, consideration is being given to a shipbroking apprenticeship which would recognise the needs of the services sector and those companies contributing to the levy.

UK maritime colleges, both in number and in their quality of training, are among the world leaders in this area. However, this does create an interesting relationship between the domestic maritime offer as a whole, and the specific maritime educational package the country exports. There is a danger that in educating foreign students, the UK loses part of its advantage in having domestically educated UK seafarers being skilled above their foreign counterparts. Nevertheless, in some cases the variety of courses on offer and

the expertise UK training institutions provide is only economically viable with the significant financial contribution foreign students make. So, a balance must be sought between these competing incentives.

Where we are going

By 2050 jobs will become more highly skilled and roles will be diverse in their requirements, meaning multi-skilled people will be highly desired, as will those with relevant specialisms. Skills will likely be increasingly data-focussed and digitally based, yet these will remain supported by knowledge of mechanical systems, as individuals create, manage, interpret, maintain and repair technology. This will call for increasing numbers of the maritime workforce to have STEM based skills, setting the maritime sector in direct competition for those skills with other transport sectors.

Recognisable skills, such as navigation, will still be necessary even with autonomous ships in case of technological malfunctions. The UK will be a global centre of excellence for maritime training and there will still likely need to be a rating workforce who will power the sector, with the most sophisticated, technologically advanced training institutions worldwide, providing high levels of training to seafarers from other nations in a cost-effective manner.

Risks, threats and opportunities

The UK has a high-quality education system. Given the right conditions, the UK can continue to be a world leading supplier of high-quality seafarers and attract talented individuals into shore based roles. There is an opportunity to develop and expand the current maritime training programmes to meet resource gaps on shore and at sea. In the longer term, the UK can take the initiative to think ahead, develop training programmes for new roles and administer qualifications for any new skills needed. The high quality of the UK's maritime training also gives the opportunity to sell training across the world, whether that be by UK training organisations opening branches throughout the world, or by encouraging more international students to study here in the UK.

There are risks that may threaten the UK's position as a leading supplier of maritime training, however. Whilst the UK government has recently significantly increased its funding commitment for seafarer training, some other maritime nations continue to fund training even more. Stakeholders can on occasion, therefore, perceive UK training as expensive. The consequence of this perception could be that companies choose to train their maritime workforces elsewhere, leading to a reduction in the supply of UK-based maritime personnel. Nevertheless, the quality of UK training is very well regarded and UK trained officers continue to be in high demand. It is thus the level of quality of the UK maritime training offer that differentiates it from the competition.

There is potential to reduce the cost of maritime training if training providers explore opportunities to collaborate more closely, allowing for cost effectiveness. These providers, including the Royal Navy, could work together to develop the latest training technology – such as augmented and virtual reality – to share best practice, streamline training delivery and lower costs. Training providers should also work to develop greater commonality of standards and training to enable a skills transition pathway across the maritime enterprise.

How we get there

STEM based education is already embedded in schools. Greater emphasis will be needed to create the training that equips the maritime workforce with the skills that will be needed in the future.

Necessary skills will need to be identified as they appear on the horizon and early action will be needed to upskill the workforce. Agility to adapt in a proactive way will also be necessary in order to identify new members of the workforce with skills the industry requires. Development of training packages and approvals on qualifications will also need lead in time in order to be ready for new ways of working. For example, the MCA is well placed to explore the increased use of virtual reality and augmented reality tools within training programmes.

Reviews of the skills needed, and which will likely be needed in future, will be undertaken to ensure that UK maritime training programmes are equipping the maritime industry with the skills it needs. This will be achieved through setting up a Maritime Skills Commission, bringing together leading skills experts from across government, the maritime sector and academia. This Commission will seek to keep abreast of future industry changes, and consequently ensure that all parts of the sector are up to date and training offers match and exceed industry expectations. Furthermore, to be a global provider of maritime training, marketing strategies will be designed to position the UK at the forefront in this global market.

To ensure the workforce is adequately skilled, industry, as well as government, must take a far-sighted approach. To this end, the marine engineering and manufacturing parts of the sector will work closely with universities to help them take R&D successes to market. The maritime technology, robotics and IT industries will be supported and encouraged with the aim of making the UK the biggest creator and exporter in these fields, capitalising on our skilled workforce and ensuring jobs for the future.

More comprehensive training requirements will further enhance the demand for the quality training offered by the UK. Moreover, actively pressing for an uplift in international training standards in the IMO will also serve to improve standards, as more seafarers trained in best practice globally will reduce the risk of unnecessary and unavoidable accidents. The UK will similarly work with employee representatives and industry to promote standards, in both training and welfare, through the ILO.

Recommendations

Short term (1-5 years)

- Government will support Royal Navy efforts to enhance training facilities and delivery, developing assured and accredited maritime training centres which will use their capacity to support the training of all maritime enterprise skills.
- Government will introduce appropriate regulatory changes to realise the benefits of new technologies to seafarer training.
- Government aims to establish a Maritime Skills Commission bringing existing leading maritime skills experts together, to report on the existing and future skills needs of the industry on a 5-yearly cycle, to inform the maritime training curriculum and keep it up to date with the evolving needs of the sector.

Medium term (5-15 years)

- Government to increase UK global influence on seafarer training by providing the policy and regulatory direction needed to support further roll out of UK maritime training institutions/programmes overseas.
- UK will develop cutting edge seafarer training maximising the use of future technologies such as virtual reality and augmented reality.

Long term (15 years and beyond)

- Through to 2050, the UK to play a leading role at IMO and ILO, in setting the global framework for maritime training and skills, and positioning the UK as the world leader.

7.6 Need for continuous education and training

The vision for 2050 in this area is:

Continuous education and training will be an integral part of career development. Learning for personnel will be integrated and delivered through many forms, generating interest and a desire to study it further through higher education or employment opportunities. Training will continue throughout an individual's career and clear career pathways will be in place setting out what skills are needed and at what level.

Where are we now

Technology has been developing at an increasing rate over the last decades. This has led to an increasing expansion of demand for skills involved in technology development, maintenance and repair. This is expected to continue as the maritime industry is increasingly using new technology to improve efficiency and to meet regulatory requirements where needed. Overall, the sector's skills profile is changing and will continue to change through to 2050. As such, there is a need for the workforce to keep existing skills updated. This will allow the sector flexibility as it manages its business. Existing personnel will require retraining as the skills they need change, while simultaneously allowing vital industry knowledge to be retained rather than lost.

Currently, career paths within the maritime industry are not always transparent and clearly mapped. This can make progression, particularly within the land-based parts of the industry, more difficult than it needs to be. One particular area of difficulty is known to be the transition for seafarers from working at sea to working on shore. There are few available signposts for them to use and the interruptions of time at sea can be problematic. Courses and qualifications are available to enable career transition and progression, but they can be difficult to access while working at sea, either because they are not available online, or because of the high cost of internet access while at sea.

Threats, risks and opportunities

There is a risk that if continuous education and training cannot be delivered within the maritime industry then, as technology develops and is implemented, industry may have to continuously look for new skills outside of its existing workforce. This could lead to high personnel turnover, a loss of attractiveness to the prospective workforce and a loss of operational industry knowledge.

There is an opportunity to map career paths for the maritime industry thereby providing clarity for the workforce. This would allow a proactive approach to career planning and be a constructive development to enable and encourage lifelong learning.

Opportunities surrounding new technologies can be taken to improve access to education. For example, the UK has expertise in satellite technology, as outlined in the technology chapter. The UK could use this knowledge to explore how better internet connectivity at sea could be provided. This would remove a key obstruction to continuous learning.

Where we are going

Technological change will require existing staff and new entrants to the maritime industry to be supported and retrained to work with new systems. Emphasis on cross-sector mobility will see data specialists and technicians move in and out of the sector to suit changing demands. Greater flexibility in

sharing talent across the industry and in encouraging people to move into maritime at later stages of their careers will be an important factor in addressing skills gaps. In turn, this will bring new ideas into the industry and encourage new ways of working.

Additionally, simulators and virtual and augmented reality environments will be at the heart of maritime training. With improved internet connectivity, ever more advanced augmented reality and virtual reality devices will allow seafarers to continue learning while at sea, as will online training courses. The maritime workforce of 2050 will be adaptable to change and have a willingness to learn new skills.

How we get there

Through the Maritime Skills Commission, the sector and government will keep abreast of trends and influence and adapt any reskilling programmes that are being proposed as necessary. To this end, government and industry will be alive to training programmes and reskilling initiatives in other sectors, allowing opportunities to be taken to attract new workers from a wider section of society, and ensuring existing maritime workers are never barred from suitable training programmes.

Alongside this, career paths will be mapped and clear information about the courses and qualifications needed for each step in that path will be provided. The maritime workforce will be encouraged to have individual learning and development plans to give focus to long term career trajectories. The possibility of improving connectivity at sea will be investigated to ensure seafarers are able to access study while in the workplace. Working with industry experts and academia will be necessary to ensure progress can be made on internet connectivity.

Recommendations

Short term (1-5 years)

- The Maritime Skills Commission will be tasked with overseeing the identification of opportunities for the UK maritime sector to access reskilling programmes, ensuring the workforce can take advantage of a wide range of initiatives.
- Government, industry, and academia to jointly establish an internet connectivity working group to identify action needed to drive internet connectivity at sea in support of social care and continuous education.

Medium term (5-15 years)

- The Maritime Skills Commission will, working with maritime training bodies, consider how to ensure professional development plans are

built into training programmes across all roles so trainees know from the outset the routes available to them and the qualifications needed.

7.7 Considering the human in the face of technological change

The vision for 2050 in this area is:

In 2050, the UK will be a leader in technological change that impacts the human being in a positive way. People will be valued as the creators, maintainers, and repairers of those systems. People will be seen as the providers of innovation, efficiency, and problem solving when systems break down. The human needs of those individuals will be a key consideration in ensuring a smooth running, efficient, and effective business and industry.

Where are we now

The evidence gathering phase has highlighted that maintaining good conditions for seafarers is important. The lack of transparency and supervision on deep-sea ships compared to every day jobs on land means standards are less easy to enforce. This is currently enforced via the ILO's Maritime Labour Convention, and supported by a global minimum wage for seafarers, although the latter is not mandated in international law and is guidance only. While a global issue, the UK uses its position as a maritime hub to push for conditions and monitoring of welfare issues to improve, particularly in terms of health and safety, manning hours, harassment and bullying.

Seafaring is often perceived as a challenging sector in which to work, driven by increasing pressure on costs, more distant voyages, faster turnarounds and new responsibilities. This has a negative impact on seafarers increasing working hours, isolation and keeping wages low. The global nature of shipping means it is difficult for the UK to make a difference on its own and we need to work with international institutions to enact change. While this and earlier chapters noted the potential beneficial impacts of technology on people in the workforce, there is also a growing concern about wider negative impacts. The UK is good at promoting and protecting the welfare of its people across all industries and has a good record in this respect in the maritime industry too, in particular when it comes to seafarers. This needs to continue, with increasing weight given to understanding the impacts of technological change on people.

Today, there is a high incidence of mental health conditions among seafarers, largely due to the pressures, nature, and isolation of working at sea. Technological change that results in a greater number of shore-side roles may reduce the scale of these issues, but for those who continue to work at sea, smaller crew sizes may only exacerbate feelings of isolation. Currently, sea-

based connectivity, one way to alleviate these problems, is neither widely available, highly functioning, nor always offered at an accessible price.

Risks, threats and opportunities

There is a risk that increased internet connectivity at sea could impact safety by distracting workers from their jobs. This is of particular relevance to those



operating heavy machinery. There is also a potential mental health consequence as connectivity could make individuals more acutely aware of problems and issues at home, generating a keenly felt sense of helplessness if they are unable to alleviate such problems. Smaller crews on a given vessel may mean that those that are at sea could be at greater risk of increased isolation and the consequential mental health issues related to it. Multi-national crews are common place on ships. This can lead to increased feelings of isolation for crew members as there are a limited number of

people that share their background or cultural upbringing. Reductions in crew numbers could compound that problem.

There is an opportunity for the UK to lead the way in consideration of the mental health of seafarers, who as a workforce have one of the highest rates of suicide in comparison to other professions. The UK could develop mental health care guidelines and ensure seafarers are aware of their mental resilience to cope with life at sea, in line with government positioning on maritime workforce welfare. In conjunction, there is an opportunity to develop a high-level social framework between workers and business, setting out the expectations of maritime workforce welfare standards for the UK.

The UK has an opportunity to lead in the fight against the commodification of humans. This could come in the form of a significant advancement of the Modern Slavery Act, where the UK would not only focus on the abolishment of negative practices, but also the promotion of a more positive attitude towards employees across the global maritime sector.

The spirit of this ambition is that it should be championed across the globe and significantly raise the status of the UK's maritime activities, attracting the best talent, greater levels of investment and acting as a catalyst for change in other industries.

This would not only be the right thing to do but would also result in reputational benefits for the UK. It would be essential to leverage the global reach of UK based organisations such as the Mission to Seafarers, Apostleship for the Sea and Nautilus International, as many problems result from wildly differing application of regulations by different flag states.

Where we are going

The UK will be setting the standards in workforce welfare standards that the international maritime organisations will want to follow globally. Standards set will include coverage of health and safety (including mental health provisions), working hours, and measures to minimise isolation and any adverse use of technology. We will be working with industry to set those standards so that they benefit both individuals and organisations.

The expectation of a better work/life balance will lead to shorter sea-time for those who go to sea, but voyage times and the cost of changing crew will be a limiting factor to this. Seafarer welfare will have more stringent rules and regulations in place thanks to the pressure placed on international bodies to raise standards.

International and bilateral legislation will be used to ensure complete regulatory coverage to all workers. This will consider protection for workers who may not be UK resident but either work in the UK and its territorial waters or are part of a larger supply chain. By their very nature, international requirements are broadly written, and this allows for a degree of variation in interpretation by signatory States. We will be working to narrow that degree of interpretation to achieve a truly global level playing field.

There is potential that jobs will become more isolating, both at sea and on shore, with less spontaneous interactions due to the increase in machines completing work or increased virtual engagement. Sea based connectivity will have improved allowing seafarers more contact with home and family but there will still be a risk of the current mental health issues that are associated with being away at sea occurring, along with the risk of mental health issues associated with the overuse of the internet (gaming addiction/social media). This is particularly high if crew sizes decrease and the current nationality ratios for rating models continue. Greater diversity, in terms of nationality, could increase the sense of isolation. However, awareness of these issues will be higher and there will be measures in place to mitigate the risks.

How we get there

We will keep pushing for better standards on health and safety and working hours, through both UK policy and international influence at the ILO and IMO. This will include lobbying for limits on shift lengths to reduce seafarer fatigue, and issuing mental healthcare guidelines to support seafarer welfare. Moreover, we will encourage cooperation and alignment between the IMO and ILO, and make the case through these institutions for the high welfare standards set in the UK to apply internationally.

Through these same fora we will promote the worldwide recognition and standardisation of seafarer ID cards. These will not only ease the verification process for immigration officials and reduce the risk of forgery, but will also increase seafarers' ease of movement, enabling their fundamental right to shore leave.

We will also continue our work on modern day slavery, collaborating with industry to do so, and contributing to the wider government drive to eradicate this blight on society.

The government will also work to introduce a National Minimum Wage for seafarers operating in UK territorial waters in the near term. Currently, the National Minimum Wage only applies in UK internal waters, which in itself limits its effectiveness, but it also only applies to those who are working on UK registered vessels and whose contract is in the UK. Given the complexity and international nature of the maritime industry, many seafarers are not covered by this legislation. It is the intention to extend the protection to all seafarers on all vessels working on domestic trade in UK territorial waters or on the UK continental shelf. Applying the legislation to all seafarers working in these waters, regardless of their nationality and the flag of the vessel they are on, will allow UK seafarers to compete more fairly for domestic jobs, while increasing the protection for all seafarers in our waters. By limiting it to our domestic trade and excluding vessels on international trade, it will also be compliant with international law on rights of innocent passage.

Furthermore, we will develop the concept of a social framework in the UK making it clear to all what standards of welfare are expected for our maritime workforce throughout their careers, whether they be on land or at sea. This will comprise of a statement of expectations, formulated with unions and industry, that will position the UK at the lead of international welfare standards and setting an example for the rest of the world.

Recommendations

Short term (1-5 years)

- Develop a social framework that lays out UK expectations for the welfare of the UK maritime workforce.
- Government and industry to push for worldwide recognition and standardisation of seafarer ID cards through the ILO.
- Government to introduce a National Minimum Wage for all seafarers working in the UK territorial waters, affording them the same protection as land-based workers.
- Government and industry to produce mental healthcare guidelines and develop mental resilience testing for seafarers.

Medium term (5-15 years)

- Push for a limit on hours per shift through IMO and ILO to combat seafarer fatigue.

Long term (15 years and beyond)

- The UK will lead on exploring opportunities to encourage greater cooperation between the ILO and IMO on seafarer welfare issues.
- Lead the way in addressing modern day slavery concerns within the industry with the aim of eradicating it.



8. Environment

UK vision for maritime environment in 2050

In support of the government's 25-Year Environment Plan, the Clean Growth Strategy and the Clean Growth Grand Challenge, the UK maritime sector will play its part in helping us to be the first generation to leave the environment in a better state than we found it. It will be environmentally sustainable and its impact on the marine environment, climate and air quality will be close to zero. The UK will be seen as a global exemplar in green maritime issues and will be a leading supplier of zero (and low) emission shipping technology and green maritime finance. The UK will continue to play a leading role in setting international standards in this field. More broadly, the UK will be taking advantage of the opportunities presented by the increasing technological and economic transition associated with climate change mitigation and adaptation.

8.1 Introduction

As the global economy, and the blue economy within it, continues to grow, goods and people are moving around the world in greater volumes than ever before and the scale of environmental impacts from transport is increasing. Under international and domestic agreements, other transport and economic sectors are moving quickly to reduce their environmental and climate impacts.

To keep pace with global shifts in the approach to the environment, the maritime sector must act with a sense of urgency and quickly reduce its environmental impacts. Other transport and economic sectors such as power generation, have taken advantage of significant growth opportunities in responding to the need for reducing environmental impacts. The concept of blue growth and sustainable growth in the marine and maritime sectors is increasingly a factor in commercial decisions.

The need for a transition to low impact maritime transport is clear and the long term transition cannot be avoided. The economic prize for first movers and early adopters may be significant. International competition is increasing and the UK has the opportunity to quickly position itself as a leader in this field. The UK has strengths in industries which could take advantage of the new market, such as high value maritime technology, and the potential to capitalise on new ones such as green maritime financial services.

This chapter sets the overarching vision for the UK to become a world leader in the move to clean maritime, simultaneously reducing the environmental impacts of the maritime sector and building growth opportunities for UK businesses. In pursuing this leadership role, there is a need for a co-ordinated

approach across government, industry and academia. We consider that the following principles provide a solid foundation for delivering 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.

To reach this vision of the future, this chapter is broken down into the following four strands of action:

- Zero emission shipping.
- Minimising the wider environmental impacts of maritime.
- Adapting successfully to the impacts of climate change on the maritime sector.
- Achieving our goals through continued international leadership.

8.2 Towards zero emission shipping

The vision for zero emission shipping is:

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.

Where we are now

In considering the move towards zero emissions shipping, this strategy covers emissions of air pollutants and GHGs from three sources of shipping:

- **Domestic shipping** – ships which have come from a UK port and are making a call at a different UK port.
- **International shipping** – ships calling at UK port which have come from or are going to an international destination.
- **Shipping in transit** – ships which are not calling at a UK port but which are passing through UK waters.

Where relevant, this strategy also discusses emissions of air pollutants and GHGs from port activities, and from ships which are not in UK waters but which are registered to the UK flag.

Air pollutant emissions

Air pollution¹⁰⁸ is the top environmental risk to human health in the UK, and the fourth greatest threat to public health after cancer, heart disease and obesity¹⁰⁹. This underlines the importance of the recently published UK Clean Air Strategy (CAS). 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 2035. Certain air quality pollutants such as nitrogen oxides and ammonia, are also known to affect biodiversity. The government's consultation on the Clean Air Strategy 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 2030.

To date, domestic policy on transport-related air pollutant emissions has largely focused on roads (particularly in relation to nitrogen dioxide concentration)¹¹⁰. However, average levels of nitrogen dioxide at the roadside are at their lowest level since the government first started to collect these statistics. As emissions from road transport begin to decrease as a result of significant mitigating intervention – as set out in the government's Road to Zero Strategy - the contribution of relatively smaller sources of air pollution including the maritime sector, will increase.

Historically the fuel used for shipping has been less clean than road transport fuels, which have to meet strict quality requirements to protect human health and the environment, as stipulated by the EU¹¹¹. The introduction of ECAs 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 for road vehicles.

Our understanding of the evidence on 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 (NO_x), sulphur dioxide (SO₂), particulate matter (PM_{2.5} & PM₁₀), volatile organic compounds (VOCs) and ammonia (NH₃). In 2016, domestic shipping

¹⁰⁸ Key air pollutants from maritime are: nitrogen oxides, particulate matter, non-methane volatile organic compounds, hydrocarbons, carbon monoxide, sulphur oxide and black carbon.

¹⁰⁹ <https://consult.defra.gov.uk/environmental-quality/clean-air-strategy-consultation/>

¹¹⁰ In 2017, the Government published their Air Quality Plan for tackling roadside nitrogen dioxide concentrations. This required areas with nitrogen dioxide exceedances to develop local plans to achieve compliance in the shortest possible time.

¹¹¹ https://ec.europa.eu/clima/policies/transport/fuel_en

alone (ships that start and end their journey in the UK, including overseas territories and crown dependencies) accounted for 11% of the UK's total domestic NO_x emissions, 2% of primary PM_{2.5} and 7% of SO₂¹¹².

But the numbers above do not present the full picture, as they only focus on domestic emissions. It should be recognised that the volume of emissions from international shipping and shipping in transit through UK waters may be much higher than that from domestic shipping.

NO _x Emissions from Shipping 2016 (Kt/year) ¹¹³	
Domestic	75
International	233
In Transit	433

Table 1 - NO_x emissions from UK shipping¹¹⁴

Greenhouse Gas Emissions

In terms of CO₂ emissions, shipping is considered one of the most efficient modes of transport. However, it also represents a substantial source of GHG emissions.

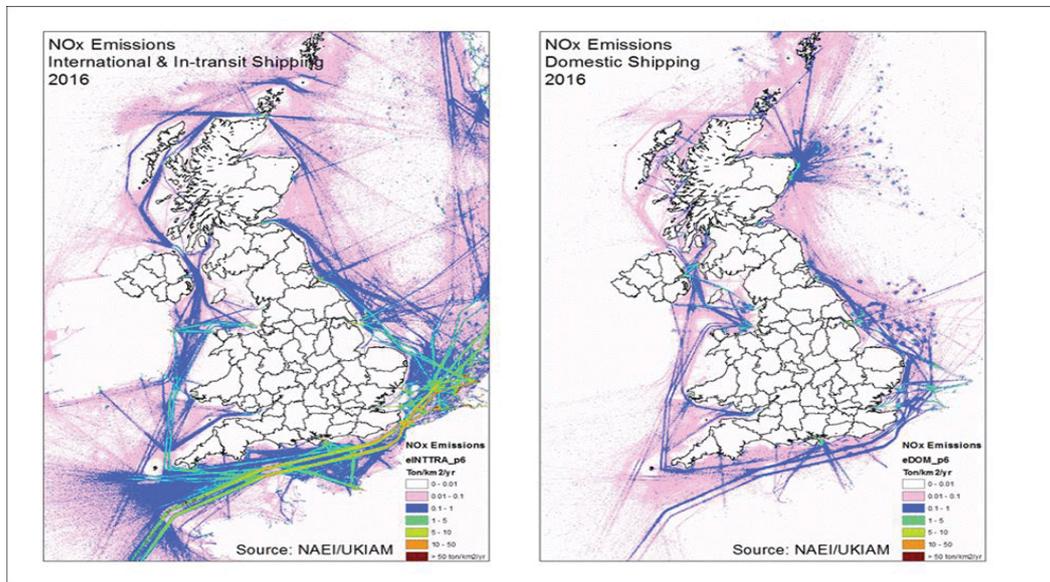


Figure 12 - NO_x emissions from international, in-transit and domestic shipping, 2016

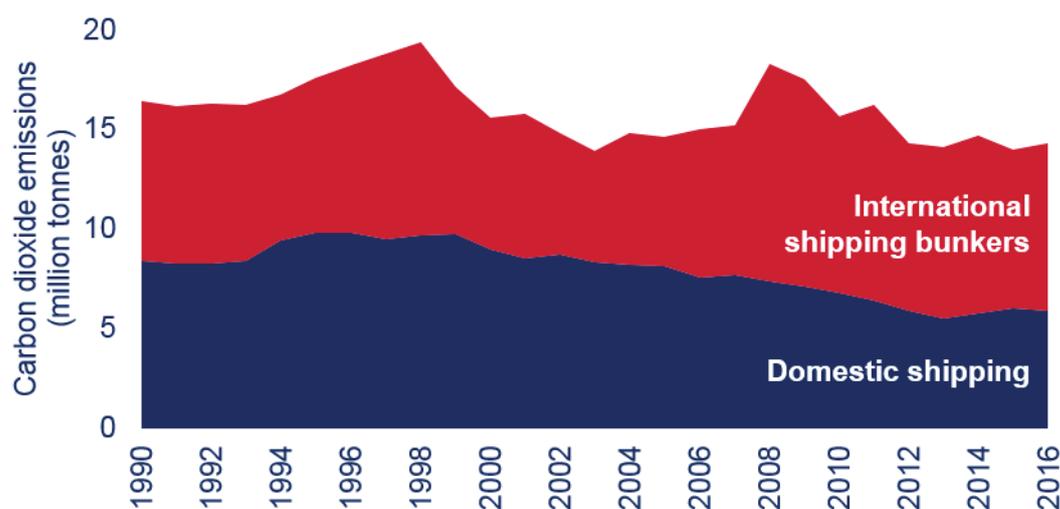
¹¹²https://ukair.defra.gov.uk/assets/documents/reports/cat09/1810160958_DA_Air_Pollutant_Inventories_1990-2016_Issue1.pdf

¹¹³ The domestic emissions in table X are not identical to those reported in the NAEI, where additional emissions are included outside the map area modelled by Imperial College, for example for fishing, and where naval emissions are also added.

¹¹⁴ Imperial College

The most recent study by the IMO estimates that international shipping accounted for 2.2% of global CO₂ emissions in 2012¹¹⁵. This is equivalent to the total emissions of Germany, the world's 4th biggest economy¹¹⁶. If no further action is taken then a prediction from the IMO suggests CO₂ emissions from international shipping could grow by between 50% and 250% by 2050. Given emission reduction projections for other parts of the global economy which show progressive emissions reductions by 2050, a study for the European Parliament suggests that by 2050 international shipping could account for 17% of global CO₂ emissions¹¹⁷.

The UK does of course contribute to these global maritime GHG emissions, both through international shipping calling at UK ports and domestic shipping. For the purposes of reporting GHG emissions, the UK's share of international shipping emissions is estimated from the refuelling from bunkers¹¹⁸ at UK ports (although these emissions are not included in the UK's emissions total in the national GHG inventory). As shown in Figure 13 below, international shipping bunkers was responsible for 59% of UK's CO₂ shipping emissions in 2016, and its emissions have been more variable than those from domestic shipping. It should be noted that, as this only includes bunkers bought in the UK, it does not cover all ships at UK ports which have come from or are going to other countries.



Source: UK greenhouse gas emissions statistics, BEIS

Figure 13 - Source of UK shipping carbon dioxide emissions, 1990-2016

As a percentage of the UK's overall GHG emissions, shipping's contribution (both international and domestic) is relatively small, at 3.4%¹¹⁹. However, as emissions from other parts of the economy decrease in line with UK

¹¹⁵ [Third IMO GHG Study](#)

¹¹⁶ <http://appsso.eurostat.ec.europa.eu/nui/submitViewTableAction.do>

¹¹⁷ [http://www.europarl.europa.eu/RegData/etudes/STUD/2015/569964/IPOL_STU\(2015\)569964_EN.pdf](http://www.europarl.europa.eu/RegData/etudes/STUD/2015/569964/IPOL_STU(2015)569964_EN.pdf)

¹¹⁸ A large container or compartment for storing fuel.

¹¹⁹ <http://naei.beis.gov.uk/>

commitments and action on climate change, the contribution of relatively smaller sources of GHGs, including the maritime sector, will increase.

The current regulatory and policy framework

Air Pollutant Emissions

Globally, air pollution from shipping is regulated by the IMO through the International Convention for the Prevention of Pollution from Ships. 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 quality¹²⁰, 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 emissions¹²¹.

At present, 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. We have played a leading role in negotiating international limits to pollutant emissions from shipping, for example through the North Sea ECA where a sulphur cap of 0.1% was introduced in 2015 (a ten-fold reduction from the 1% limit introduced in 2010).

In 2008, Member States at the IMO agreed to a 0.5% sulphur limit for global shipping outside 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. The UK continues to co-operate closely with other Member States at the IMO on a number of 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. The same meeting agreed to designate the North Sea as a NOx ECA. From 2021, new ships operating in these waters will need to reduce their NOx emissions by around three-quarters. This represents significant progress and the industry has invested heavily in new technologies like exhaust gas cleaning systems and liquefied natural gas (LNG) as a fuel in order to meet these new limits.

At a domestic level, the CAS, which was published in December 2018, 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 has been 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.

¹²⁰ Directive 2008/50/EC ambient air quality and cleaner air for Europe

¹²¹ https://ec.europa.eu/clima/policies/transport/shipping_en and <https://www.eea.europa.eu/themes/air/national-emission-ceilings/national-emission-ceilings-directive>

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 IMO. 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% by 2050. This strategy sends a strong signal to the shipping sector as a whole to stimulate investment in the development of low- and zero-carbon fuels and innovative energy-efficient technologies. However, the hard work now begins of charting a course towards this 2050 target.

Domestic policy relating to emissions of GHGs from the maritime sector is based around the Climate Change Act 2008. The government has committed to contribute 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. Emissions from domestic shipping are included in both the carbon budgets and the 2050 target. Emissions from international shipping are not currently formally included in either.

However, government must take these emissions into account when setting carbon budgets, and existing carbon budgets have been set at a level that the Committee on Climate Change considers is consistent with meeting the 2050 target when international shipping emissions are included. While this national policy sets the context for national targets on emissions, there are currently no specific targets in place for UK domestic or international shipping emissions. Likewise, the government has not yet formally accepted any planning assumption for international shipping emissions.

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.

Technological solutions for zero emission shipping

There are two key sources of maritime air quality and GHG emissions: port operations (landward emissions) and vessel operations (seaward emissions). This strategy deals predominantly with emissions from vessels but does touch on landward emissions as port operations do generate both air quality pollutant and GHG emissions

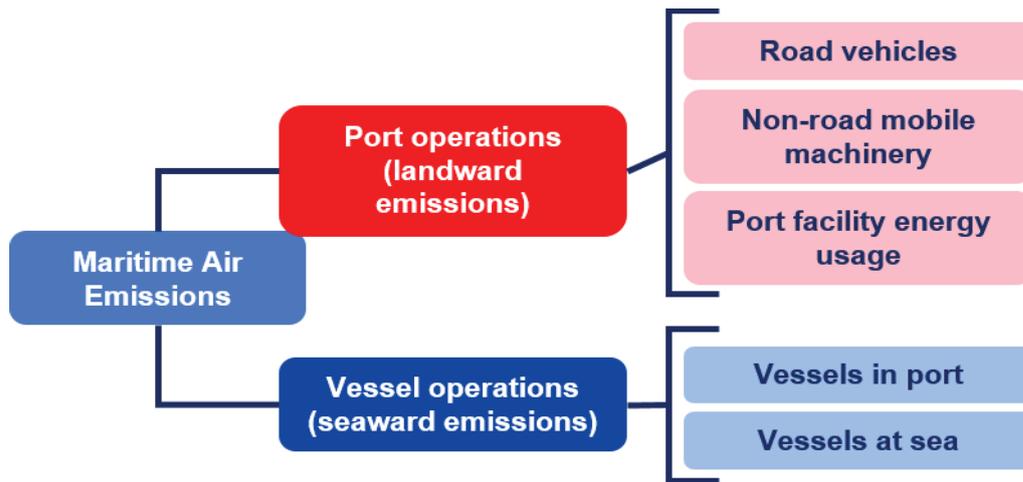


Figure 14 - Sources of maritime air pollution

Emissions from vessels arise from their use of fuel for propulsion and auxiliary power, and for other wider uses, such as producing hot water. Solutions to reduce emissions therefore can be thought of in three key ways:

- Treating emissions at exhaust (for example, NO_x emissions can be reduced significantly by using selective catalytic reduction systems).
- Improving fuel efficiency (whether through improved vessel design or better operations of a vessel once constructed).
- Substituting existing fuels with less polluting alternatives.

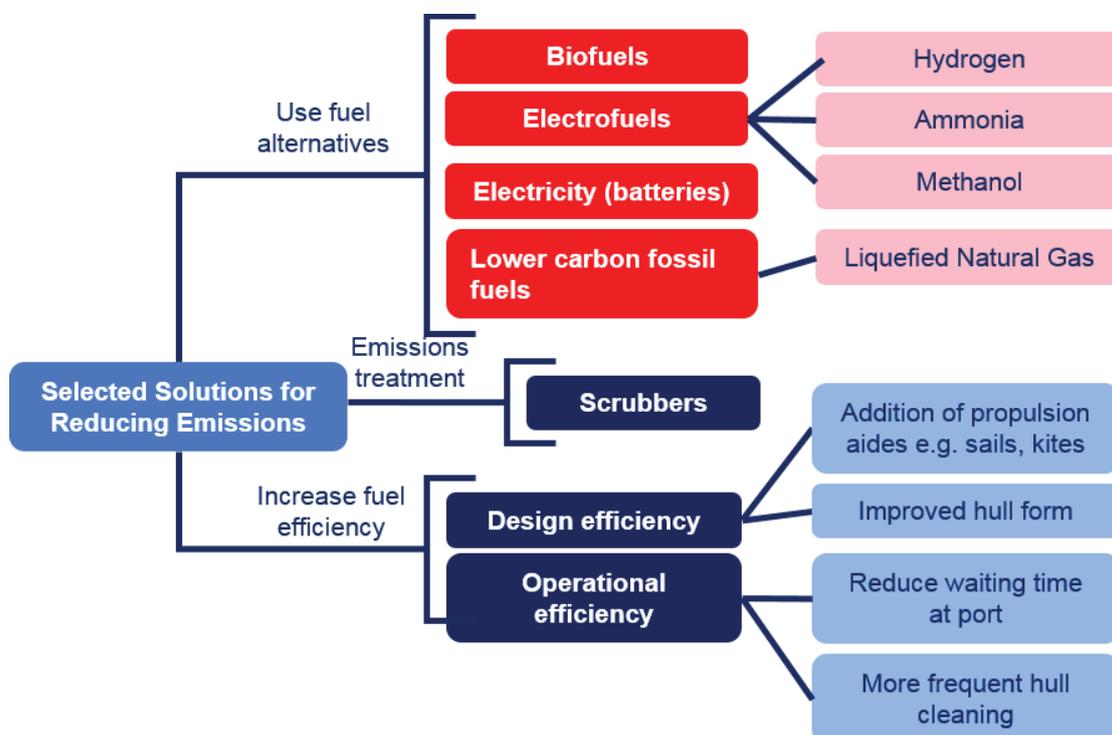


Figure 15 - Selected solutions to reducing emissions

While improvements to fuel efficiency will be essential in addressing both air quality pollutants and GHG emissions, there has been research which suggests energy efficiency improvements alone will not be sufficient to achieve absolute reductions in shipping's CO₂ emissions, whilst transport demand increases¹²².

At present ships generally use three types of fuels: heavy fuel oil (HFO), marine diesel oil (MDO) and marine gas oil (MGO). Research suggests that a number of fuel alternatives are possible, as shown in figure 15 above¹²³. Each fuel type has different characteristics which will affect the uptake of each:

- Some may be easier to use in existing engines, others may require new engine and/or vessel design, storage and handling.
- Some may be easy to store and transport, others may require significant investment in new supply chains which in turn will have implications for global markets and geopolitics.
- Some may be produced using readily available feedstocks, others may require the use of scarce or constrained resources.
- Some may generate greater upstream emissions than others.
- For the above and other reasons, some may be more costly than others.

The UK Clean Maritime Plan, which will be published in 2019, will seek to consider the barriers to market for technological solutions to achieving zero emission shipping and the potential for the UK to capture our share of the economic benefits from this transition.



¹²² Smith, T. W. P., Raucci, C., Hosseinloo, S. H., Rojon, I., Calleya, J., De La Fuente, S. S., Wu, P., & Palmer, K. (2016). CO₂ emissions from international shipping: Possible reduction targets and their associated pathways. UMAS, from:

http://www.lowcarbonshipping.co.uk/files/ucl_admin/DSA_2016_Co2_emissions_in_shipping.pdf

¹²³ <https://www.lr.org/en/insights/global-marine-trends-2030/zero-emission-vessels-2030/>

International competition and domestic opportunities

International competition

Many countries are demonstrating a keen interest in the development and implementation of green shipping innovation and are moving swiftly to demonstrate leadership in this field.

Scandinavian countries, particularly Norway and Sweden, have been frontrunners in sustainable shipping and the use of alternative fuels. Both countries seek to be leaders in the adoption of clean technologies to decarbonise maritime transport. For example, Norway has cut emissions through the NOx tax and business-led NOx Fund, now in operation for over a decade. The Swedish Shipowners' Association (SSA) "Climate Roadmap"¹²⁴ has stated its ambition to reach zero CO₂ emissions and other harmful substances by 2050.

The port of Rotterdam in the Netherlands, which is the largest port in Europe and one of the most significant logistics hubs in the world, shows how ports can reduce emissions. The port area has recently installed wind turbine capacity of 170 megawatts (MW), which represents around 10% of all the wind power in the Netherlands, and is working to expand this to 300 MW by 2020.

In the Americas, a 200 nautical mile ECA to reduce NOx, SOx and particulate matter emissions around the north American coast line has been in operation since August 2012. An ECA has been in place covering waters adjacent to the coasts of Puerto Rico and the United States Virgin Islands since 2014. Canada is also investing heavily in projects to look into hybrid technologies integrating hydrogen fuel cells into new build ships.

Countries across Asia are also making early moves in green shipping technologies. Most recently, China has committed to enforce the IMO global 0.5% sulphur cap around its territorial waters by 2019, one year ahead of the agreed implementation date of January 2020. Projects on the incorporation of hybrid and hydrogen fuel cells in ships are also taking place in Japan.

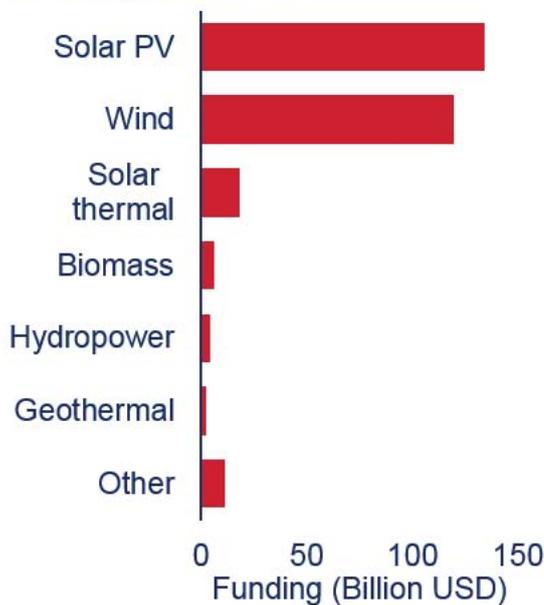
These and other examples show that other countries have already taken a lead at a domestic level on promoting green initiatives within the maritime sector. However, it is important to understand that the business model of the UK maritime sector particularly in relation to ports, is different to that of many other countries. While in many other countries, ports may be state-owned, in the UK our ports operate in a competitive market, and decisions about their operations or infrastructure are made on a commercial basis. In placing itself amongst international competitors therefore, an important consideration for the UK will be the need to ensure government doesn't distort the level playing field.

¹²⁴ <http://www.sweship.se/in-english/>

The UK maritime sector also needs to look to the success of other sectors in attracting funding for the uptake of green technologies. The figure below shows public and private sector investment (in USD billion) in renewable energy in 2015/2016. This demonstrates the potential associated with a large scale global market for investment in green technology, worth a total of almost \$300 billion.

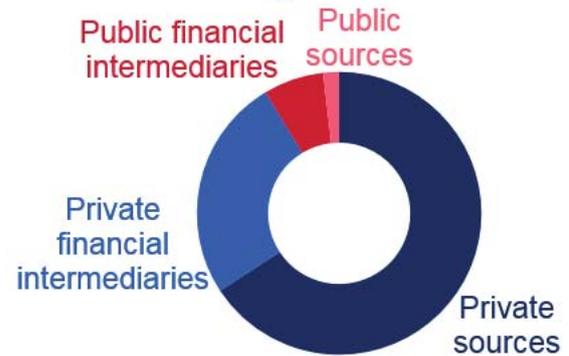
The average annual investment in renewable energy 2015-2016 was **\$297 billion**

Techologies funded



Source: International Renewable Energy Agency

Sources of funding



Destination of funding

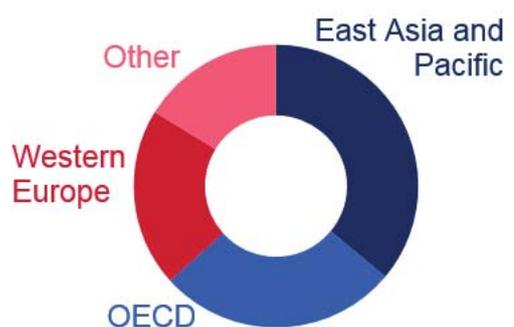


Figure 16 - Landscape of renewable energy finance

Domestic opportunities

There is still time for the UK to play a leading role in zero emission shipping by exploiting its areas of excellence and the opportunities offered by the development of clean growth initiatives. As reflected in the chapters on UK attractiveness and technology, London and the UK remain dominant in maritime professional services (insurance, ship broking, law, accounting and financing). It is important we maintain pace with emerging economies like Singapore and countries with well-established capabilities in high-value manufacturing. The UK could consider introducing initiatives to support the great innovation currently present in British marine manufacturing, technology, fuel and financial markets, encouraging the translation of this expertise to the zero emission shipping challenge.

The UK maritime industry has, particularly through Maritime UK, been engaging with government on a strategic growth agenda for the maritime sector in the context of government's Industrial Strategy, and in light of relevant Grand Challenges (in particular, Clean Growth and the Future of Mobility). The publication of the National Shipbuilding Strategy in September 2017 also opened considerable potential for the development of new commercial initiatives across the marine sector and the wider UK supply chain.

The Industrial Strategy Challenge Fund brings together world-class UK research with business investment to develop the technologies that will transform existing industries and create entirely new ones. In Wave 1 of the Fund, the government announced £1bn of investment across the UK – focused on areas of strategic importance to the UK. This included areas of potential importance to green shipping, such as the Faraday Battery Challenge – which focuses on the design, development and manufacture of batteries for the electrification of vehicles and efficient use of renewable energy.

The forthcoming Clean Maritime Plan (which will be the Maritime 2050 Environment route map) and the establishment of a Clean Maritime Council, which held its first meeting in October 2018, will provide a powerful vehicle to deliver partnership between government, industry and academia in pursuit of the long term vision of zero emission shipping. Both the Plan and the Council will explore opportunities to take advantage of existing initiatives, such as those presented through the Industrial Strategy, as well as defining new initiatives where these are necessary.

Maritime Research and Innovation UK (MarRI-UK)

MarRI-UK will provide a collaborative innovation vehicle for UK industry and academia to jointly tackle challenges including autonomy and green shipping.

The project is led by foundation partners comprising eight companies, four universities, and one trade association, with the aim of improving coordination and resources in maritime research and development. These partners are Babcock, BAE, BMT, Cammell Laird, Lloyd's Register, QinetiQ, Rolls Royce, Shell, Newcastle University, University of Southampton, University of Strathclyde, University College London and the Society of Maritime Industries.

MarRI-UK will use a hub-and-spoke model, drawing upon research and innovation assets across the country. The MGS review recognised the need for greater industry focus on collaborative research and innovation. That call was repeated in the Foresight Future of the Sea report, which estimated the value of the 'blue' or 'ocean' economy jumping to \$3 trillion by 2030. The report recommended greater coordination and a more long-term focus in research and innovation in order for the UK to capitalise on emerging

Where we are going

As global pressure increases for a transition to zero emission shipping, markets are emerging for the supply of emissions reduction technologies and alternative fuels. While the potential scale of the global market for green shipping technology is as yet unknown, growth predictions for similar markets are impressive. For instance, Global Markets Insights Inc. have estimated the fuel cell electric vehicle market is estimated to reach over USD 9 billion by 2024¹²⁵. Meanwhile, Goldman Sachs recently estimated the value of the global market for lithium-ion batteries associated with the electric vehicles as reaching USD 40 billion by 2025¹²⁶.

It is already clear that the UK contains several areas of industrial and academic excellence relevant to zero emission shipping:

Primary renewable energy	<p>Government is funding a prototype through its T-TRIG scheme which will demonstrate the commercial and functional viability of small wind powered autonomous surface vessels (WASV) for cargo transport.</p> <p>The UK Energy Technologies Institute (ETI) is providing majority funding for the world's first installation of wind-powered technology on a Maersk product tanker vessel. Norsepower rotor sails will be fitted with testing at sea during 2019, with Shell acting as project coordinator.</p>
Hybrid vessels	<p>Three hybrid roll-on/roll-off ferries are in operation in the Clyde and Hebrides Ferry Service. Each use a low-carbon hybrid system of traditional diesel power and electric lithium-ion battery power. The ferries are operated by CalMac Ferries Ltd and were built by Ferguson Marine Engineering Ltd in Port Glasgow¹²⁷. A further hybrid ferry is operated by Wightlink between Portsmouth and the Isle of Wight.</p>
LNG	<p>There are currently a number of major ports with the facility to provide LNG bunkering in the UK, including Southampton, Teesport and Immingham. In 2017, at the Port of Immingham, Flogas bunkered a ship with LNG for the first time ever in the UK¹²⁸. Teesside LNG is an LNG import terminal which was originally developed by the Saudi Arabia Basic Industries Corporation (SABIC) following its agreement with Shell LNG for the supply of LNG fuel to its</p>

¹²⁵ <https://globenewswire.com/news-release/2018/01/22/1298259/0/en/Fuel-Cell-Electric-Vehicle-Market-worth-over-9bn-by-2024-Global-Market-Insights-Inc.html>

¹²⁶ <https://www.ft.com/content/8c94a2f6-fdcd-11e6-8d8e-a5e3738f9ae4>

¹²⁷ <https://www.calmac.co.uk/article/3928/Third-hybrid-ferry-launches-on-the-Clyde>

¹²⁸ <http://www.abports.co.uk/newsarticle/495/>

	<p>vessels when calling at the port¹²⁹. Works are currently being undertaken at the Ocean Terminal in Southampton to accommodate Carnival UK's Iona, which when launched in May 2020, will be the first British cruise ship to be powered by LNG¹³⁰.</p>
<p>Hydrogen</p>	<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 UK¹³¹.</p> <p>A 14m hydrogen fuelled catamaran, 'Hydroville', was built in the UK by BWSeaCat for owners CMB Technologies of Antwerp, Belgium using a hydrogen system supplied and installed by Revolve of Essex, UK. It is the first vessel in the world to be passed by a class society (Lloyd's Register, also a UK company) to operate with passengers using hydrogen fuel in propulsion engines¹³².</p> <p>Cheetah Marine, an Isle of Wight Company, has conducted sea-trials of a hydrogen powered catamaran. Innovate UK have provided part funding for this project¹³³.</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 energy¹³⁴.</p> <p>Bristol Packet operate a small hydrogen ferry, the Hydrogenesis, as a private hire vessel. This vessel was originally commissioned by Bristol City Council in 2010 and built by Bristol Hydrogen Boats, a consortium of ferry operators (including Bristol Packet) and Auriga Energy¹³⁵.</p>

¹²⁹ <https://www.greenport.com/news101/lng/lng-terminal-set-to-reopen-at-teesport>

¹³⁰ <https://onthewight.com/southampton-lng-cruise-ships-terminal-next-generation/>

¹³¹ <http://www.emec.org.uk/press-release-funding-secured-for-uks-first-hydrogen-injection-system-on-a-ferry/>

¹³² <https://www.iims.org.uk/first-hydrogen-fuelled-passenger-vessel-passd-class-society-launched/>

¹³³ <http://www.cheetahmarine.co.uk/en/deliveries/cheetah-go-hydrogen-powered>

¹³⁴ <https://news.st-andrews.ac.uk/archive/ferguson-marine-to-develop-renewables-powered-hydrogen-ferry-hyseas-iii/>

¹³⁵ <https://www.bbc.co.uk/news/uk-england-bristol-19870653>

	<p>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 electricity¹³⁶.</p>
<p>Energy efficiency</p>	<p>ETI has launched a new project which aims to demonstrate a waste heat recovery system for ships that could deliver fuel efficiency savings of at least 8%. The £3.6m project will be led by Avid Technology, who are based in Cramlington, northeast England.</p> <p>ETI is partnering with Teignbridge Propellers International Limited to develop a High Efficiency Propulsion System for ships which aims to reduce fuel consumption by around 8%. Based in Newton Abbot, Devon, Teignbridge is the largest propeller and stern gear producer of its kind in Europe.</p> <p>In partnership with BMT Group and Black & Veatch, ETI is funding the development of a Marine Vessel Technology Assessment System which helps financiers understand and confidently quantify the benefits of investing in fuel efficient technologies. The project recently launched a new website at www.fuefficientshipping.com and is due for completion in mid-2019.</p>
<p>Low Emission Port Initiatives</p>	<p>In January 2017, the Port of London Authority (PLA) introduced their Green Tariff Scheme, which gives a discount on port charges for vessels with lower emissions, where the vessels meet an Environmental Shipping Index (ESI) score of 30 or above¹³⁷.</p> <p>The ports of Portsmouth (Ministry of Defence), Fraserburgh and Brodick offer shore-side electricity facilities.</p>

How we get there

The approach to UK domestic policy on zero emission shipping is based on the fundamental objective of ensuring the maritime sector plays its part in driving the clean growth of the economy. The approach will be based on the principles as set out in the introduction to this chapter. Given the serious economic, social, environmental and public health risks posed by climate

¹³⁶ <https://www.bbc.co.uk/news/uk-scotland-highlands-islands-43140326>

¹³⁷ The ESI, developed by the World Ports Climate Initiative, ranks ships' environmental performance based on factors including emissions of nitrogen oxide, Sulphur oxide and carbon dioxide.

change and air quality pollution, these principles including the need to move quickly, are particularly relevant to action on zero emission shipping.

Our overarching aim is for the UK to be seen in 2050 as a role model in the field of zero emission shipping, having moved faster than other countries, and having captured a significant share of the economic benefits of the transition. Policy interventions will be agile, and depending on the innovation or intervention in question, we may wish to move as a first adopter or a fast follower.

To reach this ambition, over the coming decades the UK must identify and build on its strengths, investing in this growing market. The government has a vital role to play in achieving this ambition: it must provide clear and predictable signals to the maritime sector to drive sustained business investment in zero emission shipping, particularly as new technologies bed in and establish themselves as commercially viable. Government should consider “market failures”, where the market acting on its own does not provide the right price signals to players to ensure they reduce emissions.



There is also a role for government to play in coordinating a fragmentary sector and driving greater collaboration between different parts of the supply chain. For example, UK ports have found it difficult to justify investments in “ship-to-shore” power supply (effectively an electric charging point for ships) in part because they would rely on shipping companies ensuring that their ships are compatible with this technology and, equally, because they rely on their power supplier being able to accommodate the resulting change in the power supply required to install this. We will consider the full range of measures available to government. Inevitably regulation will always play an important part in this story but we need to ensure that any new regulation is based on strong evidence; that we consult thoroughly with our stakeholders to ensure the regulation is proportionate and fair; and that we introduce the regulation in a way that minimises the burden on our maritime sector.

While the starting principle is that regulations for a global sector should be set at a global level (i.e. the IMO), the pressures we are facing in the UK, in particular to tackle local pollutant emissions, means that in some cases we will need to move faster than the global standards. There is also a sound economic argument for doing so – as the UK’s higher standards will put us in the forefront of the technology race, and provide us with highly productive jobs and exportable expertise in a global market place.

Innovation is key to meeting the challenges and taking advantage of the opportunities ahead. That is why the government has committed to increasing public and private investment in research and development to 2.4% GDP and supported this ambition with an additional £7 billion public investment since the Autumn Statement 2016 – the biggest increase in 40 years. However, this is in partnership with the private sector, where investment in innovation generates the most benefit, and government will continue to work with our thriving maritime sector to help firms recognise the benefit of investing in R&D and assisting them in benefiting from the record public sector investment.

This is why government has also set up the Clean Maritime Council to bring together experts from the public sector, industry and academia to help address these long term challenges. We are also considering launching a series of “zero emission shipping ambitions”, which are designed to focus the efforts of government, industry and academia around tackling some of the biggest specific technology challenges we face in this area.

Recommendations

The following recommendations for future policy in this area will be explored in further detail in the UK Clean Maritime Plan, to be published spring 2019.

Short term (1-5 years)

Existing commitments

- In line with proposals in the UK Clean Air Strategy:
 - Major ports will publish Port Air Quality Strategies in summer 2019. Government will produce guidance for ports on this.
 - Government will publish consultations on the extension of SO_x and NO_x ECAs around the UK, and a call for evidence to explore options for standardising environmental regulations for vessels operating domestically with the UK, including inland waterways.
 - Government will publish the UK Clean Maritime Plan by spring 19.

- Government will continue to actively participate at the IMO, working with industry and other key stakeholders, to support the smooth transition to new environmental standards.

New proposals

- 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.
- Government will consider options to promote the UK flag as the flag of first choice for vessels adopting low or zero emission technologies.
- 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.
- 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.
- Government will assess how economic instruments could support the transition to zero emission shipping in the medium to long term.
- 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.
- 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 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.
- 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 work in partnership with the British banking sector to encourage the provision of finance towards zero emission shipping technology development and manufacturing.
- Government will review the environmental and economic case for coastal shipping, and whether the government should play a greater role in encouraging modal shift.

Medium term (5-15 years)

- 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:
 - A group of hydrogen or ammonia powered domestic vessels in operation.
 - 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).
- Government will work to ensure maritime GHG 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.
- 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.
- 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.

Long term (15 years and beyond)

- 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.

- 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.

8.3 Minimising wider environmental impacts

The vision for 2050 in this area is:

In 2050, despite increasing use of the oceans and the growth of the blue economy, the impacts of the UK maritime sector on the marine environment are close to zero. Minimisation of impact is embedded into the full ship life-cycle from design and build, to operational impacts such as ballast water and plastic disposal, through to ship recycling at the end of a ship's operational life.

Where we are now

There is growing awareness about the negative impact on the marine and coastal environment of pollution and contamination from human activity. This strategy deals specifically with the impact of the maritime sector on the marine and the immediate coastal environment. It has long been recognised that individual vessels or practises by ships can have a significant impact on local habitats, and exacerbate existing environmental problems. Over the last few decades, international legislation has progressively introduced stricter environmental requirements on ships, for example the London Protocol and MARPOL annex V. Such regulation has covered a wide range of issues, from reducing the risk and mitigating the impact of accidental oil and chemical spills, to controlling the discharge of plastics, solid and liquid wastes from ships. Controls have also been introduced to address the unintentional harm caused by shipping activity – such as from the discharge of ballast water and the use of harmful coatings on the underside of vessels – which impact negatively on marine bio-diversity. In spite of these controls, the government considers it is vital for the long term protection of the marine and coastal environment that shipping takes further steps to reduce harmful impacts.

Impact of the maritime sector on water quality and ecology

Oil pollution from damaged tankers or from accidental discharge can have a serious impact on local marine environment. In recent years, the introduction of prevention and mitigation measures – notably the phasing out of single-hulled tankers – has been effective in reducing this risk.

There are international and EU rules which govern the disposal of waste from shipping. As a general rule the more hazardous the waste, the stricter controls there are for the safe handling and management. Ships which have on-board

incinerators may be allowed to dispose of certain types of non-hazardous waste at sea, but the majority of wastes generated on-board have to be disposed of at a suitable port reception facility. This does not however prevent accidental discharges or deliberate illegal dumping at sea.

Progress is being made in terms of reducing air emissions through use of alternative fuels and post combustion mitigation technologies. One of the most common mitigation technologies to reduce sulphur dioxide emissions is to install an exhaust gas cleaning systems. Any waste retained on board following the cleaning process must be discharged at a suitable port reception facility and cannot be discharged at sea or incinerated on board the vessel.

Some exhaust gas cleaning systems generate significant quantities of 'wash-water', which can only be discharged at sea if its release complies with water quality standards in the IMO Guidelines¹³⁸. The IMO permits the use of these systems as the technology was not considered to significantly impact ocean pollution, but would avert wider air pollution. Nevertheless, further studies are being carried out by industry to assess the impact of wash-water in coastal waters. If the findings indicate these systems would have a detrimental effect on local water quality then the UK would seek further international controls.

Anti-fouling paints can improve the efficiency of ships by keeping their hulls cleaner and more streamlined – allowing them to burn less fuel and produce less exhaust emissions in the process. However, they do this by slowing the growth of marine life on the hull, through the use of toxins. To counteract the most adverse effects of these the International Convention on the Control of Harmful Anti-fouling Systems on Ships has banned the most toxic version, and today's anti-fouling paints are much less toxic to the marine environment.

Under MARPOL (Annexes I, II, and V), certain sea areas are designated as "special areas" in which, for technical reasons relating to their oceanographical and ecological condition and to their sea traffic, the adoption of special mandatory methods for the prevention of sea pollution is required.

These special areas¹³⁹ are provided with a higher level of protection than other areas of the sea. In addition to this network of special areas, certain areas of sea are designated 'Particularly Sensitive Sea Areas' (PSSAs) which need special protection through action by IMO. The designation of PSSAs is on the basis of: ecological criteria; social, cultural and economic criteria; and scientific and educational criteria, such as biological research or historical value. Practically, PSSAs can overlap with 'special areas'. Much of the western coast of the UK is covered by the 'Western European Waters' PSSA.

Impacts to the land environment and public health from unregulated ship recycling

In 2015, about 75% of total dismantled shipping tonnage was recycled on beaches in India, Bangladesh and Pakistan where environmental and safety

¹³⁸ Resolution MEPC.259(68)

¹³⁹ <http://www.imo.org/en/OurWork/Environment/SpecialAreasUnderMARPOL/Pages/Default.aspx>

standards are poor and financial returns for ship owners are highest. The majority of vessels are driven onto beaches, where they are cut up, discharging hazardous materials and chemicals into the local marine environment. These practices have led to large areas of coastline and adjacent seas of these three countries being contaminated by hazardous materials. There have also been a significant number of deaths and serious injuries caused each year by the breaking and recycling of ships at unsafe and unauthorised facilities.

The recycling of ships is regulated internationally under the Basel Convention on the Trans-boundary Movements of Hazardous Waste and their Disposal. The requirements under Basel are widely perceived as being prescriptive for ship owners, difficult for Member States to enforce and - with the exception of some Chinese yards – have failed to significantly improve the safety and environmental standards of ship recycling facilities in Asia.

From the beginning of 2019, the recycling of UK flagged ships has been subject to the EU Ship Recycling Regulations, which are based on the IMO Hong Kong Convention. Even though we are leaving the EU, this is a policy that we will continue to support. The regulations prohibit the installation of certain hazardous materials on board ships and requires all ships to hold an inventory of such materials. Ships must also be recycled at an approved recycling facility. Although the HKC has yet to come into force, it has been the catalyst for a significant improvement at a number of ship recycling facilities in Asia.

Impact on marine life: disposal of plastic, underwater noise and discharge of ballast water

Awareness of the environmental impact of plastic has risen dramatically in recent years. While the vast majority of plastics in the ocean comes from land-based sources, discarded and broken fishing nets in the marine environment are a danger to many organisms, including mammals and fish. The UK is working with its Overseas Territories to ensure there is a consistently firm approach to tackling maritime pollution across the UK's waters.

Marine organisms use sound to communicate, locate mates, search for prey and avoid predators. Underwater noise generated from ships, surveys, sonar, construction works, offshore windfarms and platforms is increasing and may have a detrimental impact on marine mammals. At a UK level, the Centre for Environment, Fisheries and Aquaculture Science (Cefas), Marine Scotland and the University of Exeter have conducted the first nationally coordinated effort to quantify underwater noise levels, which could inform the development of measures to reduce or mitigate noise in the medium term¹⁴⁰.

To improve stability, ships carry water in ballast tanks, taking on and discharging water as needed. The discharge of this water in a location different to where it was taken on board has led to the spread of invasive

¹⁴⁰ <https://www.nature.com/articles/srep36942>

species, threatening and in some cases devastating native marine life. The IMO Ballast Water Management Convention came into force in 2017, and puts in place standards and procedures for the management and control of ballast water. Over time all ships will need to install on-board ballast water treatment systems.

Enforcement of environment legislation

Environmental standards and regulations are only effective if the maritime sector is compliant. This requires an effective regime of enforcement and sanctions. Enforcement of maritime regulations is challenging because of the remote and global nature of sea-going vessels.

In future, new technological developments such as remote sensing, fuel sampling kits, drones and airborne sensors offer hopes for better enforcement of maritime environmental regulation. There are innovative examples of the use of technology for monitoring compliance with sulphur limits in ECAs. A number of European States are using remote sensing devices on planes to monitor compliance with the sulphur limits in the North Sea and Baltic Sea ECAs. In Denmark, regulators have installed emission sensors on the Great Belt Bridge to monitor compliance whilst at sea. In Canada and the Netherlands, regulators use portable kits to provide indicative results from sampling ships fuel before sending the sample off to the laboratory for full testing.

Penalties for breach of regulations need to be dissuasive, to ensure there is fair competition. Foreign ships which enter UK ports are liable for inspection by Port State Control officers, who can issue detention and deficiency notices – potentially costing a major deep-sea shipping tanker £50,000 a day.

However, in the UK fines for a breach can only be imposed by the UK Courts – the powers do not presently exist to impose significant spot-fines for non-compliance as they do in other states or shore side in the UK. Moreover, the fines structure in the UK often results in significantly lower penalties than in other European states or the United States. In the last twenty years, the maximum fine secured for a pollution offence has been £35,000 (plus costs), while it is common for multi million pound fines to be levied in comparable jurisdictions.

Where we are going

The government envisages a future in 2050, where the impacts of the UK maritime sector on the environment are close to zero. For this to be the case, it will be critical that the minimisation of impact is embedded into the full ship life-cycle from design and build, to operation, through to end of life ship recycling. This will be a future where the UK has ratified international conventions which reduce the environmental impact of the maritime sector, and where we have advocated for the expansion of spatial management measures underpinned by evidence, under international law. In this future, the UK's penalty structures will be line with international best practice, and new

technologies will make the enforcement of regulation significantly easier. This vision for the future ensures that the application of higher environmental standards for maritime pollution is more consistent across all British waters, including overseas territories.

How we get there

Well-designed and proportionate regulations at the international level will continue to drive environmental improvements. The UK will therefore continue to play a leadership role at the IMO in order to help shape these regulations in a way that best meets our own high environmental standards and strategic objectives. The UK continues to support the HKC and EU Ship Recycling Regulation, which together have the potential to significantly improve ship recycling facilities and the behaviour of ship owners. Insurance companies and financiers are increasingly demanding evidence from ship owners of compliance, before they are willing to provide their services.

Historically, environmental legislation has tended to be prescriptive rather than outcome-based. This can have the advantage of providing clarity and certainty for industry, but may stifle innovation or the adoption new creative solutions. Giving ship owners a choice of using low sulphur fuel or using equipment or an alternative fuel which delivers an equivalent outcome, has encouraged the development of green technologies and alternative fuels (such as methanol). Where possible, and where it can deliver the required environmental benefit, our preference is for an outcome-based approach to environmental regulation, so as to encourage green innovation.

Regulation alone is not enough if it is not coupled with effective enforcement. Ensuring that there are adequate, qualified inspectors available, supported by proportionate and dissuasive sanctions that fit the changing nature of the industry is an ongoing challenge for many states, including the UK.

In the long term, new technologies (sensors, open data) should be used to monitor compliance and streamline enforcement arrangements. And in the long term, it should also be possible to monitor routine compliance remotely, off-site, rather than having to physically inspect a vessel. This would allow real-time confirmation of compliance for ships giving greater public reassurance and transparency as well as freeing up inspection assets for other tasks.

Green technology can help to mitigate the environmental impact of maritime, but its effectiveness could be limited by slow uptake for costly or unproven technologies. We also need to take care to avoid unintended consequences: for example, systems which improve air quality from ships should not be implemented without considering other impacts on the environment, such as the likelihood of increased GHGs or affecting water quality or underwater noise.

Recommendations

Short term (1-5 years)

- Government will ratify international conventions which reduce the environmental impact of maritime including the Ballast Water Management and Hong Kong Conventions.
- UK will continue to advocate for the designation of scientifically-based spatial management measures, provided for under international law, to protect the most vulnerable environments, for example, around Antarctica.
- Government will work to bring the UK's penalty structures into line with international best practice to ensure we effectively tackle ships which break the law. This could include a wider range of sanctions including "on-the-spot" fines.
- Government will apply a new ship recycling regime from 1 January 2019, and work with industry to improve compliance. By 2023, conduct a post implementation review to assess how effective the new regime has been in improving the sustainability of end of life shipping.
- Government will cooperate with other states in the development and application of new technologies (e.g. remote sensing, fuel sampling kits, use of drones, airborne sensors), which could be used to help industry and streamline enforcement arrangements.

Medium term (5-15 years)

- Government will work with our Overseas Territories to ensure there is a consistently firm approach to tackling maritime pollution across British waters.
- UK will play a leading role in international discussions to promote consideration of market-based solutions for wider (non-air emission) environmental issues.
- Government will consider further alignment between the UK regime for ship recycling with the Hong Kong Convention, and whether any further measures are needed to discourage non-compliance.

8.4 Adapting successfully to the impacts of climate change

The vision for 2050 in this area is:

In 2050, the UK's maritime sector will continue to adapt successfully to the evolving risks and changes presented by climate change – for example, our ports will have adapted to the reality of rising sea levels and increased flood risk. The UK will also have taken advantage of any opportunities presented by the economic transitions associated with climate change, including new trade patterns and the opening of new trade routes.

Where we are now

The UK has consistently taken a leading role in international efforts to reduce the emission of GHGs and thus mitigate the threat of dangerous climate change. From the global action plan to combat climate change agreed in Paris in 2015, to agreement in 2018 at the IMO to at least halve global shipping emissions by 2050, the government has proven itself to be a guarantor of the ambition needed to tackle one of the greatest challenges of our time.

In addition to taking action to mitigate the causes of climate change, the government also recognises the need to prepare for the uncertain effects of a projected increase in climate change. This means first understanding and then building resilience to the particular risks posed to our island nation from rising sea levels and an increase in the frequency of extreme weather events. With around 95% of goods arriving to the UK by sea, ensuring the UK's major sea ports are prepared for the impacts of climate change will be vital to safeguarding the integrity of the UK's economy and trading relationships, as well as the mobility of UK citizens.

Climate change is a profound cause of concern for the government, but it is increasingly acknowledged that it may also present certain new opportunities to the UK's maritime sector in the long term. The opening up of Arctic maritime trade routes during summer months is one such opportunity. Ensuring the maritime sector is capable of taking advantage of such opportunities in a responsible way should be a long term priority of the government. In short, the UK's maritime sector must be prepared to confront the risks as well as take advantage of any possible opportunities presented by projected climate change impacts.

Predicted impacts of climate change on the UK maritime sector

The Intergovernmental Panel on Climate Change (IPCC) and the Met Office¹⁴¹ forecasts rising sea levels and an increase in the frequency of extreme weather events as consequences of climate change. Of all of the UK maritime sector, ports are most at risk from these events.

¹⁴¹ <https://www.metoffice.gov.uk/research/collaboration/ukcp>



Increased incidents of inundation from tidal surges and extreme weather events would significantly impair the normal functioning of port estates or even lead to port closures. Moreover, UK ports' connectivity to rail and road

infrastructure would also be highly vulnerable to damage, affecting the flow of goods into and out of ports. There is also an increased risk of environmentally hazardous incidents in and around port estates if damage is inflicted by flooding and/or extreme weather events.

For the last fifty years, Arctic temperatures have risen more than twice as fast as the global average. As a consequence, researchers estimate that after 2050 the Arctic Ocean could be ice-free during summer months. As well as expediting the flow of goods, explored in greater detail in the Trade chapter, reduced travel times could bring other benefits including decreases in costs and the amount of fuel utilised.

The role of government in climate change adaptation

The 2008 Climate Change Act provides the basis for the UK's action to both mitigate and adapt to the threat of dangerous climate change. Specifically, with regards to adaptation, the Act requires the government to assess the risks and opportunities posed to the country by climate change and take actions to prepare for these predicted eventualities.

The Climate Change Risk Assessment (CCRA), carried out every 5 years, captures these risks and opportunities facing the UK. The CCRA's findings are subsequently used to inform the National Adaptation Programme (NAP) which sets out the actions the government is, and will be taking, to address the risks and opportunities posed by climate change. Ports as key national infrastructure, are encouraged to report their unique vulnerabilities as well as adaptation efforts to the NAP, under the Adaptation Reporting Power (ARP) set out in the Climate Change Act 2008.

In addition to government's oversight of national efforts to adapt to projected climate change impacts, through the EA it also plays a key regulatory, operational and advisory role in ensuring people, places and the natural environment successfully adapt to climate change. The future impact of severe weather and coastal erosion and flooding on UK ports is of considerable concern, and the EA is, and will continue to be, a crucial partner to ports in understanding and building resilience to climate change.

Building resilience at UK ports

In response to the flooding that occurred around the UK in the winter of 2013/14, DfT produced the Transport Resilience Review, setting out recommendations to the transport sector on how to prepare for the increased risks to infrastructure associated with climate change. As part of this review, the government proposed several recommendations for ports, focusing on the need for greater collaboration between the ports, the Met Office, the EA and Network Rail, in order to better forecast and plan for the adverse conditions that could disrupt port activity and connectivity.

Though government has an important role to play in supporting ports as they adapt to projected climate change impacts, as privately operating entities, it is primarily ports' responsibility to ensure they understand and respond to the unique vulnerabilities posed to them by climate change. In response to the events of winter 2013/14, ports have undertaken actions to increase their resilience. For example, ports along the UK's east coast have established a number of working groups to prepare for the risk posed by storm surges, and are also in regular contact with the Met Office to obtain bespoke and long range weather forecasts. Most ports are now also participating in local resilience fora and conducting individual risk assessments of their port estates.

Inundation of the Port of Immingham, December 2013

In the winter of 2013/14, the UK experienced a period of extreme weather not seen for decades. Successive storms struck the country, bringing the highest winter rainfall across southern England since records began in 1766. The extreme weather resulted in severe flooding across the UK and extensive coastal damage, as storm surges, combined with high tides, led to the worst coastal flooding since 1953. The storm surge at Dover was estimated to be a 1 in 1000-year event.



Ports on the UK's east coast were particularly vulnerable to inundation, and on 5th December the Port of Immingham was forced to close for several days after being inundated. As water levels rose to 50cm above the port's flood defences, 75% of the port area was submerged and there were significant IT and power supply failures.

The UK depends on the Port of Immingham; it is one of the country's busiest ports in terms of tonnage as well as a crucial conduit for petro-

chemicals and fuel. Whilst the extreme weather of winter 2013/14 cannot be categorically attributed to climate change, it exposed the significant vulnerabilities of some of the UK's most vital national infrastructure to projected climate change impacts.

Indeed, with the IPCC predicting rising sea levels and an increase in the frequency of extreme weather events as a consequence of climate change, the need for UK ports to adapt to these future threats is manifest. In response to the events of winter 2013/14, the Port of Immingham's operator – ABP – invested over £0.5m in flood resilience to safeguard electrical substations, impounding pumps, buildings and other infrastructure across the port.

Putting the environment at the centre of Arctic maritime trade route discussions

Though the UK is not an Arctic state, it is an influential observer and participant in Arctic affairs, and our geographical position means we stand to benefit significantly from the opening up of these new maritime trade routes. This is particularly the case as we look to increase our trade with the rapidly growing economies of the Far East, considered in more detail in the Trade chapter. Therefore, the government is committed to working on the international stage to ensure effective governance and environmental protections are in place to regulate ships operating in Arctic waters as they become more accessible.

At present, shipping vessels' use of HFOs and black carbon are two of the most prominent environmental issues pertaining to shipping in the Arctic. An HFO spill would severely harm the fragile marine and coastal Arctic environment, with serious long term detrimental effects. Black carbon increases the amount of light absorbed into the ice surface and can cause localised melting, which in turn contributes to the destabilisation of the ice sheet as a whole and an increased loss of ice mass. On both issues, the UK is working in the IMO to establish measures that can mitigate such detrimental impacts on the Arctic environment.

The UK played an important role in the development of the Polar Code at the IMO, which aims to increase the safety of ships' operations in polar regions, and mitigate shipping's impact on the people and environments there. While Arctic stewardship rests with the eight Arctic States, as interest in the Arctic waters as an economic corridor increases and new transport infrastructure is proposed, the UK is becoming more engaged in efforts to ensure the environment is a central consideration in any future plans for the region.

Where we are going

The government envisages a future in 2050, where the maritime sector will continue to adapt successfully to the evolving risks and changes presented by climate change. This will include the adaptation by ports to increased flood risk and rising sea levels.

Government will work with ports to understand their preparation and implementation of adaptation measures. By 2050, the UK will also be taking advantage of any opportunities presented by the economic transitions associated with climate change, including any new trade patterns or trade routes. Alongside this, particularly in relation to the Arctic, the UK will have been established as a voice on the international stage working to ensure effective governance in place to regulate ships in newly accessible trade routes.

How we get there

Specific recommendations on how the UK maritime sector can prepare for the risks and opportunities presented by climate change are detailed earlier in this chapter. Recommendations for building port infrastructure resilience can be found in the Infrastructure chapter. The Trade chapter contains our ambition for the UK to be part of the push for responsible governance of the Arctic environment as shipping routes open up.

Recommendations

Short term (1-5 years)

- Government will work with ports to review their understanding and implementation of climate change adaptation measures, and encourage periodic reporting on preparedness through the adaptation reporting power.
- Government will work on the international stage to ensure effective governance and environmental protections are in place to regulate ships operating in Arctic waters as they become more accessible.

8.5 Achieving our goals through continued international leadership

The vision for 2050 in this area is:

In 2050 the UK will continue to play a leadership role in global maritime environmental diplomacy. In this way the UK will have successfully ensured that the global maritime sector plays its part in meeting climate change, air quality and wider environmental goals. The UK's "soft power" in this area will also help to ensure that the global regulatory framework is shaped in, and aligned to, the UK's strategic and economic interests as well as our environmental goals.

Where we are now

The UK is a global leader in the field of international maritime environmental diplomacy. It has an important influence on the global fora including, but not limited to, the IMO and international think tanks such as the International Energy Agency and Organization for Economic Co-operation and Development. Being a global leader in this way not only gives the UK a prominent voice in the creation of environmental regulation, but is also a form of 'soft power', which increases the diplomatic standing and political influence of the country.

The blue economy is projected to double in size to \$3 trillion by 2030. In the UK alone, it is currently estimated to contribute around £47 billion GVA and employ more than 500,000 people.¹⁴² As the scale of the blue economy increases, the economic benefits associated with the maritime sector are also likely to increase, and thus the diplomatic interest in global maritime environmental regulation. It is apparent that many countries are keen to demonstrate leadership in this field – for example the UK was one of 57 countries which signed the



International Ocean Declaration in Portugal in October 2018. As the home of the IMO we have had the opportunity to be a leading voice here. At the IMO the UK has led on and been involved in a wide range of issues, from the work to deliver a ban on the discharge of high viscosity products to shaping the Ballast Water Convention. Most recently we have been at the forefront of a coalition of likeminded countries to push for and achieve an ambitious IMO Initial Strategy on the Reduction of Greenhouse Gases from Shipping.

The UK's commitment to minimising the maritime environmental impacts of shipping are framed by, and contribute to, the government's wider environmental diplomatic effort. This includes:

- The Blue Belt programme, protecting marine biodiversity and sustainably managing activities within the UK and the UK Overseas Territories maritime areas through the designation of Marine Protected Areas (MPAs) and other management tools.
- The Intergovernmental Conference to develop a new international agreement under UNCLOS on the conservation and sustainable use of marine biological diversity of areas beyond national jurisdiction (BBNJ).

¹⁴²https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/706956/foresight-future-of-the-sea-report.pdf

- The International Seabed Authority (ISA) to establish regulations for environmentally sound and commercially viable deep sea mining.
- Regional fisheries management organisations negotiating domestic and Overseas Territories priorities.

Providing a holistic overarching framework, the government's 25-year Environment Plan, "A Green Future", sets out protections for the marine environment at an international level. Commitments include implementing a sustainable fisheries policy¹⁴³ and completing our ecologically coherent network of MPAs, which have signalled our support of the UN work on oceans.¹⁴⁴

Where we are going

The government envisages a future in 2050, where the UK will continue to play a leadership role in global environmental diplomacy. It will work to ensure that the global maritime sector plays its part in meeting climate change, air quality and wider environmental goals. The UK's 'soft power' in this area will also help to ensure that the global regulatory framework is shaped in, and aligned to, the UK's strategic and economic interests as well as our environmental goals.

By 2050, we will remain an active presence in developing global maritime regulatory framework at the IMO, including work to ensure the meaningful implementation of the IMO's strategy on GHGs. By 2050, it is expected that economies around the world will be benefiting from the rapid growth in the zero emission shipping market, and the UK aspires to see the poorest countries (including small island development states and the least developed countries) having been able to participate in this global transition. In this future, global maritime regulation will be based on the best available science, and the UK will promote and support the development of the evidence base. The world in 2050 will be addressing the issue of maritime litter and plastics, and the UK will have played a leading role in shaping this regulatory area. More broadly, the UK will in 2050 be using its international influence to enhance the sustainable use of ocean resources.

How we get there

Acknowledging that the UK is already a global leader in this area, over the next decades we must ensure that this not only continues but that the UK plays a central role in leading other nations to create a unified response to the environmental challenges facing the maritime sector.

¹⁴³https://publications.parliament.uk/pa/bills/cbill/2017-2019/0278/cbill_2017-20190278_en_1.htm. The Fisheries Bill, amongst other things, set out to ensure that fishing and aquaculture activities are environmentally sustainable in the long term, and managed in a way that is consistent with the objectives of achieving economic, social and employment benefits, and of contributing to the availability of food supplies.

¹⁴⁴ <https://www.gov.uk/government/publications/25-year-environment-plan>

Recommendations

Short term (1-5 years)

- UK will continue to maintain an active presence in developing the global maritime environmental regulatory framework at the IMO, ensuring that the UK ratifies international environmental conventions to which we are a signatory, in particular the Ship Recycling Convention and Ballast Water Conventions.
- UK will ensure that there is meaningful progress at the IMO GHG negotiations to take forward an action plan and pursue early implementation of specific short term measures ahead of 2023, and progress work on mid and longer-term measures to meet the targets in the Initial IMO Strategy.
- UK will take advantage of its experience on carbon pricing and market-based measures from other sectors. We will work hard to achieve this at a global level through the IMO but if progress isn't sufficiently rapid, we will need to consider options for taking additional steps with other like-minded partners.
- International maritime environmental regulation should be informed by the best available science and evidence, therefore the UK will commit to funding and promoting research in the field that facilitates effective evidence-based policy making.
- UK will play a leading role in the development of an action plan at the IMO on marine litter and plastics.
- UK will continue to use its influence across international and regional bodies to enhance the conservation and sustainable use of ocean resources, such as the suppression of illegal, unreported and unregulated (IUU) fishing and the development of appropriate frameworks to manage deep sea mining and biodiversity beyond national jurisdiction (BBNJ).

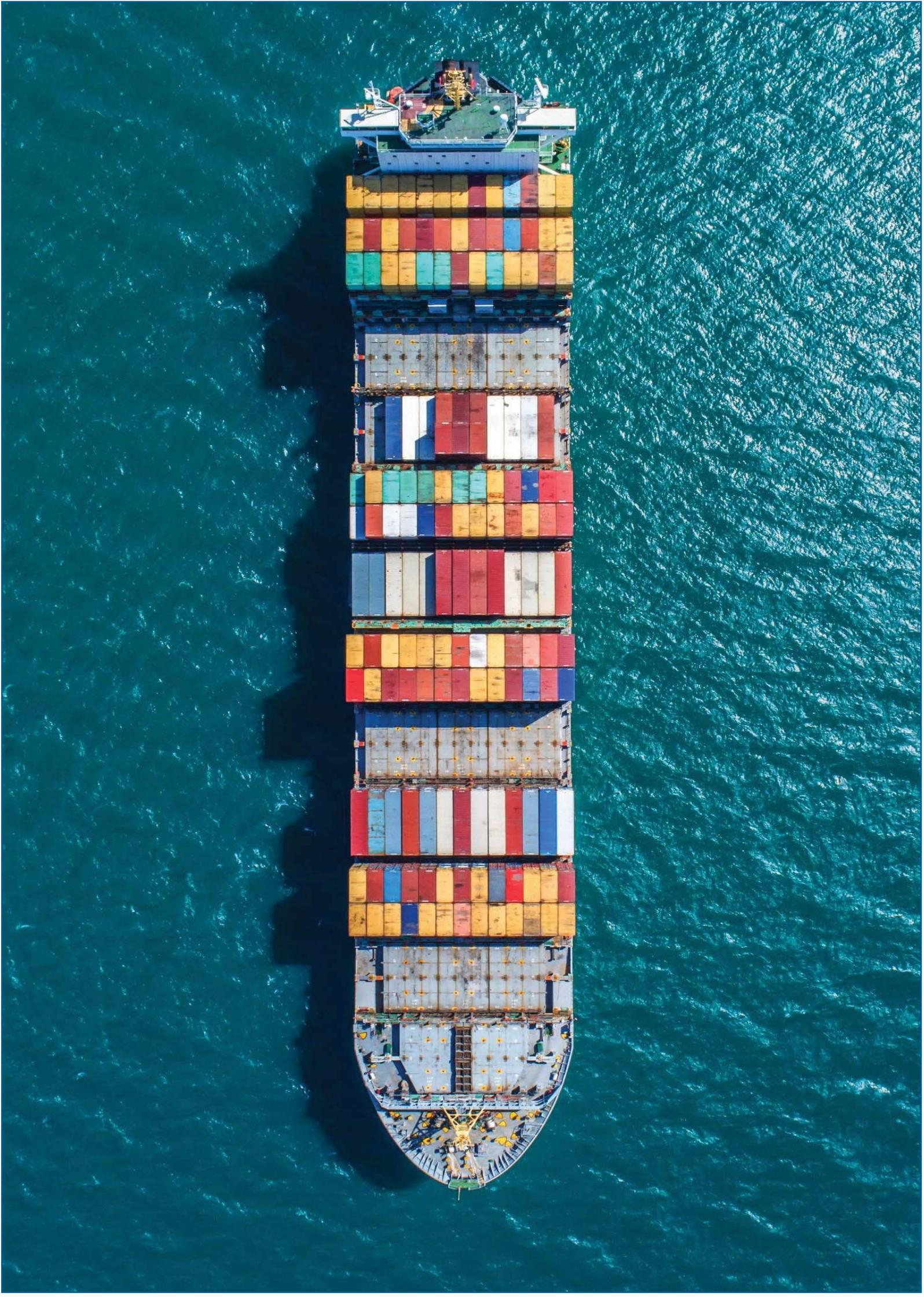
Medium term (5-15 years)

- UK will promote the establishment of an objective and globally recognised body of evidence in the field of shipping emissions as an important step towards monitoring progress and assessing solutions towards the temperature goals of the Paris Agreement on climate change.
- By 2030, in line with the UN Sustainable Development Goal 14, the UK will have supported the poorest and most vulnerable countries, in

particular Small Island Developing States (SIDS) and Least Developed Countries (LDCs), to pursue wider benefits from growth in zero emission shipping, and will encourage other countries major economies to do likewise.

Long term (15 years and beyond)

- UK will push for a significant and sustained global increase in investment for new infrastructure, capacity building and technical co-operation for the poorest countries and those most affected by climate change (in particular LDCs and SIDS) for effective global implementation of the IMO Initial Strategy on the Reduction of Greenhouse Gases from Shipping.



9. Trade

UK vision for maritime trade in 2050

Growth in global maritime trade in goods and services between now and 2050 will be determined by a number of factors including population growth, GDP growth, national and international policy-making, and technological change. Existing trends in population and GDP growth mean that maritime trade is likely to be increasingly diverted from traditional Atlantic economies and toward Asia. International trading relationships may change – resulting in increasing or decreasing globalisation. The nature of goods demanded in the UK may drastically change (for instance 3D printing), as well as where these goods are produced.

9.1 Introduction

The maritime sector is a key facilitator of trade in all kinds of goods and services and as such it is of central importance to the global economy, as well as to the economy of the UK. When we talk of ‘maritime trade’, it is easy to miss the diversity of activities that term covers. Maritime trade can mean the trade in maritime goods such as vessels or marine equipment. It can mean the conduct of trade using maritime means: through shipping goods of all kinds, or of people on ferries or cruise ships.

Alternatively, it can mean trade in professional services, such as financial or legal services for the maritime sector. We must also take account of the myriad trade activities which the maritime sector supports, whether through shipping and logistics, tourism, or global energy production. Together, the wider impact¹⁴⁵ on the economy of these activities is the indirect support of just under one million jobs and the contribution of almost £40bn to the UK’s GDP. This chapter touches on each of these elements in order to demonstrate the breadth and depth of maritime trade activity, and the factors which will affect it between



¹⁴⁵ In addition to the direct contribution of the sector, this includes the indirect impacts (the impact on industries that supply inputs to the maritime sector) and induced impacts (the impact on the wider economy when direct and indirect employees spend their wages).

now and 2050. When we talk of maritime trade, therefore, we must take account not only of the maritime goods trade, or provision of the maritime sector's professional services.

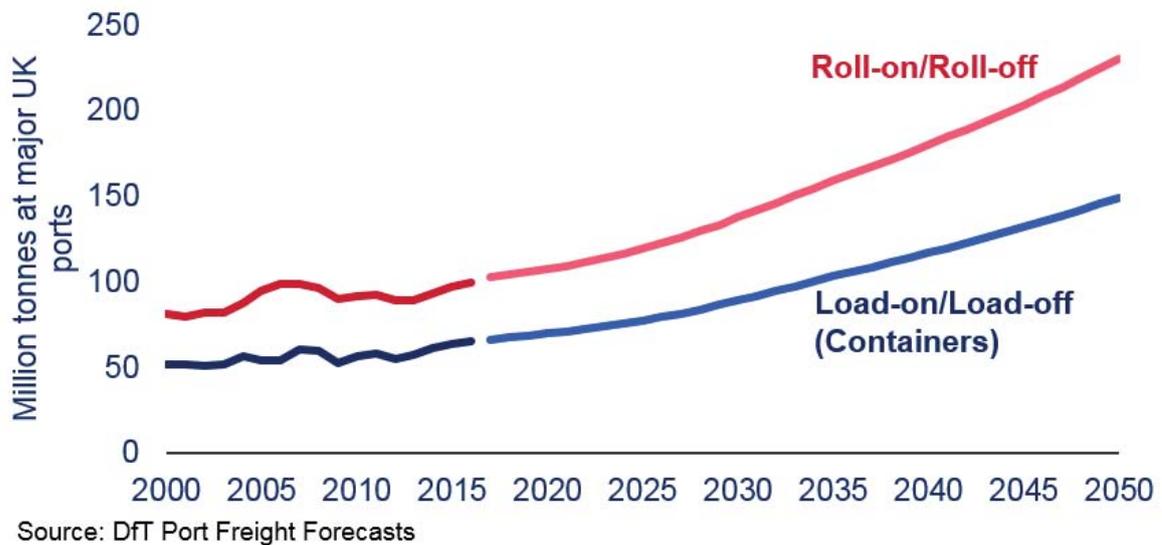


Figure 17 - UK port freight projections

Figure 17 above for example, shows UK's Lift-On/Lift-Off (Lo-Lo) and Roll-On/Roll-Off (Ro-Ro) port freight projections out to 2050, indicating significant increases in the future. So, the maritime sector sits at the heart of the global economy and of international trade.

Looking to the future, existing trends in population and GDP growth mean that maritime trade is likely to be increasingly diverted from traditional Atlantic economies and toward Asia. Consequently, the first sub-theme of this chapter investigates the supply and demand of goods and services provided by the maritime sector, and how these are liable to change. Similarly, technological change will not only have an impact on the goods or services traded and how they are conveyed, but will also significantly affect the infrastructure, skills, and business models employed in order to trade most effectively. The impact of new technologies on global trade flows thus constitutes an additional sub-theme of this section, in addition to its detailed coverage in the Technology chapter of this strategy.

Moreover, further development of global rules and norms will set the direction of the intergovernmental decision-making framework for international trading relationships, determining the extent to which a trend of increasing globalisation continues or dissipates. An assessment of the global rules-based trading framework is therefore included as an additional sub-theme.

Furthermore, confidence in the UK economy, its workforce and its position within the global trading regime will play a pivotal role. Consequently, two related sub-themes are identified: the UK's position as a competitor in a

globalised world and the opportunities for UK trade promotion to support the maritime sector. Together, each of these elements will determine the manner in which the growth in maritime trade takes place, and the extent to which it is facilitated by open and cooperative trading regimes. This will in turn, set the framework for the global trading environment. It is therefore vitally important that UK's approach to trade is fit for today, tomorrow and the years to come.

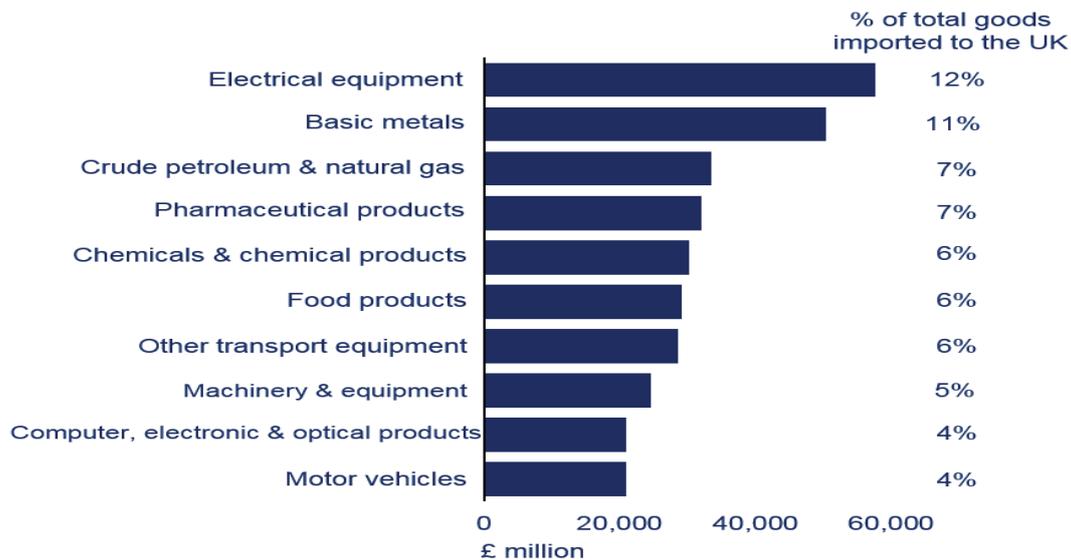
9.2 Supply and demand

The 2050 vision in this area is:

World trade has changed a great deal in the past 30 years: it will doubtless do the same in the next 30. This not only affects the goods traded, but also how they are traded or transported, and the consequent demand for maritime professional services. Changes in supply and demand are invariably driven by external factors which are highly volatile, for instance energy costs, commodity cycles, and external shocks such as war, natural disaster, or sanctions. Trends in supply and demand will fundamentally determine what is traded where, with whom, and by what means. This will have a knock-on effect for infrastructure investment, the environment, and skills.

Where we are now

Recent trends show that international trade has grown rapidly over the medium to long term. Global goods exports are now 38 times higher than they were in 1950 and world trade as a percentage of the global economy has more than doubled since 1960.



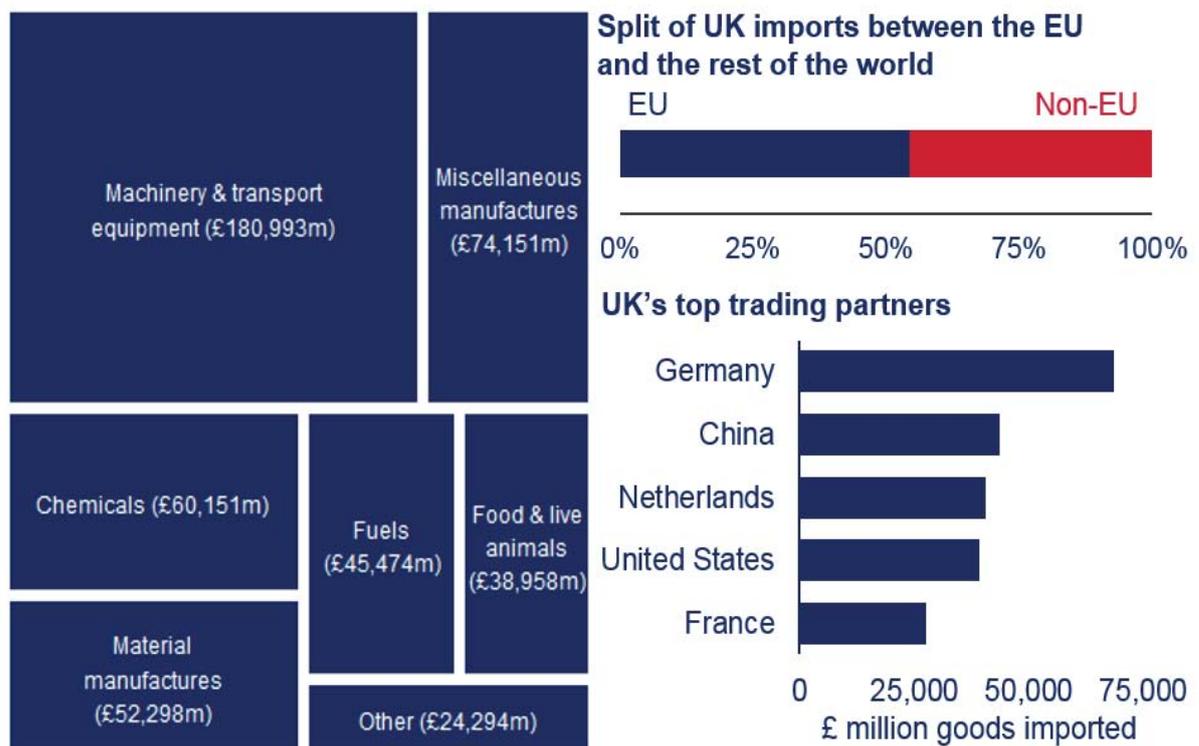
Source: UK Trade Statistics, Office for National Statistics

Figure 18 - UK's top 10 imports

This trend has continued in recent years. Between 2010 and 2016, the value of UK goods exports grew by 12%, but the value of UK services exports grew by 40%, with services accounting for around 45% of the value of UK exports in 2016. The maritime sector sits at the heart of this trade – whether in terms of maritime goods, maritime professional services, or by transporting or processing goods of all kinds. After all, around 95% of goods (by weight) that we import or export to or from the UK are transported by ship.

Figure 18 above shows the UK’s top 10 imports for 2017 highlighting that machinery and transport equipment are amongst the largest imports by value.

Figure 19 below, shows the types of commodities imported into the UK in 2017, the split of our EU and rest of the world imports and the UK’s top trading partners. This highlights that the UK’s principal trading partners comprise of European nations, the US and China.



Source: UK Trade Statistics, Office for National Statistics

Figure 19 - Top commodities imported into the UK in 2017, split of our EU/ROW imports and our top trading partners

The breakdown of our largest imports and exports with China is demonstrated in figure 20. This data shows that we export approximately £4 billion worth of cars to China and this has increased by 69% from 2011 to 2016. Our largest import from China is clothes and this has seen a modest increase of 9% between 2011 and 2016.

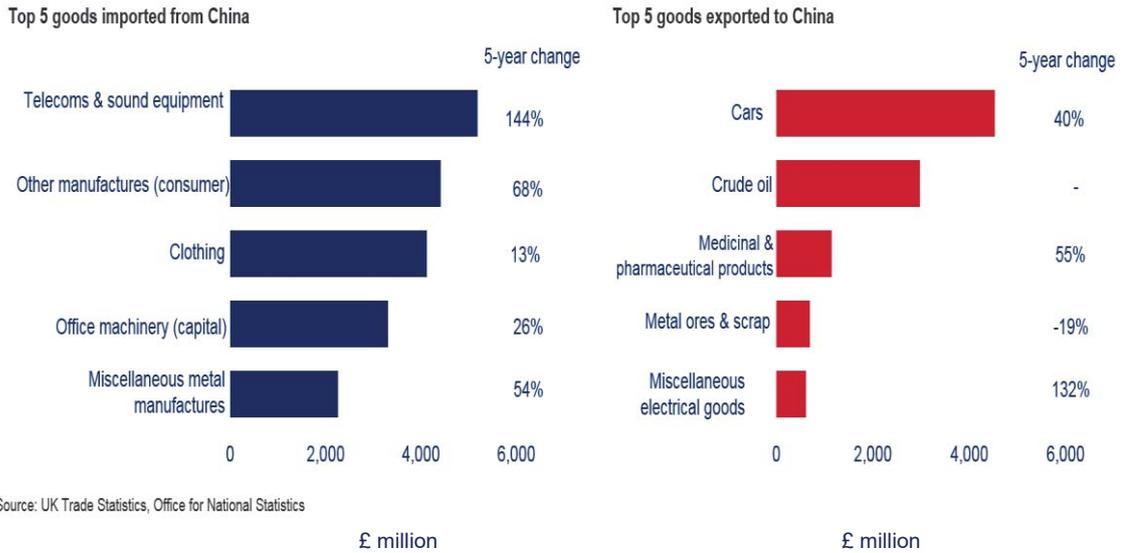


Figure 20 - UK trade with China, top 5 imports and exports

Figure 21 below shows the breakdown of our largest imports and exports with the United States. The data shows that we export approximately £7 billion worth of medicinal and pharmaceutical products to the United States and this has increased by 50% from 2011 to 2016. It should be noted that within the same period, export of cars to the United States increased by 166% (worth approximately £6.5 billion in 2016) and works of art have increased by 172% (worth approximately £3 billion in 2016).

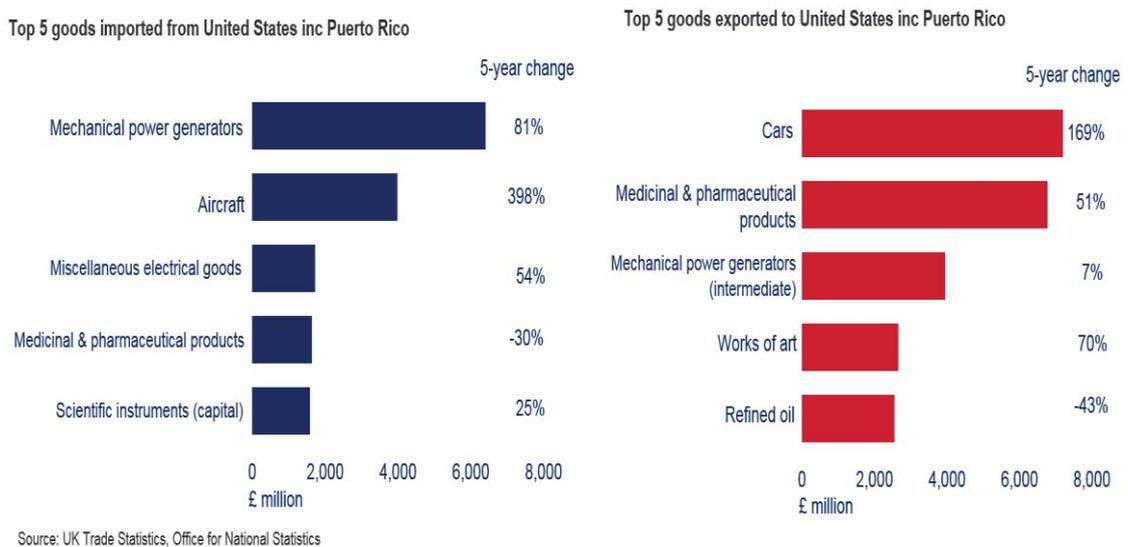


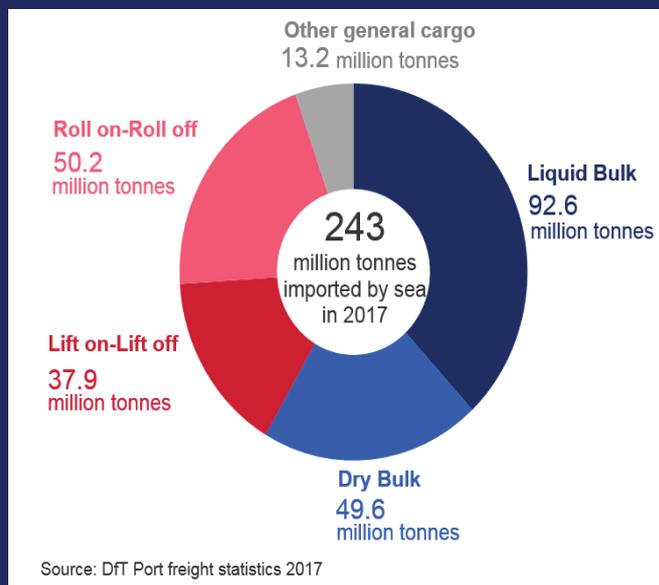
Figure 21 - UK trade with the United States, top five imports and exports

As these statistics demonstrate, the goods which we are importing and exporting, are constantly changing. Not only does this mean that the maritime sector has to adapt to the changes in the volumes of goods traded, but also their type and destination. The case study below provides more detail on this with regards to the energy sector.

The Energy Sector

Liquid bulk, mostly comprised of crude oil and oil products, is the largest commodity type by tonnage imported through UK ports, with just under 100 million tonnes imported in 2017 (Figure 22).

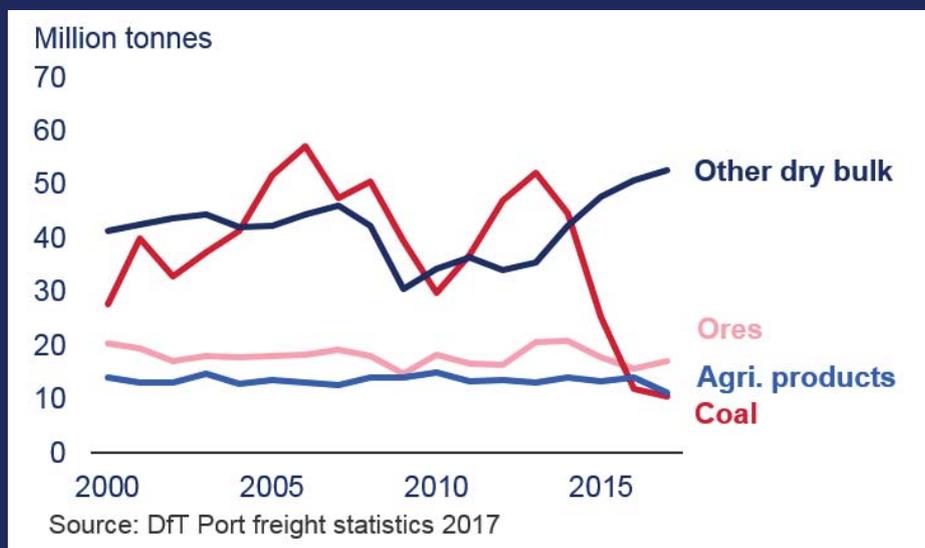
Figure 22 - UK imports by commodity types (tonnage)



Crude oil was historically the majority of liquid bulk handled, however the amount of crude oil has more than halved since 2000, driven mostly by exports which have fallen 64%. Coal imports have fallen 84% since the peak in 2006 and are now the lowest level since 2000.

While coal has fallen, trade in “other dry bulk” has doubled over the last 8 years - evidence suggests that this is largely due to increases in biomass. (Figure 23).

Figure 23 - Dry bulk cargo through UK ports by type



The trade in goods relies on the maritime sector, and the maritime sector is defined by its role at the heart of the global trading system. The UK's place in this system is significant. In 2017, the UK registered trading fleet was the 18th largest trading fleet in the world, on a deadweight tonnage basis, with the tonnage of UK registered trading vessels growing by 6% to 14.4 million deadweight tonnes that year.

What's more, the UK is a world leader in the provision of maritime business services, providing a broad range of competitive and highly regarded services from established companies. It is for good reason that the UK is often referred to as a "one stop shop" for maritime services. This was also covered in detail in the chapter on the UK's Competitive Advantage.

Figure 24 shows the UK global market shares in major maritime service sectors¹⁴⁶. The UK underwrites 35% of maritime insurance premiums and 60% of Protection and Indemnity (P&I) insurance, has 26% of shipbroking revenue, and employs 25% of maritime legal partners.

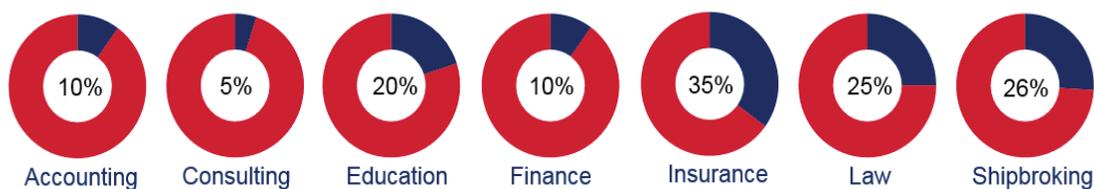


Figure 24 - UK global market shares in major maritime service sectors

English law is the global industry standard and the UK boasts unrivalled legal and judicial expertise on shipping, insurance and international trade matters. Moreover, significantly more maritime disputes are settled by English arbitration than by the rest of the world in total. The UK's dominance in maritime law and insurance therefore sits at the heart of its maritime offer.

UK maritime business is global. 80% of services provided by UK maritime law firms are provided to clients outside of the UK (30% with Europe, 10% with China, 10% with other Asian countries and 30% with the rest of the world. This puts the UK in a strong position now, and as we look forward to the opportunities of the future.

In terms of passenger services, the UK is also highly competitive, serving an international as well as domestic market in cruise and ferry services. The cruise industry is in the midst of strong growth. In 2017, there were 26.6 million cruise passengers globally¹⁴⁷, and 1.9 million cruise passengers at UK

¹⁴⁶ <https://www.cityoflondon.gov.uk/business/economic-research-and-information/research-publications/Pages/maritime-professional-services.aspx>

¹⁴⁷ <https://cruising.org/-/media/files/industry/research/annual-reports/clia-2017-annual-report.pdf>

ports – almost double the amount a decade ago¹⁴⁸. Passenger services contributed £1.3 billion GVA to the UK economy in 2015¹⁴⁹, and represents a genuine opportunity for growth over the short to medium term, with many cruise passengers travelling from around the globe to visit the UK.

The UK's marine manufacturing sector is recognised globally for its skills and expertise in marine systems, equipment, design, manufacturing, engineering and architecture. The UK also has strengths in building naval vessels and submarines, high-end leisure ships, marine equipment systems for international shipping and autonomous systems. It has recently been estimated that the UK ship building, repair and maintenance sector supports over 26,000 jobs in the UK (not including leisure boat building).

Perhaps most strikingly of all, the geographical spread of the UK's maritime sector reaches across the country. Southampton is strong in education, consulting, technical services and marine classification. Glasgow is strong in cadet training and ship management. Aberdeen is strong in offshore services, while marine engineering and manufacturing are spread across the country but with hubs in Scotland, Merseyside, Solent and the South West of England. With such a geographical reach, the economic benefits the sector brings at present are spread across the country, emanating from several clusters of maritime business activity – an aspect that was given greater focus in the UK Competitive Advantage chapter.

All told, the UK is a global leader in maritime trade, whether in terms of manufacturing maritime goods, providing maritime services, or undertaking or supporting the provision of those maritime transport activities which underpin international trade as a whole. At present, the UK's maritime offer is broad and it is deep – it offers goods and services which are in demand, and delivers for the UK economy at large in both jobs and GVA.

Where we are going

Government's ambition is to strengthen the UK's position as one of the 21st century's great trading nations. World trade has changed a great deal in the past 30 years or so, and it is almost certain to do the same over the next 30 years. The goods and services in demand will alter, as will the locations where maritime trade take place. With ships carrying such a high proportion of global trade in goods and shipping being underpinned by maritime professional services, the opportunities for the UK maritime sector to grow its presence in international trade arise from providing the goods and services in demand.

The opportunity here is significant, as global trade is predicted to rise. Moreover, most industry observers expect container traffic to grow super-proportionally in relation to global GDP. Though this is an area where UK ports may need to compete with others in northwest Europe, it can only be

¹⁴⁸ <https://www.gov.uk/government/statistics/sea-passenger-statistics-all-routes-2017-final>

¹⁴⁹ <https://www.maritimeuk.org/value/shipping-industry/>

good news for UK maritime. At a global scale, a 1% increase in GDP generally corresponds to a 1.1% growth in seaborne trade (tonnes)¹⁵⁰.

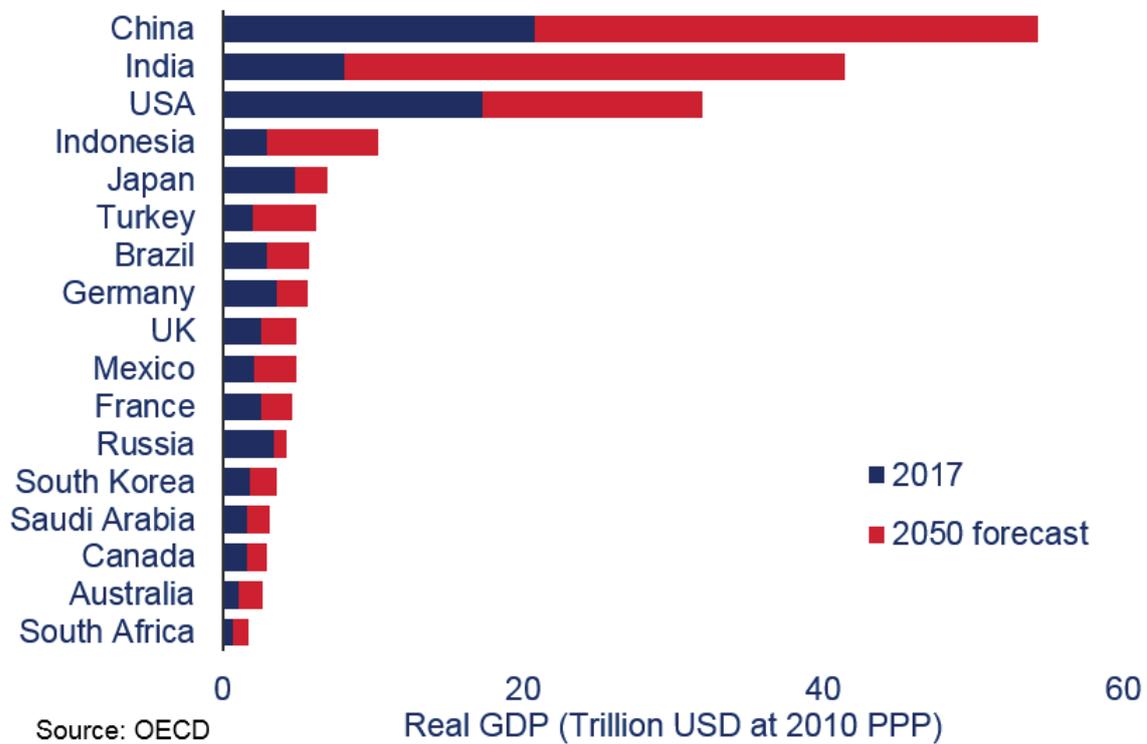


Figure 25 - Economic growth as GDP (Purchasing Power Parity) in \$¹⁵¹

Overall, the UK is well placed to capitalise on its current position as a major provider of maritime goods and services, particularly given its strengths in marine engineering, technology and innovation, marine science and maritime professional services. That said, both government and the maritime sector itself must work to maximise this opportunity and drive growth in maritime trade.

Risks, threats, and opportunities

Several challenges exist in trying to achieve these ambitions and chiefly concern the complexity of the drivers of global trade. Maritime supply and demand are governed by a number of factors, many of which directly impact upon global trade:

- Global political and economic output.
- Production costs.
- Commodity cycles - seaborne commodity trades, for example, can be subject to seasonal cycles in the short run due to changes in industrial

¹⁵⁰ Growth prospects, challenges, and uncertainties for selected ocean industries. OECD.

¹⁵¹ Source: Global Strategic Trends out to 2045, MoD

demand, transport policies, and the depletion/discovery of resources (e.g. crude oil, grain, container trade).

- Transport costs, such as fuel.
- Costs of trading, including administrative and practical barriers to trade.
- External shocks (war, natural disaster, sanctions) – these can intensify the impact of seasonal or economic cycles, increase baseline costs/risks (e.g. insurance), or disrupt normal business flows.

Should demand for maritime business services, shipping, maritime goods, or ports decline for any of the above reasons, there could be significant losses in tax revenue, employment, and GDP. Moreover, should the UK be unable to match the demand in the maritime sector, this would represent significant opportunity cost.

We must also be aware of the competition from other nations. Countries such as Singapore and China are working to build a maritime services sector to compete with the UK, using their financial power and government incentives to attract businesses to relocate. Growing trade in South-east Asia may further increase this challenge, allowing cities in this part of the world to offer an integrated offer to compete with that of London. Moreover, as always, competitor ports such as Rotterdam, Hamburg, and others are vying to grow at the expense of UK counterparts.

How we get there

Trends in supply and demand will fundamentally determine what is traded where, with whom, and by what means. For the UK to succeed, it must focus its energies not only on targeting those markets where growth is anticipated, but also on producing the products and services that the market of the future will demand.

It is with this in mind that government has already committed to partnering with industry through its trade officials at diplomatic missions around the world, provision of a network of Trade Commissioners at a regional level across the globe, and its network of national Trade Envoys. Connecting industry to overseas customers and

markets will be a vital tool in identifying trends and opportunities, as well as turning them into the trade growth we are determined to deliver.



The government has already begun consulting on where it should focus its efforts in terms of future trade. Moreover, the DIT trade has established a

global network of trade representatives and trade envoys to champion the interest of UK companies around the world and to identify opportunities for UK companies to increase their exports.

Though external factors and economic shocks are hard to predict, the government can partner with industry to mitigate their impacts and develop policies which help the sector to adapt and thrive. By working more closely with the UK maritime sector, government is confident that the sector can utilise its market reach, expertise and talent for innovation in order to develop the goods and services of the future. We cannot be certain what those will be, but we can be prepared to lead the way in innovation while seizing and delivering upon the commercial opportunities which arise around the globe.

More generally, the trends outlined in this sub-theme underpin not only the conclusions and recommendations drawn in the rest of this chapter, but in much of the entirety of this strategy. A majority of recommendations across chapters can thus be seen as means to shift demand for maritime products in the UK's favour, responding to competitors, and enabling the country to take advantage of changing global trends.

Recommendations

Short term (1-5 years)

- Government has already committed to helping create a network of Export Champions across the UK who offer expertise and guidance to support other companies on their exporting journey. This initiative will be fully supported and implemented in the near term.

9.3 Global rules-based trading framework

The vision for 2050 in this area is:

World trade is governed by international norms, conventions, and rules. Developments within this framework will determine the extent to which trade will become more or less globally interconnected. At a national level, the UK will be well placed, as a major economic power, to utilise this international trading framework to extend market access for the maritime sector and lower barriers to trade. Multilateral and bilateral trading agreements will be used as a means of growing the UK economy and enabling the maritime sector to continue to compete and succeed on a global level.

Where we are now

It would be easy to think that trade “just happens”, and to a certain extent that is the case. However, trade does not just happen in a vacuum. Trade operates within a global rules-based framework incorporating bodies such as

the WTO, treaties such as free trade agreements (FTAs), and instruments such as tariffs or quotas. Governments manage their national engagement with this framework, while businesses must exploit its provisions in order to deliver competitive advantage.

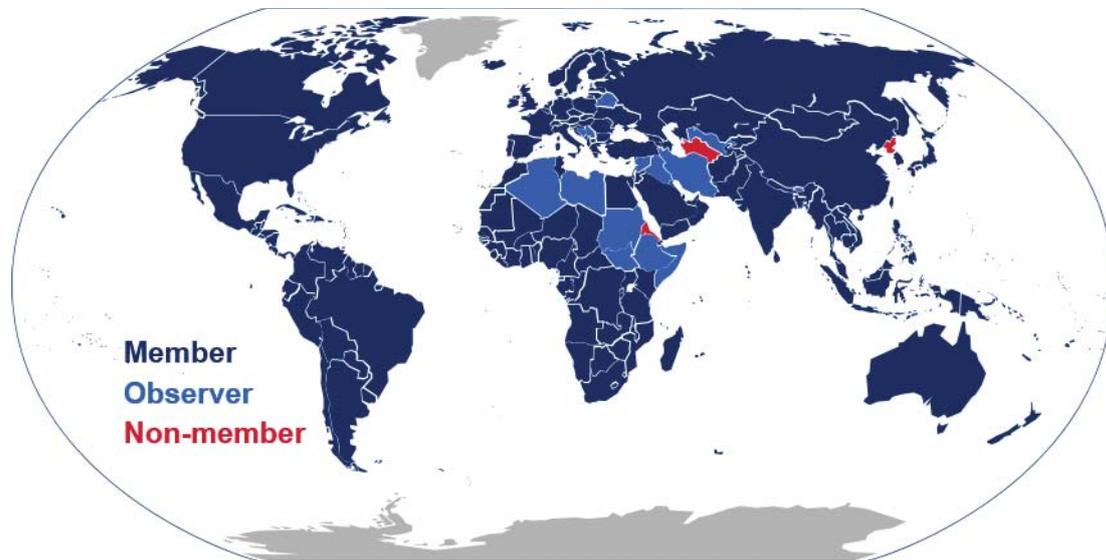


Figure 26 - Map of current WTO members and observers negotiating accession

For the past forty years, the UK has navigated this framework within the auspices of the European Community and the European Union. Now however, the UK is setting a new and independent course which will enable government to retake its seat as an independent WTO member, sign bespoke free trade deals with other countries across the world and align individual instruments of trade policy with national economic interests. All the while, government will undertake a more ambitious programme to assist UK businesses to trade internationally.

Where we are going

Looking ahead to the future, the UK is in an excellent position to engage proactively through the global rules-based trading framework with trading partners around the globe. This can be achieved through both multilateral institutions and bespoke agreements. Underpinning it all, it should not be forgotten that increased global trade will bring a direct benefit to the maritime sector.

The UK has long been, and remains a strong supporter of an open, rules-based international trading system. The UK is a full and founding member of the WTO and has consistently supported its efforts to liberalise trade and enforce international trade rules. The UK is already a powerful pro-trade advocate and proponent of the multilateral system.

A key element of trade policy concerns the negotiation of trade agreements. Trade agreements boost economic growth and lower prices by increasing competition and innovation. This has a twofold effect on the maritime industry; not only does increased trade boost the sector by increasing the volume of goods transported, but maritime businesses themselves can more easily export their own services and products.

Additionally, such agreements also serve a third, broader function. They support social cohesion and stability between countries, advance cooperative standards and values, and can benefit developing countries through their integration into mutually beneficial trading relationships. As the UK looks toward the future, trade agreements will be developed with these truths in mind, and through comprehensive, evidence-based policy making in collaboration with industry.

Risks, threats, and opportunities

Trade liberalisation is not an inevitability, however. In recent years the use of protectionist measures has been increasing around the world, constituting one of the principal threats to increased global trade. Protectionist measures are interventions that unreasonably restrict or increase the cost of trade and investment by discriminating against overseas firms. They can include subsidies and bailouts for domestic industry, in addition to more conventional measures, such as new or increased tariffs, customs regulations and rules of origin restrictions on trading partners. Combatting such protectionist measures is therefore vital to achieving the global free-trade environment the UK seeks to promote.

How we get there

Concerning trade agreements, the UK will seek to maximise its trade opportunities globally by boosting trading relationships with old friends and new allies. The government has already consulted on proposals for ambitious trade agreements with the USA, Australia, and New Zealand. Consultation has also been undertaken regarding the prospects of the UK acceding to a broader trade partnership, the Comprehensive and Progressive Agreement for Trans-Pacific Partnership (CPTPP). Such consultation will form the bedrock of UK trade policy and will ensure that future trade agreements are negotiated in the interests of UK businesses and livelihoods.

When the UK leaves the EU, it will regain its independent seat at the WTO. As an independent member and one of the largest economies in the world, the UK will be in a position to intensify its support for robust, free and open international trade rules which work for all, and to help to rebuild global momentum for trade liberalisation. The UK will build on this to play a leading role in the global rules-based multilateral trading system, as well as expanding our existing bilateral trading relationships.

Moreover, the UK will seek to maximise the potential of its existing influence in international organisations. Concerning the maritime sector, the IMO and

ILO constitute the key bodies the UK will seek to shape and influence in order to facilitate global trade. Furthermore, by taking the lead at the IMO, the UK will retain its competitive advantage by ensuring that it is at the heart of global rule-making in the maritime sphere.

On an institutional level, the UK is a key player at the IMO and the ILO, organisations which play an instrumental role in shaping the global regulations which directly affect the operation of maritime trade. This position is of huge strategic importance and ensures that the government can engage internationally to help set those rules and obligations which benefit both the UK's interests, and the sector as a whole. Such an approach lends authority and credibility to the UK as a responsible and capable maritime power.

To caution against protectionist measures, the UK will lobby within multilateral institutions. The WTO's existing trade dispute settlement mechanism aims to resolve trade conflicts between countries and, by underscoring the rule of law, makes the international trading system more predictable and secure. The UK will fully support such mediation efforts.

Beyond FTAs and the WTO framework, other instruments are available, such as Memoranda of Understanding, bilateral treaties and international engagement by government Ministers. These approaches can unblock existing barriers to trade and facilitate the smoother and more efficient operation of bilateral trading relationships. They therefore comprise an assortment of mechanisms through which the UK's wider policy aims will be achieved, to be used as and when appropriate.

As we develop our new trade policy and re-join our place at the table of independent trading nations at the WTO, we will be able to be a rule-setter and actively encourage free-trade across the developed and developing world. The maritime sector, as a key enabler of global trade, will be central to that process.

Recommendations

Short term (1-5 years)

- Government will seek opportunities to pursue an ever more ambitious free trade agenda with the rest of the world, while ensuring continuity of existing EU third country free trade agreements to maintain their benefits and provide certainty to businesses.

Medium term (5-15 years)

- Government will develop new free trade agreements with like-minded countries – with a view to opening up trading opportunities and new markets.

Long term (15 years and beyond)

- Government will pursue strategic development of a transparent and fair regulatory playing field through the IMO and the ILO to enable trade to continue to grow.
- The UK will maximise its trade opportunities globally and across all countries by boosting trading relationships with old friends and new allies.
- Government will continue to pursue economic prosperity for the UK and lead by example through its liberal economy and pursuit of free trade. Government will work towards developing, supporting and enforcing a fair and proportionate rules-based system for trade, domestically and internationally.

9.4 Competition in a globalised world

The vision for 2050 in this area is:

Global competition in the maritime sector is increasing, and in order to compete the UK will need to ensure that it provides an attractive environment within which businesses can operate. The UK will undertake to ensure that its business and regulatory framework is globally competitive, enabling trade in the UK maritime sector to continue to thrive.

Where we are now

As already noted, the UK is a world leader in the provision of maritime goods and services. That said, other nations are becoming increasingly able to compete with the UK in traditional maritime activities and exports, lowering barriers to entry to the market for those goods and services currently underpinning maritime trade. Artificial incentives, innovative policies and regulatory alignment have an increasing influence on the location of globalised business operations. As a result of this, stakeholders have highlighted that the UK needs to offer a competitive package of fiscal measures to attract inward investment, so as to ensure that the UK keeps pace with competing nations. Creating such a business environment was given further consideration in the UK Competitive Advantage chapter.

That said, the UK remains strong in value-added areas of the maritime sector, maintaining a distinction between many of the products and services it trades and those of competitor nations. On the domestic front, the UK has a mixed model for ownership of ports which is significantly different to neighbouring European countries, which predominantly have publicly owned ports. 70% of UK ports are privatised, while others are owned by municipal authorities or trusts. This mixed but largely privatised ownership model means that UK ports

are alive to competitive pressures, typically offering a service that matches and exceeds customer expectations and investing billions of pounds in their operations to remain world-leading maritime hubs. This is considered in more detail in the Infrastructure chapter.

Where we are going

Our ambition is to strengthen our position as one of the 21st century's great trading nations. As such, we want to consolidate the advantage we already have in the maritime sector, building on our existing position as a centre for excellence and maintaining and expanding our market position. The UK's Industrial and Export Strategies lay the groundwork for the national economy to flourish in the century ahead, tackling the challenges which are facing all nations, and unlocking our trade potential. As a key facilitator of international trade, the maritime sector stands to be at the forefront.

At the same time, we must recognise that whilst globalisation has spread prosperity and lifted millions out of poverty, some have felt left behind. Ensuring that increased maritime affluence is spread across the industry in the UK, and is not limited to one geographic locale or sector, represents an important challenge in the years to come. Aligning the UK's domestic Industrial Strategy and its trade ambitions will be key to delivering the innovative, competitive and growing economy that benefits individuals and communities, and will ensure the value of trade is shared more widely across the whole country.

How we get there

Remaining globally competitive is a constant and not insignificant challenge. As a growing number of countries become able to compete in those areas where the UK has a significant market presence, for instance in professional services (Figure 27), the UK must constantly seek to maintain and improve upon its competitive advantage.



Figure 27 - Top 10 maritime services hubs in Xinhua-Baltic index

With specific reference to those areas where the UK currently excels, London and the country more generally must aspire to remain the world leading centre for maritime professional services. This can only be achieved through both government and industry focussing on their own areas of expertise, and working together to deliver an ever-improving and enticing offer for prospective trade partners or investors.

Those organisations which constitute the life blood of UK maritime trade must seek to innovate and adapt, creating products and services which set them apart from global competitors. This will be achieved by developing new products in cutting edge fields such as green finance and artificial intelligence. Equally, it will be achieved by updating or improving existing products or services, for instance to improve quality or efficiency. Early adoption of new technologies, such as online trading platforms and blockchain supported insurance systems, will be key to ensuring that the UK remains competitive in the professional services sector, as outlined in more detail in the Technology chapter. Moreover, these goals will also be achieved by working more effectively to harness existing assets and making the most of public-private cooperation.

Part of this process will involve bringing more of the UK's excellent businesses, maritime and otherwise, into the practice of exporting. There is a strong appetite around the world for UK products and services, and as more UK businesses of all types begin to export, the maritime sector will stand to gain. With this in mind, the government has committed, through the DIT, to support businesses in rising to the challenge and reaching their potential to trade more. The government has identified four key parts to this:

- Encouraging and inspiring more businesses to export.
- Informing businesses about the practical assistance available on exporting.
- Connecting UK businesses to overseas buyers, international markets, and each other.
- Utilising export finance to support UK exporters.

For the maritime sector specifically, government and business will work together to identify how regulatory and fiscal levers can be moved to ensure the UK remains an attractive and competitive place to do business. For instance, we will support industry to investigate how innovative customs arrangements or the creation of 'Free Ports' can encourage investment into the UK's ports, taking into account the unique nature of the UK economy.

Similarly, we will explore how barriers to trade can be lowered at home in order to make the UK and its maritime businesses even more attractive for prospective international trading partners. To meet some of these outlined aspirations, government will work with the maritime sector to produce a study to better understand the competitiveness of the maritime business services sector. This study will look at the UK offer compared to that of some of our competitors. It will also look at wider issues such as tax and investment, and

determine whether we need to refine or better promote the UK offer in order to maintain our competitive edge.

Government and industry must together take a strategic view of policy making and generate new policy solutions which meet the complex needs of the sector and the wider economy. More generally, we must build on the work already done to help more UK companies to export – generating a trade ripple effect which will strengthen our maritime sector.

Recommendations

Short term (1-5 years)

- Government will work *with* the maritime services industry, to commission and deliver a study into the competitiveness of the sector.
- Government will engage with ports and the manufacturing industry to consider the case for free ports in the UK.

9.5 New technology and future modes of transportation

The vision for 2050 in this area is:

It is highly unlikely that an entirely new mode of transport will replace shipping as the dominant means of moving goods internationally. However, there will be increased competition from niche employment of other existing transport modes such as rail freight. More fundamentally, technological changes such as 3D printing and the utilisation of new energy sources will change the dynamics of international maritime trade. The manner in which we trade both goods and services will also radically alter through the deployment of new technologies such as blockchain, virtual reality, and artificial intelligence.

Where we are now

The maritime sector currently incorporates a wide variety of technology, from satellite communication to complex electronic navigation systems. Technological change is inevitable, and therefore we must ask whether new technologies or even different transport modes or routes will radically alter the operation of international maritime trade. Moreover, we must ask if changes in the global supply chain brought about by new technology will fundamentally alter the demands placed upon the maritime sector – and the opportunities it faces to grow into the future.

Technological developments have always played a central role as a driver of trade, both in terms of how goods and services are traded, but also in terms of what those goods and services comprise. Similarly, the mode of transport used to trade goods has varied over time but maritime transport has

consistently been the dominant force in global trade. Could new technologies alter this? To answer this question, a consideration of the future of the maritime sector is not only necessary, but also how competitor industries are likely to evolve. The share of cargo transported by railroads, for instance, increased 144% in 2017 compared to 2016. The international union of railways estimates that China-Europe rail services could double their share of trade in volume over the next 10 years.

The share of freight travelling by rail is small, but it has increased in recent years. The share of the value of freight has risen from 0.4% in 2012 to 2.6% in 2017, partly reflective of the fact that rail carries higher value goods than sea. In 2017 the value of rail freight travelling between the EU and China averaged €11 per kg, sea freight €3 per kg and air freight a towering €73 per kg.

New technologies that reduce the cost of competing transport modes may affect the attractiveness of shipping. Nevertheless, the maritime sector seems very likely to remain central to the operation of global trade. Over the centuries it has incorporated new technologies in order to enhance its competitiveness and has sought new routes in which to undertake its operations faster and more efficiently.

Indeed, Eurostat figures¹⁵² support the fact that maritime trade still currently dominates EU-China trade flows. Figure 27 shows that in 2017, 92% of freight (by weight) between the EU and China left or arrived in Europe by sea. The dominance of maritime is not expected to change - in utilising new technologies, the industry can in many instances ensure it offers a service unmatched by competing transport modes.

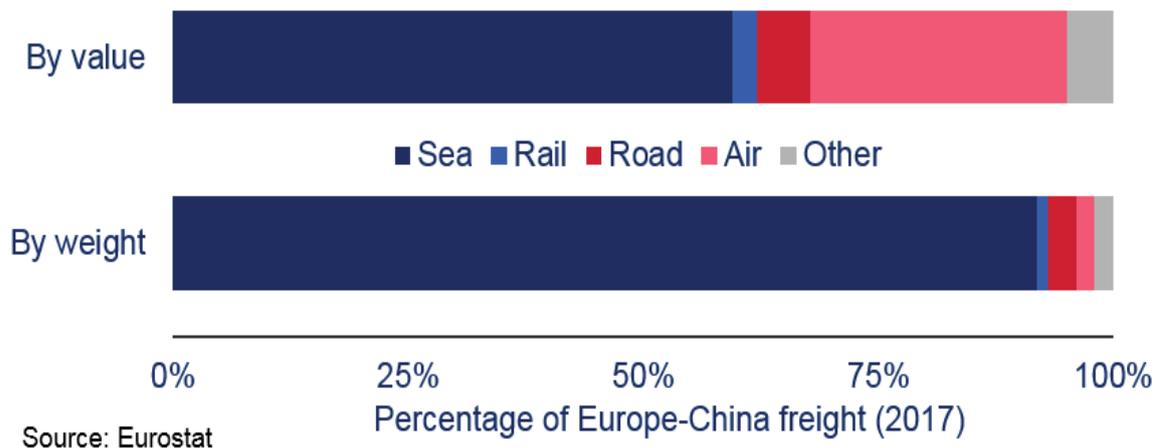


Figure 28 - Percentage of Europe/China freight in 2017 by mode used when leaving or entering Europe

¹⁵² Note that the mode recorded is the mode used when entering/leaving the EU and may not be the mode used for the majority of the journey.

Where we are going

The government's 'Future of the Sea' report suggests that another mode of transport is unlikely to disrupt maritime transport for 100 years. So, a potential shift towards a 'new' mode of transport is highly unlikely by 2050. For example, hyperloop technology is some way off and would require significant efforts in planning and construction, suggesting this is not a credible alternative to maritime transport for a long time to come. It would also likely be limited to short distances in view of the cost and technical challenges of construction. Indeed, Hyperloop One is exploring the possibility of building short hyperloop tunnels between offshore ports and storage sites examined in the Infrastructure chapter. Rather than competing with maritime transport, this initiative would serve to complement it.

Smarter, more efficient use of 'green' ships is more likely and the status of maritime trade in the next 30 years is unlikely to significantly change. It is much more likely that smart shipping will act as a disruptor to the maritime sector than hyperloop technology, as demonstrated in the use of drones to inspect ships or in the full automation of the container yard and the remote operation of quay cranes at London Gateway covered elsewhere in this strategy.

Indeed what we are seeing, and will likely see in the future, is an increasingly "smart" global logistics chain, as demonstrated by the technology, environment and infrastructure chapters. In this scenario the "smart" ship is one part of an end-to-end logistics process involving increasingly advanced ports and underpinned by digitally enabled maritime services. Final port to door delivery is undertaken by a smart logistics chain potentially embracing newer technologies like drone delivery. All told the "smart" global logistics chain, with maritime prevalent throughout, is increasingly efficient, brings new cost effectiveness and brings about improvements in environmental performance.

Although a new mode of transport is unlikely to overtake the predominance of the maritime sector, challenges still exist from competing sectors. Notably, the expected increase in infrastructure investments that result in the electrification of shore transport modes could make them more competitive than shipping, and increase their modal share.

The influence of new technologies could also significantly alter patterns of trade and the demand for goods. For example, the rise of 3D printing, the consumables for which are significantly different than those required in standard manufacturing processes, could drive a trend for a different type of shipping and handling. ING Bank has estimated that 50% of manufactured goods could be printable by 2060. They also estimate that if investment in 3D printing technologies continues at the current pace, trade will be 23% lower in 2060. Only time will tell if 3D printing will so radically alter the volume of global trade in 2050, and the types of vessels supporting this trade.

Blockchain is also a technology which has the potential to act as a major disrupter to maritime trade. This applies as much in its operation in a customs function as in its application to the undertaking of maritime professional services such as ship finance or insurance. There are significant commercial opportunities to be realised from adoption of digital technologies, especially in an industry which is currently so reliant on analogue technology and physical documentation. This is seen as inefficient and causes delays which trickle down the supply chain causing significant financial losses. Blockchain is just one way in which such processes could be radically altered and improved in the near future, facilitating more efficient international trade.

It is not just new transport modes which may alter the trade in goods, but new transport routes may emerge as well, radically altering the flow of trade around the globe. For instance, maritime trading routes could shift as technology facilitates safer and cheaper use of Arctic routes opened up by climate change (see case study below). This topic is thus also pertinent to environmental and technological issues, and is therefore also given note in the relevant chapters of this strategy.

Arctic Trade Routes

The figure below shows the main shipping routes used by the maritime industry. From 2003 – 2012, there has been very strong growth in traffic around Asia and between Asia and Africa (as well as fairly strong growth on the route from Asia to Europe).

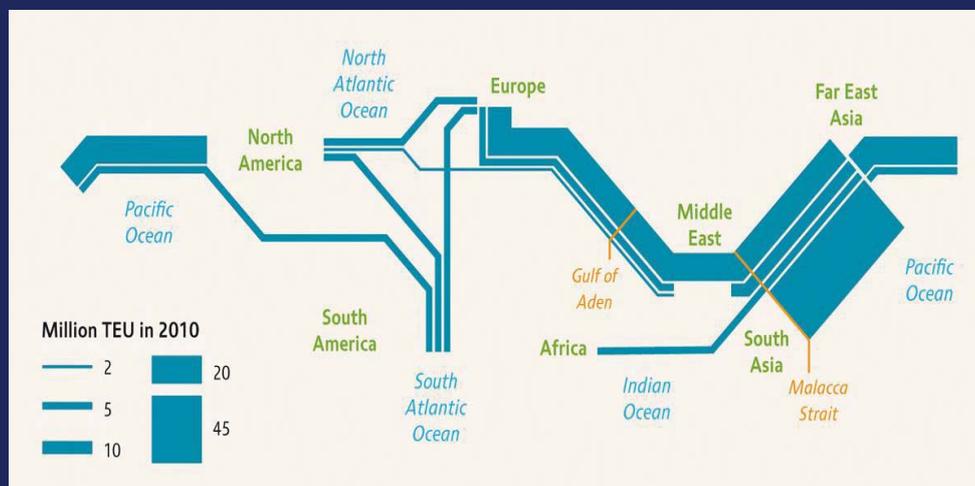


Figure 27 Main shipping routes¹⁵³

Warming temperatures and declining sea-ice have exposed areas of Arctic waters previously hard to access, creating potential for new shipping routes transporting goods between Asia and northern Europe. Shipping in the Arctic is already increasing, especially ships originating from a destination within the Arctic itself, whereas transit shipping remains limited to the

¹⁵³ Image produced by UNITAR, <https://www.unitar.org/unosat/piracy>

summer months when sea-ice is at its lowest extent. It is conceivable that seasonal maritime routes will open through the Arctic, though it is less clear to what extent year-round routes could open or when.

Transit through the Arctic region could reduce travel time between Asia and northern Europe by 10-12 days. As well as the time saving, this would also cut fuel costs, therefore incentivising shipping companies to utilise these routes with greater frequency.

It is not clear the extent to which trans-Arctic shipping will become a reality between now and 2050, however it is clear that the UK has a geographical comparative advantage when it comes to Arctic shipping. As well as the reliance on climatic changes to make such shipping routes viable, there are specific challenges which would need to be overcome from a technical and commercial angle before routine trans-Arctic shipping became a reality.

For instance, new technology will be required in order to meet the challenges of transport via the Arctic and to ensure the safety of crew, cargo, and vessel. Alongside this, it is highly likely that there would be implications for insurance, environmental and labour regulation, and international agreement over territorial boundaries.

In order to overcome these challenges, and to ensure the UK continues to be well placed to benefit from the regular opening of trans-Arctic trade routes, consideration of the technological and regulatory challenges posed by such routes need to be incorporated into everyday government planning. Further, government must monitor the climatic, political, and environmental factors involved in a more accessible Arctic.

Finally, industry and government must work together to better understand what, if any, new infrastructure would be required to prepare the UK for this new trade route.

Risks, threats and opportunities

There are doubtless risks associated with investing in the wrong technology at the wrong time, however, there are also risks associated with falling behind competitors and failing to realise the potential of new technology until it is too late. This further reaffirms the requirement for the government and maritime sector to bring to bear all its power as a thought leader and an early adopter or fast mover covered already in both UK Competitive Advantage and Technology chapters.

It is not possible to predict the technological developments which will shape the maritime trade of the future. What we can and must do, however, is maintain a constant and optimistic vigilance for the potential benefits of new technologies. We must also work across government and industry to identify the means by which technology can provide opportunities for growth in the UK's maritime trade.

How we get there

Technology will be such an important driver of international trade that it is of critical importance the UK maritime sector remains agile, ensuring it is 'tech-enabled' for the coming years. This will involve infrastructure, skills, security, and environmental considerations. Only by remaining vigilant to technological change can maritime businesses ensure they are innovating to compete with their global peers, and are able to support the wider operation of international trade.

Government and industry must work together to identify these trends and ensure the UK is well prepared to seize the opportunities provided by new technology, enhancing its competitiveness and its place as a leading maritime nation in the 21st century. Moreover, the UK must integrate its thinking on technological development into its plans for future trade agreements and maritime regulations. This will ensure the correct provisions are put into such agreements now so as to be ahead of the game as and when new technologies become the norm.

Beyond those technologies affecting maritime transport and professional services, and those which promise to shake-up existing manufacturing processes, new technology will also profoundly influence the interconnectivity of transport modes. As noted, it is unlikely that new modes of transport will develop to supplant maritime by 2050. However, it is entirely possible that the way in which ports connect to the hinterland may change in line with new technologies. This connectivity will likely be facilitated by new port-based technologies and smart ports.

Each of these issues is directly relevant to future patterns of trade. Such is the expected impact of technological change, it is given specific focus in the Technology chapter of this strategy. The discussion here should therefore be viewed as a synopsis of the detail given in that chapter, where technology specific recommendations and actions are also outlined. Moreover, the development of new technologies could open entirely new prospects for the sector, such as the ability to more safely and efficiently navigate Arctic waters to open up more competitive trade routes. Industry and government must work together to ensure the opportunities this offers are not missed and to make sure that the risks it poses to the sector are mitigated.

Recommendations

Short term (1-5 years)

- UK will partner with like-minded nations to coordinate mutual understanding of how to successfully develop the services and technology necessary for safe, secure, environmentally sound and reliable Arctic maritime activity in order to maximise mutual benefit from new shipping routes.

9.6 Trade promotion

The vision for 2050 in this area is:

The UK will take advantage of opportunities to expand its maritime export market to new and emerging economies. Coordinated and effective government trade campaigns will be launched to ensure British maritime products and services continue to be desired across the world. As global wealth and prosperity continues to rise out to 2050, the UK's expertise in technical, high value-add sectors will be increasingly demanded. Domestically, export initiatives will ensure UK businesses do not miss out on the available opportunities, ensuring that a lack of knowledge is never a barrier to meeting external demand.

Where we are now

Although the UK's role in large scale ship building has reduced it continues to have a world class reputation in areas such as marine equipment and systems, the development of autonomous vessels, marine science, and specialist areas such as composite materials used in the manufacture of vessels.

The maritime sector is highly export-orientated as a consequence of the limited opportunities in the domestic UK ship construction market, with 30% of UK leisure, superyacht and small commercial marine industry revenue in 2017 originating from export transactions¹⁵⁴. The UK is a market leader in the building and exporting of leisure craft such as superyachts; the marine sector contributes £6.4bn GVA to the UK economy with leisure marine accounting for £0.9bn of that¹⁵⁵. The UK currently accounts for 10% of the global non-defence vessel systems market, within a total global marine sector value that exceeds £100bn¹⁵⁶.

To take further advantage of these export opportunities a range of coordinated DIT Export Campaigns have been running for over two years. They have initially focussed on marine engineering, predominantly marine equipment and services. These were designed to target those markets that aimed to develop capabilities in higher margin, more complex and intelligent vessels.

The current campaigns are focussed on China, Brazil, South Korea and from 2018, ASEAN (Vietnam, Singapore and Indonesia). In maritime services, the current campaign is focussed upon Greece. Underpinning these campaigns is the clear message that the UK offer is differentiated by a premium service and expertise as underlined by the values and ambitions set out at the start of this strategy.

¹⁵⁴ <https://www.maritimeuk.org/media-centre/publications/annual-review-2018/>

¹⁵⁵ <https://www.maritimeuk.org/value/marine-industry/>

¹⁵⁶ <https://www.maritimeindustries.org/write/Uploads/UKMIA%20Uploads%20-%20DO%20NOT%20DELETE/UK-Marine-Industries-Technology-Roadmap-2015.pdf>

Where we are going

A five-year implementation strategy is in the process of being agreed between DIT and Maritime UK to coordinate activity and identify where government can best add value. To respond more effectively to industry, DIT has combined the work of the marine engineering team with the wider maritime sector, which includes maritime business services, education, training and skills and ports and infrastructure. Work to date has identified four areas in which there are large opportunities for the UK. The following have been put forward by industry:

- **Green Shipping** – In the medium to long term there is a drive to lower and zero emission energy creation, enabling opportunity in an estimated \$260bn industry.
- **Digital Technologies** – Increasingly the backbone of the shipbuilding and operating market as owners look to create efficiencies, reduce costs and increase their cyber-security. The UK shipping technology sector is now a £4 billion industry, estimated to be worth £13 billion per year by 2030.
- **Specialist Vessels** – Complex vessel design and build is high value and a good match for the UK supply chain. Cruise ships, research vessels, and cryogenic tankers all come into this market, with a global market of £4bn per annum and an accessible value to the UK of circa £500m.
- **Autonomous Vessels** – Autonomous shipping offers the opportunity to reduce crewing costs, which can be up to 50% of total costs. The \$52bn market opportunity includes the sub-24 metre autonomous surface and underwater vessels increasingly used in the defence, energy and marine science industries.

The demand-side focus of DIT's campaigns will continue to target owners (i.e. tourism companies) as a well as yards, integrators, design houses and government departments with the recognition that the supply chain is truly global. Supply-side activity will be increasingly based on account management of the key companies and understanding and mapping the UK offer.

Other parts of DIT will play an important role. UK Export Finance (UKEF) will become a key part of the UK offer in all our markets, particularly for buyer side finance. UKEF is already proving a useful way to enhance procurement options and support UK bidders into projects. The GREAT brand will develop material supporting a high-impact maritime campaign, replicating the success of some other sectors in their use of the brand. And there may be some scope for supporting promotional events internationally. However, these will have to

be targeted, show value for money and achieve our trade development ambitions.

More broadly, each of these initiatives can capitalise on the fact that the UK is already a very strong and established maritime nation with businesses that operate at the highest level. Alongside a world-beating maritime cluster, the UK's experience and reputation are unrivalled. The country can use these assets as the basis for an ambitious and outward reaching approach to trade in the future, presenting a clear opportunity for the nation.

How we get there

Ever increasing coordination across government and between the Maritime 2050 strategy, the National Shipbuilding Strategy, the Industrial Strategy and DIT's Regional Trade Plans and cluster plans will be necessary. DIT will lead on the trade and investment components of this work. A whole of government approach is anticipated that will require effective co-ordination and knowledge across Whitehall of the challenges and disruptive technologies affecting the industry. The importance of the increasingly deep partnership between Government and industry was set out in more detail in the UK Competitive Advantage chapter.

Industry and other key stakeholders will be involved throughout to develop joint planning and delivery and to ensure that the UK presence at key trade shows is comparable with our competitors. LISW will continue to be a global leading showcase for UK maritime, an event which is also given more specific focus in the UK Competitive Advantage chapter of this strategy.

A more bespoke account managed approach will be adopted to help with market entry. This will also include forming strong UK consortia where appropriate to tackle large-scale opportunities. A recent example of this is the establishment of the UK cruise group to tackle opportunities in China resulting in the planned UK China Maritime Innovation Alliance.

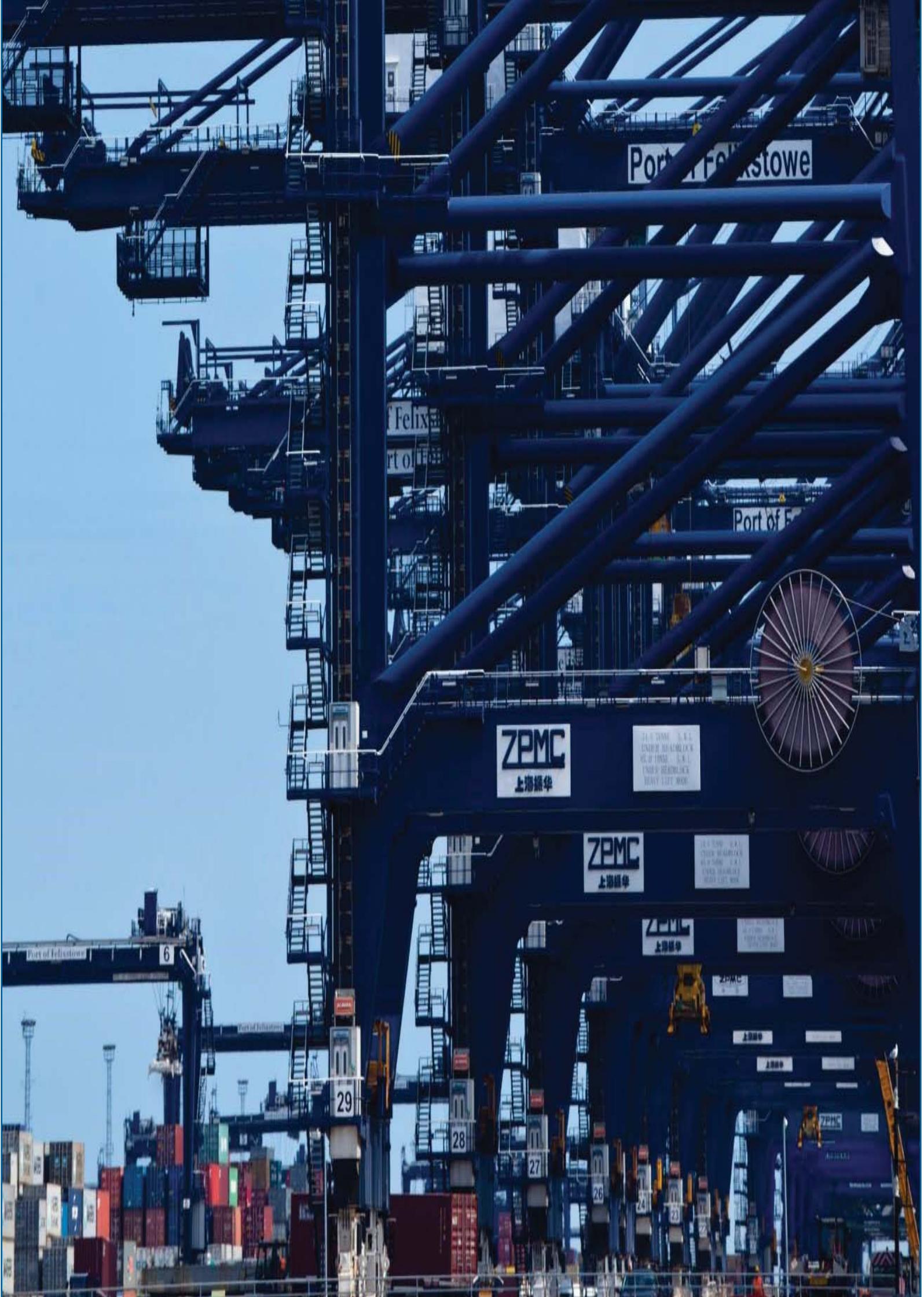
DIT's front line staff will be encouraged to acquire the knowledge, skills and information to effectively prospect for and develop a range of relevant opportunities in the sector. This is likely to be addressed by intensive training in the UK, together with better collateral material generated by DIT in collaboration with the industry.

The UK is well placed to take advantage of a range of future trade opportunities through our Global Britain approach. Emerging markets in the East comprise the largest of these opportunities, although the country's existing strengths in the current high-end technical and leisure markets will not be neglected. Cross government collaboration, led by the DIT, will be key to delivering effective campaigns. At the heart of these campaigns will be a promotion of the UK's premium offering, providing high quality and technically advanced goods and services to the rest of the world.

Recommendations

Medium term (5-15 years)

- Government will comprehensively consult with industry on the direction of UK trade policy, how it can best serve the maritime sector, and the mechanisms for involving them during negotiations
- Government will collaborate closely with industry to increase UK exports, as a proportion of the UK's GDP from 30% to 35%, supporting the maritime sector in its role as a key facilitator of trade.



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10. Infrastructure

UK vision for maritime infrastructure in 2050

Maritime infrastructure will be agile and open to change as technology development cycles and adoption become faster. The UK's maritime infrastructure will need to match the level of modern technology in comparable industries, embedding best practice. Autonomy, interconnected smart systems and big data will bring the shipping, cargo handling and inland logistics elements ever closer together, maximising efficiency, reliability and reducing costs. Changing perceptions around social and environmental responsibility will place greater precedence on maritime infrastructure, both at sea and on land, to operate in a cleaner, safer and more ethical manner. Changes in consumer demand, for instance 3D printing, will require changes in infrastructure at ports and onward freight transport.

10.1 Introduction

This chapter discusses the importance, aims, ambitions, and vision of the UK's maritime and marine infrastructure, considering the risks, opportunities, and challenges to the sector over the period to 2050. Moreover, it considers the interdependencies of physical infrastructure with the other key themes of the strategy.

Maritime and marine infrastructure varies extremely from mega vessels, gantry cranes, and lighthouses to subsea oil and gas pipelines and cables. It is also a central point for the movement of goods and people, enabling recreational facilities at sea and ensuring the safety and security of our coastline. In order to consider its full extent, the following five sub-themes have been identified: Port and Harbour Infrastructure; Port Connectivity, the Supply Chain, and Logistics; Sectoral Infrastructure; Ship and Boat Building; and Shipping in the supply chain. The remainder of this chapter examines each sub-theme at a strategic level, and accordingly, it will be complemented by an Infrastructure route map to be published in 2019.

10.2 Maritime infrastructure today

The maritime sector has invested meaningfully and with a great deal of success across all facets, from ports, such as London Gateway's investment in autonomous equipment, to renewable wind facilities, including the Siemens factory located quayside on the Humber. Similarly, the wider supply chain has seen substantial investment such as Amazon's warehousing facility at the Port of Tilbury and UK shipyards continue to deliver world-leading vessels, for example the Royal Research Ship (RRS) Sir David Attenborough which was built on Merseyside.

While this evidence suggests that the UK has world-leading maritime infrastructure that is pushing at the boundaries of economic and technological enhancement, we can further improve. UK ports are a success story but could be enhanced with even greater efficiency savings. Our coasts and harbours are secure but a renewed challenge is presented in the face of new technologies and cyber security to ensure this continues. Our ship building sector is supporting the capability of the UK military but there are opportunities to develop specialised and technologically advanced vessels and maritime and marine equipment.

Moreover, further improvements in maritime safety can render the UK as a paradigm for the rest of the world. In seizing these opportunities, responding to those challenges, and efficiently adapting to changes there is a role for industry and government, individually and collectively, to deliver the infrastructure of the future.

10.3 Drivers of change

We expect maritime infrastructure to be influenced by the following drivers:

- Future-proofing and pace of development
- Value addition and land utilisation
- Innovation and R&D
- Data analytics, digitalisation, and automation
- Trade and consumer preferences
- Policy and regulation

The opportunities, challenges, risks, and threats of each of these drivers are considered in relation to their potential impact on the identified sub-themes described below.

Future-proofing and pace of development

The long term nature of physical infrastructure through its design, construction, and operating life span is at odds with the fast pace of technological development. The speed of technological enhancement seems unlikely to slow and obsolescence will be an issue.

Challenges, risks, and threats

A significant part of the existing infrastructure and that which will be built over the forthcoming years will exist beyond 2050. Technology is expected to evolve rapidly throughout the same period. Allowing for levels of adjustment in future design, there exists significant challenge in ensuring that the infrastructure of today has the capability and capacity to interact with future technologies.

Opportunities

The foresight to future-proof and the ability to retrofit new technology to infrastructure will be vital to keep pace with the developments. There is a significant opportunity to place passive and active provisions within infrastructure to render it able to adapt to change. The UK also holds a strong position in technological development and there is potential to explore new markets in the development of life-extending technologies. Greater use of international collaboration and bench-marking with world leaders on infrastructure delivery, 'smart' technologies, and the sharing of best practice will likely stimulate economic and productivity benefits.

Value addition and land utilisation

Ports are traditional infrastructure facilitating modal shift: moving cargo from a ship to truck, train, barge or pipeline. Ports across the UK have the potential to do much more than this with some for example becoming logistic hubs. Maritime infrastructure owners and in particular, port owners, can combine their access to local and international markets, availability of land and central position in the supply chain, to exploit significant opportunities to develop new ancillary and value-adding services to their core business.

Challenges, risks, and threats

Changing customer needs mean that there are increasing opportunities to use port land for new activities. Raising demand for immediate delivery of goods requires new warehousing and logistics techniques. Ports are an ideal place to locate warehousing, value-added activities, and co-location of expertise as well as remaining a confluence for new (e.g. Hyperloop) and existing (e.g. road) transport modes.

Opportunities

Autonomy, interconnected smart systems, and big data have the potential to bring the shipping, cargo handling, and inland logistics elements even closer together, maximising efficiency, reliability and reducing costs. Maritime infrastructure and its integration with new transport technologies such as Hyperloop and drones, may present new and shared business opportunities as well as for the potential co-location of services.

Innovation and R&D

Innovation will be a key factor in ensuring the UK continues to compete on a global stage, and maintains its position in developing future technologies which will drive changes in infrastructure. Disruptors, new actors, and changing business practice can be seen in other industries. For instance, the world's largest taxi company – Uber – does not own any vehicles, the world's most valuable retailer - Alibaba – does not hold any stock and the world's largest accommodation provider – AirBnB - owns no property. Adapting,

augmenting and aligning will be key to maritime infrastructure responding to future changes and challenges.

Challenges, risks, and threats

Setting the correct environment will be crucial to foster the innovators such as start-ups, SMEs and academia to undertake R&D in the right areas and with the correct industry partners. True innovation will require significant change in both thinking and delivery. Changing business models, developing proof of concept, identifying funding models and managing the level of risk to reward/failure will present a challenge to the maritime sector to drive innovation.

Opportunities

There is great opportunity for both industry and government to play a key role in incentivising and bringing together the maritime sector with these innovative organisations, to test concepts and drive early adoption. Financing and funding will remain essential as feasible business cases will still be required for new technologies. Similarly, there is an option to develop a renewed approach to government/industry partnerships, to promote the UK as a test-bed for innovation and world-leadership in terms of first adopters of new technologies in the maritime sphere. These are themes well noted in earlier chapters on the UK's Competitive Advantage and Technology.

Data analytics, digitalisation, and automation

The utilisation of artificial intelligence, machine learning, automation, digital twins¹⁵⁷ and virtual and augmented reality will radically enhance the maritime working environment. Automation will allow for a more effective throughput of goods, presenting opportunities to ports, the wider supply chain and the end user, to generate greater revenues and/or achieve cost savings. Big data should increase the quality and accuracy of information in real time across the sector, from shipping and offshore energy, to ports and the wider supply chain – enhancing communication, reliability and transparency.

Challenges, risks, and threats

Integrating differing operating systems and bringing together technologies from different sectors at varying stages of development, and matching this to existing infrastructure will be a significant challenge, as will the need to prevent obsolescence in the face of technological enhancement. These issues are amplified as much of the maritime sector is internationally based with differing standards, regulatory environments and legislation. Moreover, greater digital connectivity also brings potential vulnerabilities in the form of possible cyber-attack.

¹⁵⁷ Digital twin is a virtual model of a process, product or service.

Opportunities

Greater automation presents significant opportunity in the form of increased operational efficiency. For government, setting the right policy framework for cyber security and the wider digital agenda will be vital in ensuring that shared technology platforms, distributed ledger technology and Internet of Things will allow all parties to share verified information in real time to securely monitor the shipment of goods. Similarly, it could present an opportunity for the government to enhance processes such as customs declarations.

Trade and consumer preferences

Goods and energy products will continue to be transported by sea, transiting our ports, and entering the wider supply chain while offshore energy infrastructure will also need to be supported. Passengers will continue to travel by sea while leisure and traditional maritime activities will remain important for our island nation.

Challenges, risks, and threats

The origins and destinations of future trade flows are difficult to predict and may well be subject to alteration based on changes in the location of manufacturing centres, trade deals, geo-politics and new route availability. UK maritime infrastructure will need to be adaptable to take account of these changes. Consumers' expectations for rapid delivery of goods are likely to increase, driving supply chains and next day/same day delivery models.

Opportunities

Short-sea and coastal shipping could improve the environmental impact of how we move goods around the UK while providing a boost to the smaller ports, benefiting from different trade routes. It could also take freight vehicles off the road and freight trains off the rail network, alleviating the burden on valuable inland transportation. In the leisure and recreation sector, there is opportunity to build an even greater affinity between the British public and the sea. Similarly, there is opportunity for government to work together with industry to export our maritime infrastructure expertise and products (e.g. superyachts) to untapped foreign markets.

Policy and regulation

The level and impact of policy and regulation on maritime infrastructure is significant from technical authorities such as the Marine Management Organisation (MMO), MAIB, and international bodies like the IMO, as well as government. Guidance and regulation will continue to be set and the requirement to adhere to this will remain. That makes the need for proportionate and well-balanced regulation, described earlier in this strategy in the UK Competitive Advantage, fundamentally important.

Challenge, risks and threats

Policy making and regulation will be a significant factor until 2050 as government and supporting bodies seek to deliver changes, act as arbitrators and ultimately drive the economic, social, and fiscal development of the country. There is however, a delicate balance to be struck for policy makers, enacting initiatives which drive innovation and investment, remove unnecessary regulation and rigmarole, and allow invention where there is identified need. It is a challenge to ensure that any regulatory framework achieves a balance between wider outcomes and benefits, whilst maintaining conducive business conditions and maintaining profitability.

Opportunities

In the shorter term, there is significant opportunity to build closer relationships between government, academia, the maritime sector and related industries, to strengthen the UK's position as a hub for shipping business. In the longer term, there are opportunities to explore new models for conducting business in the maritime sector and its infrastructure so as to be a key contributor to the delivery of major government policy such as the Industrial Strategy.

10.4 Ports and harbour infrastructure

The vision for 2050 in this area is:

Port and harbour infrastructure will largely be recognisable as the industry of today continuing to facilitate trade, passengers and pastimes alike - however below the surface ports will interact, integrate and respond differently due to developments across the full spectrum of innovation to revolutionise the efficiency of the port sector. UK ports will be a test bed for innovation and concept development.

Where we are now

There are over 100 active UK commercial ports that vary greatly in terms of size, capabilities, cargoes and ownership models. Those ports facilitate trade by handling around 95% of all goods imported in and exported from the UK (that equated to 384 million tonnes of international freight in 2017), provide passengers' services (22 million international passenger journeys in 2017) and infrastructure for the 1 million boat and water sport craft owners¹⁵⁸. These facilities have rendered the UK's maritime sector one of the largest and most dynamic sectors in Europe in terms of infrastructure. This contribution is only likely to increase and several significant port policies exist to support this aim, from the most recent PCS¹⁵⁹ and Port Good Governance Guidance¹⁶⁰, to

¹⁵⁸www.britishmarine.co.uk/Services/Growth/Statistics-and-Market-Research/Headline-Statistics-and-Infographics

¹⁵⁹<https://www.gov.uk/government/publications/transport-connectivity-to-ports-review-of-the-current-status-and-future-infrastructure-recommendations>

¹⁶⁰ <https://www.gov.uk/government/publications/good-governance-guidance-for-ports>

longer standing policies such as Ports Master Plans Guidance¹⁶¹ and the National Policy Statement for Ports¹⁶².

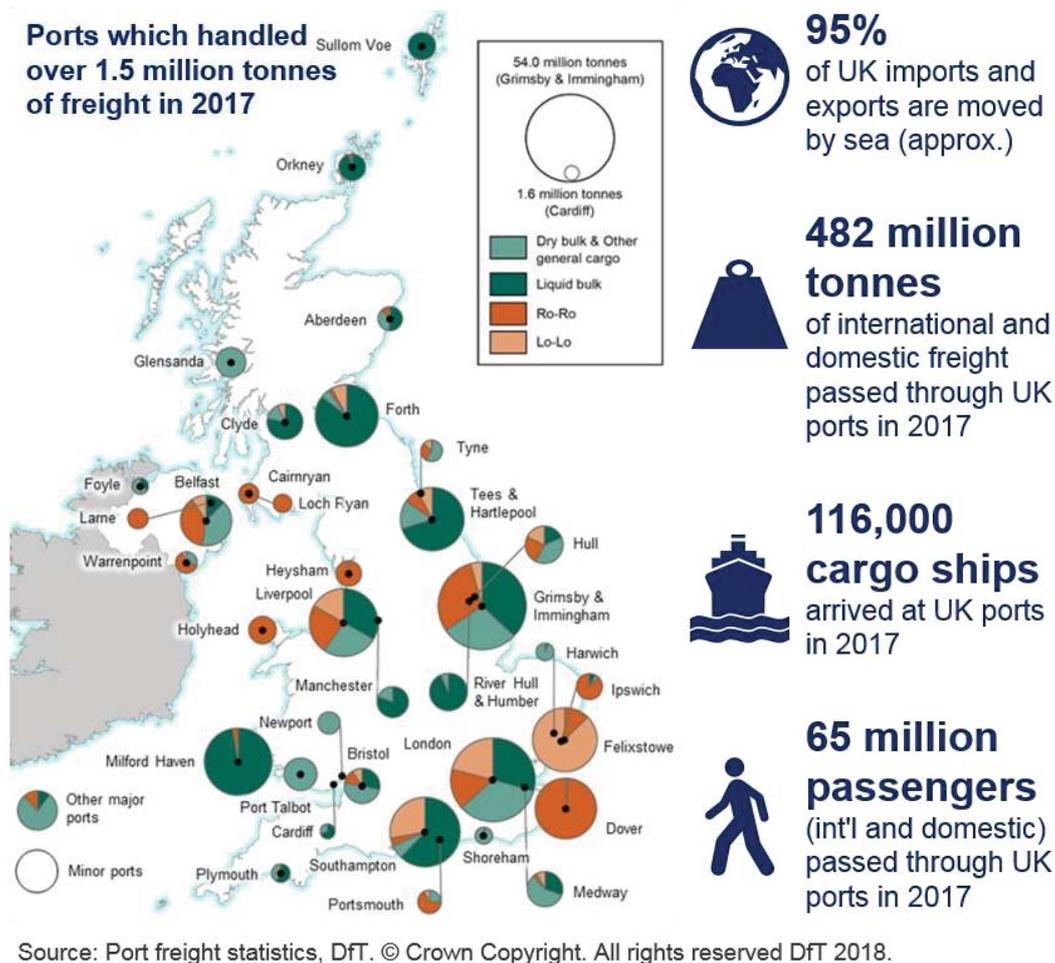


Figure 29 - Passengers and freight at UK ports

Commercial UK ports operate in a competitive market without ongoing public sector financial support. The ownership structure and the relationships between stakeholders is complex. Modern UK ports are a community of independent enterprises tied together by a common interest in maritime affairs. Central to this community is the port authority which can take many forms: always a regulator, usually a landowner, often a developer and sometimes a terminal operator.

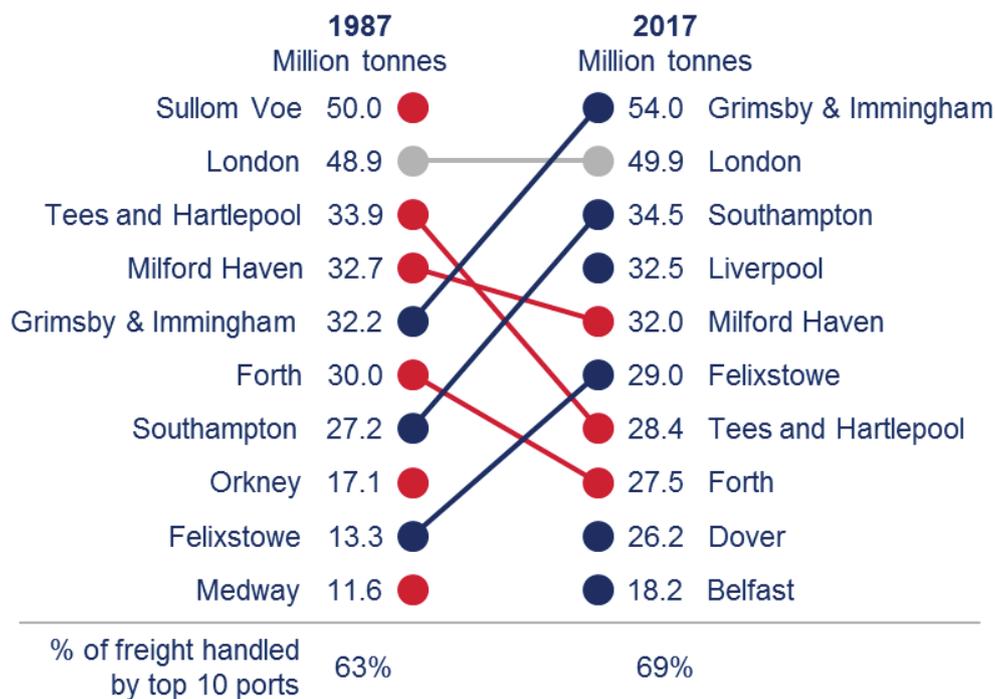
The Ministry of Defence (MoD) owns and operates a range of maritime infrastructure facilities including naval bases (and port authorities) in Clyde, Devonport and Portsmouth, a number of oil fuel facilities and ammunition facilities, all of which have waterfront infrastructure; noting that the site at Devonport is part owned by Babcock. The naval bases are highly regulated

¹⁶¹https://infrastructure.planninginspectorate.gov.uk/wpcontent/ipc/uploads/projects/TR030001/TR030001-001984-121026_TR030001%20Port%20master%20plan%20guidance.pdf

¹⁶²<https://www.gov.uk/government/publications/national-policy-statement-for-ports>

and are a key part of the Royal Navy's strategic base and comprise: a base port for ships and submarines, complex high-hazard (including explosives and nuclear) industrial sites and supporting administrative, logistic and engineering infrastructure.

The UK is perceived as a stable environment to conduct business where, due to the absence of governmental financial involvement in the sector, ports are able to compete on a fair and open basis. As a result, investors consider UK ports as attractive long term projects and in turn, UK ports have a very successful track record of investment in new infrastructure in recent years - including completely new container ports, terminals and facilities to handle new cargoes, such as biomass. Further major investments are already planned in the coming years. Examples, by no means exhaustive, include the second phase of works at the Liverpool 2, the marina and offshore energy development at Milford Haven in the West, and the container terminal enhancements at Felixstowe, Hull and Immingham in the East. In Scotland we have seen the development of the Aberdeen Harbour Extension Project and the quay-side extension at the Port of Dundee to support increased traffic and decommissioning¹⁶³. Figure 30 below shows the top 10 ports by freight handled in 1987 and 2017.



Source: Port freight statistics, DfT

Figure 30 - Top 10 ports by amount of freight

Changes in trade, commodities, consumer demand and policy impact ports significantly. Over the last 30 years three of the largest ports in 1987 (Sullom

¹⁶³https://www.britishports.org.uk/system/files/documents/18_03_06_-_uk_port_infrastructure_project_pipeline_analysis_report_-_march_2018_0.pdf

Voe, Orkney and Medway) are not in the top 10 in 2017, mainly reflecting changes in volume and location of North Sea oil cargoes. Their places in the top 10 have been taken by Liverpool, Dover and Belfast as these ports have developed their relative importance. Figure 30 shows that while freight handled at some ports has changed little in absolute terms, it has increased considerably at others, notably Grimsby and Immingham, Felixstowe, Dover and Belfast. The figure also shows that the share of total freight handled by the top 10 ports has increased by 6 percentage points over the period, reflecting a noticeable concentration of freight at the largest ports. Another important trend over recent years for maritime infrastructure has been the increasing size of vessels using UK ports – most noticeably container ships. This has been a driver of investment in freight handling equipment as well as operations such as dredging to deepen berth pockets and approach channels to the port.

As set out in the National Policy Statement for Ports (NPSP)¹⁶⁴, decisions about the timing, location and type of new port infrastructure are taken by the private sector. This approach, which reflects the broad policy approach of successive governments over many years before the NPSP was published, has provided the country with the port capacity it needs to meet demand for trade in goods and movement of passengers, allowed for competition between ports serving similar markets and has provided a degree of resilience. As part of the consenting process all port capacity proposals must of course meet all legal, social and environmental objectives and constraints including those arising from EU legislation such as the Habitats Directive. The government has confirmed that EU based environmental legislation will continue in place once the UK leaves the EU in March 2019.

The ports sector does have a concern that while supporting the principle of environmental and other protections, the consenting arrangement for port infrastructure development can be complex and time consuming. It can involve a number of different regimes among which, development consent orders, marine licensing, harbour revision orders, permitted development rights, and marine planning, are each required depending on the nature of the development. Such regimes consider how to balance the impact of trade and commerce with environmental protections, including protected areas such as Special Protection Areas (SPAs) and Marine Conservation Zones (MCZs).

Where we are going

Port and harbour infrastructure will continue to facilitate trade, passenger services, fishing and recreational activities and as such will keep being major contributors to the economy in 2050. Future port infrastructure will be influenced by trade patterns and deals, technological developments, changes in the energy sector, in fuel consumption, in ship sizes and in manufacturing techniques. Physical infrastructure must be able to adapt to changes and disruptions while ensuring environmental and regulatory obligations are fully met. Continued access to finance to fund investments will also be key. In

¹⁶⁴ <https://www.gov.uk/government/publications/national-policy-statement-for-ports>

terms of resilience, we expect the sector to maintain and improve its ability to deal with disruptions in activity, whether from extreme weather events, climate change or criminal and terrorist activity. At the same time, there is a role for government in bringing a focus on innovation, aid the development of appropriate partnerships with SME's and innovators and incentivise enhancement. Ports can be test beds for new technologies to become world leaders in operational testing and concept development.



In the short term, port investment and master planning will need to ensure that infrastructure investment conceived, designed, developed, and built has the necessary scope to allow retro-fitment and life extending add-ons to keep pace with new technologies and associated industries. In the long term, ports will invest significantly in new infrastructure and technology to meet the changing needs of the economy and society in moving freight and passengers, adapting to market developments, and continuing to provide facilities for recreation.

We expect greater specialisation in commodities carried at ports and likely fewer ports to deliver the majority of goods and products to the UK. Particular types of freight are likely to be more focussed at certain ports, reflecting global trade routes, international relations, economies of scale in port operations, vessel size and business consolidation in connected industries. As a result, some ports will handle very different volumes and types of freight.

Ports will also see greater diversification into new activities, for example relating to offshore activities in communication and energy generation or leisure. This could lead to the sector having a greater concentration of specialised port operations than general facilities. It is possible that some ports may have very different business models having transitioned from commercial freight handling to predominantly leisure activities. Ports will also be maximising the use of their land banks for both direct maritime and freight-

related use, and supporting other emergent non-maritime sectors such as energy and information technology, as well as delivering the appropriate fuelling facilities to serve an international shipping market.

Ports will also interact with users differently with developments across the full spectrum of innovation to help drive the efficiency of the port sector and broader supply chain. This will include continuing use of automation to manage loading/unloading of vessels, to track cargoes while they move through the port, and adopting shared technology platforms and solutions with other parts of the logistics sector to provide a seamless supply chain. Ports and harbours will be a national 'centre' test bed for innovation and concept development within the sector and for related sectors.

Regarding the military, the Royal Navy's maritime infrastructure is a fundamental part of the strategic base and work is ongoing to increase utilisation and optimise its use, together with working with local commercial operators and councils to identify opportunities for greater shared use.

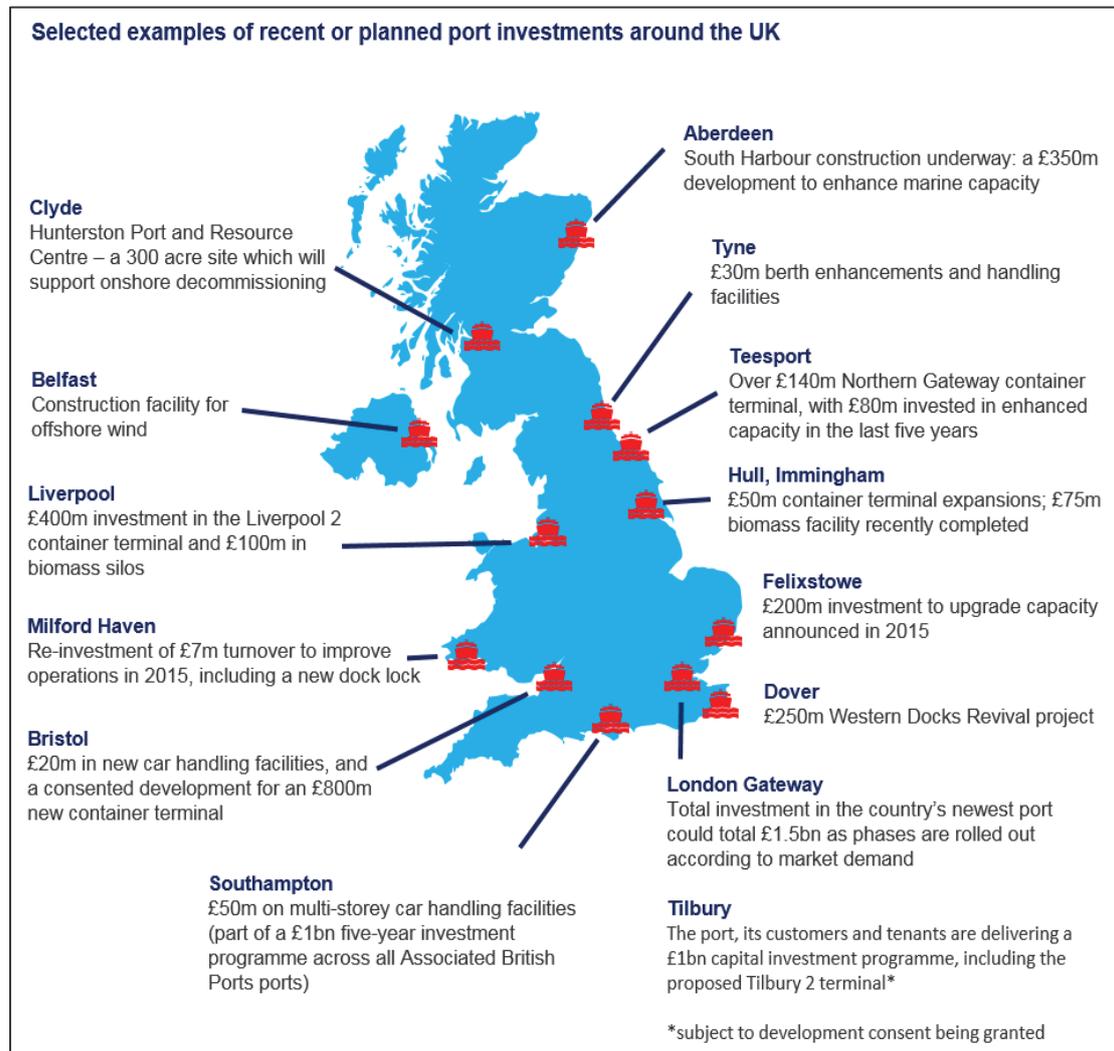
How we get there

Port infrastructure consists of long-lived assets such as cranes and quays, typically depreciating over 15 to 30 years. A significant amount of existing port and harbour infrastructure which is in use today or will be built in the forthcoming years is likely to be in existence in 2050. However, investment in new technologies including automation used in ports is typically over much shorter terms than infrastructure, given rapid advances in technology and its application. The need to plan ahead to future-proof and/or retrofit infrastructure with new technology will be vital to keep pace with developments.

There are a number of new and emerging technologies that will transform the way many ports operate in handling freight and communication to customers and the wider supply chain. New technology in shipping will also have a direct influence on ports operations and investment decisions. The government's ambition is for our ports to take maximum advantage of new technologies and become amongst the most technologically enabled ports in the world. To this end, the government will explore further opportunities to continue to support maritime innovation such as trialing new technologies in ports and other areas (see UK Competitive Advantage chapter). Government will also look to develop a framework between the public and private sectors, acting as a test bed for further development. Namely, creating an environment conducive to the testing and research of all technologies that would enhance our maritime and marine infrastructure through designating a 'National Port for testing and Innovation'.

The government will augment this framework and support innovation by continuing to work closely with the maritime and port associations, and others, as they seek to develop their futures programmes such as the UK Major Ports

Group (UKMPG) 'Ports 2050' initiative¹⁶⁵, as well as similar bodies of work from the BPA¹⁶⁶ and Maritime UK¹⁶⁷. Ports will continue to invest in new infrastructure and thus they will need to attract the necessary funding which will principally be from commercial sources. While there is nothing to suggest that ports' previous track record of attracting finance will change, government may need to look at alternative options to address any potential shortage of funding options should they arise.



New investments will continue to need consent through the planning system whether through Development Consent Orders, permitted development rights, planning approval, harbour revision orders, marine licencing or a number of these. Ideally all these consenting procedures should provide timely, predictable and robust decisions for applications, in line with legal obligations and relevant policies. This will allow ports to put in place new physical infrastructure in a way that protects the environment and meets planning policies, but that also helps minimise costs and allows benefits from the

¹⁶⁵ <http://ukmajorports.org.uk/port-2050-what-the-uks-biggest-ports-think-could-shape-the-port-of-tomorrow-and-boost-trade/>

¹⁶⁶ <https://www.britishports.org.uk/Port-Futures>

¹⁶⁷ <https://www.maritimeuk.org/programmes/futures-programme/>

investment to be realised. The continued government policy of a presumption of support for new harbour development (as set out in the National Policy Statement for Ports) should support this, and will also need to take into account potential changes to the use of port land and non-maritime developments such as port-centric distribution activity.

The government will seek to ensure that the planning and consenting processes are effective in allowing ports to invest in a timely way in new freight handling facilities and other infrastructure needed to meet new opportunities. This includes facilities for managing increased exports as the UK makes the most of new trading opportunities following its departure from the EU. The government will also examine the case for supporting an enhanced strategic approach that focuses on ports and their role in supporting the national economy.

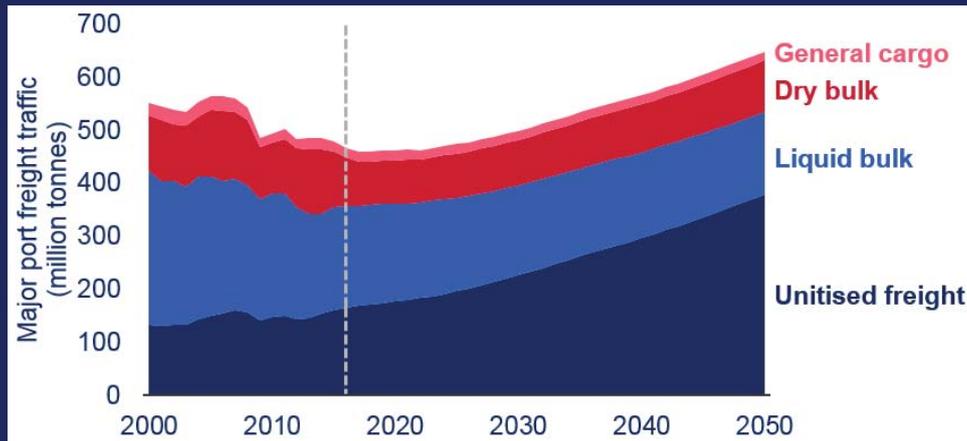
To do this the government will take a two-fold approach. First, government will ensure appropriate representation for the ports, harbours and marine sectors. Secondly, and more specifically in relation to creating a stronger link between ports and government, government will develop Port Economic Partnerships with strategic ports to leverage the maximum benefit from infrastructure investment. Ports will need to consider potential changes in freight and passenger demand and patterns arising from technological and economic changes. In support of this activity, government will continue to review and revise port freight and passenger forecasts to inform future decision making.

Government will also look for potential further means to support the sector across planning, environment and connectivity issues and as a first step will conduct a review of Ports Master Plans Guidance to better understand the challenge. Additionally, consideration may be given to whether further support is needed when the National Policy Statement for Ports is next reviewed.

UK Major Port Freight Traffic Forecast

DfT has produced updated forecasts for freight traffic at major UK ports, covering the years 2017 through to 2050. These replace the previous forecasts which were produced for DfT by MDS Transmodal in May 2006. The forecasts are based on an in-house forecasting model built by DfT for the first time. We will continue to develop and build on the forecasting tools in future years and publish new forecasts accordingly.

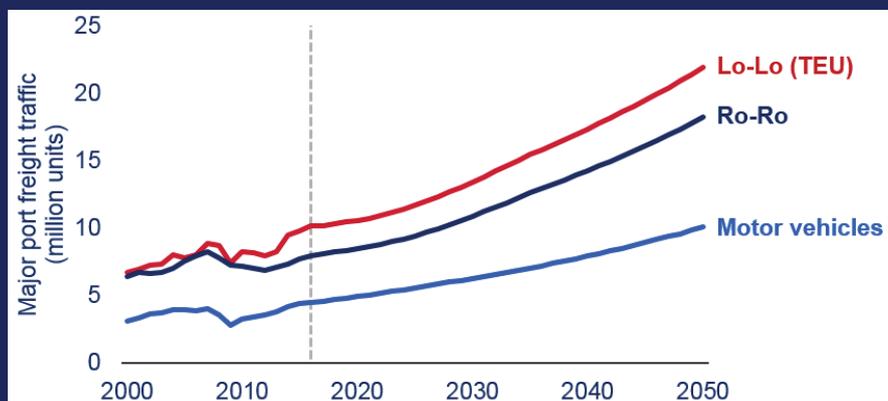
It is important to recognise that predictions about the future of a particular sector are inherently uncertain and the UK ports sector is particularly reliant on the performance of other sectors of the economy, such as the UK steel industry. The results presented here are for our central projection, but the full set of forecasts contain scenarios to reflect the uncertainty surrounding the drivers, such as GDP and population.



Overall, port traffic is forecast to remain relatively flat in the short term but grow in the long term, with tonnage 39% higher in 2050 compared to 2016. The long term growth in port traffic is driven by increases in unitised freight traffic. In the short term, this growth in unitised traffic is counteracted by decreases in the other categories.

Liquid bulk traffic has the largest forecasted decreases. This is almost entirely due to falls in crude oil traffic, in line with the decreases which have been seen historically. It is likely that projected decrease in other liquid bulk traffic is partly due to the shift from liquid bulk to tank containers for some shipments. Similarly, general cargo is forecast to decrease, in line with the historic decreasing trend, which is likely driven by increased containerisation of goods. Dry bulk traffic is forecast to have a relatively large decrease in the short term, driven primarily by demand for coal being projected to fall. However, in the long term, dry bulk traffic is forecast to increase, with other dry bulk, the largest category, continuing to increase as it has done historically. This historical increase is linked to the increase in trade of biomass.

Note that freight tonnage forecasts do not include motor vehicles, which are only forecast in units and are also forecast to grow strongly, as is the TEU forecast for Lo-Lo and the unit forecast for Ro-Ro. These are all driven by economic growth.



Recommendations

Short term (1-5 years)

- Government will monitor the availability of funding to ports through commercial lending, identifying any market failures and developing plans to address these, together with the sector.
- Government will review Ports Master Plans Guidance identifying opportunities to better support the port sector across planning, environmental and connectivity issues.
- Government will consider renewing the National Policy Statement for ports, to provide additional support if needed.
- Government will implement a targeted programme of Port Economic Partnerships, for ports meeting specific scheme and success criteria, leveraging the maximum benefits from both government and industry investments.

Medium term (5-15 years)

- Government will explore the feasibility of new infrastructure models (e.g. floating offshore ports) to support ambitious future development, and ensure these are responsive to land use and transport network challenges.
- Government will create an environment conducive to the testing and researching of all technologies that would enhance our maritime infrastructure, initially holding a competition for ports to bid to be designated the UK 'National Port for innovation and testing'.

Long term (15 years and beyond)

- Where appropriate, government will support UK ports to capitalise on their estate by utilising all commercially available land.
- The maritime sector will explore, within the framework provided by government, the business opportunities for greater confluence of transport modes to help drive cost effectiveness and time efficiency.

10.5 Port connectivity, the supply chain, and logistics

The vision for 2050 in this area is:

The maritime sector will continue to be the driving force in domestic and international supply chains. Shipping will continue to be a cost effective means of transporting goods and raw materials over distance, and ports will provide the hub for a seamless supply chain which facilitates the transfer of goods between modes. UK ports will have adapted to incorporate new developments in digital and physical infrastructure, and will act as a logistics, manufacturing and multimodal freight clusters, that are able to facilitate imports and exports by sea, with increasing effectiveness and efficiency.

Where we are now

The supply chain

Ports have always been the predominant facilitator of trade for our country. The modern maritime supply chain remains an efficient means of moving freight over great distances and as one can imagine, port and shipping operations are closely related. Efficient cranes, quayside machinery, and computer-managed container yards result in reduced dwelling and turnaround times – even with larger ships and greater offloads.

This marked improvement in efficiency and productivity is true not only for the container trade but also for dry and liquid bulks. Improvements in communications and technology across the supply chain have rendered estimation of ship arrivals and cargo deliveries more accurate and easily accessible than ever before. Beyond this, we have seen the development of logistics parks, warehouses, and distribution facilities providing value-added services on site and thus time and cost efficiency, by allowing goods to move straight into distribution channels. Household name retailers such as Asda and Tesco at Teesport, Tetley Tea at the Port of Tyne, Lidl at London Gateway, and Amazon at Tilbury and Bristol have done so. Similarly, ports are playing an

important role in sectors such as the automotive industry, taking advantage of onsite land availability such as the multi-storey car parks at Southampton, to provide levels of storage that are not possible at factories and allowing value-added activities to be carried out dockside, such as manufacturer pre-sale checks.



While the efficiency of ports and shipping functions is already high and there is an improved co-ordinated approach, there is still some way to go for full supply chain integration, in terms of transparency, resilience and efficiency. For instance, trucks still on occasion carry half loads and containers can be routed to ports further away from their destination because it remains a more economically viable decision. Moreover, rail freight trains and their paths cannot always provide the flexibility for changing circumstances and there are missed opportunities to utilise inland transport infrastructure more efficiently. For example, separate trucks of non-time sensitive cargo move by road to a given destination rather than a consolidated load by coastal ship. It is this bigger picture which requires greater exploration.

To this end, there has been an increasing focus on the maritime sector's role in the wider supply chain and thus, investments in ports and expansions of rail terminals are realised to accommodate greater levels of traffic. This has seen the instigation of sophisticated vehicle booking systems to manage the entry of road freight into the port in the most efficient way; and the use of automated loading systems that provides swift and safe loading.

Connectivity

Currently the UK has good levels of maritime connectivity and it is clear that ports are investing to enhance their services and operations. These are two of the key factors for a successful maritime supply chain. The other is ensuring there are effective hinterland connections in place.

The PCS¹⁶⁸ highlighted the importance of hinterland access in the economic health of the UK and how an effective supply chain can boost economic growth, productivity and international competitiveness. Aside from the PCS, the Transport Committee freight inquiry¹⁶⁹ has examined the potential effects of our exit from the EU on UK freight operations. The National Infrastructure Commission is undertaking a freight review¹⁷⁰ to improve the existing infrastructure and recommend ways to use new technologies and processes to transform freight movement.

And in a similar vein, the government Office of Science has also looked extensively at freight in its Future of Mobility study¹⁷¹. Apart from government bodies, there has been an enhanced level of focus from delivery bodies – Network Rail and Highways England - on freight and its physical improvement through transport investment on rail and road.

Ports have - alongside shipping lines, shippers and other third parties - invested significantly in developing facilities and modernising their equipment to enhance their efficiency and productivity. They have also, in more recent

¹⁶⁸<https://www.gov.uk/government/speeches/transport-infrastructure-for-our-global-future-a-study-of-englands-port-connectivity-and-supporting-documents>

¹⁶⁹<https://www.parliament.uk/business/committees/committees-a-z/commons-select/transport-committee/inquiries/parliament-2017/freight-and-brex-17-19/>

¹⁷⁰<https://www.nic.org.uk/our-work/freight-study/>

¹⁷¹<https://www.gov.uk/government/consultations/future-of-mobility-call-for-evidence>

times, embraced technology, digitalisation and automation to maximise efficiency and drive greater integration across the supply chain. In terms of relationships, ports are working ever closer with associated sectors and end-customers to enhance their offering and have also been proactive in seeking out opportunities for further value-added activities. Similarly, government has recognised the importance of hinterland connections which have been firmly placed within its transport infrastructure plans.

This represents a solid foundation to approach the next 30 years, where changes in the supply chain, new technologies, business models and innovation could be as radical as the transformation which occurred at the advent of containerised transport.

Where we are going

The maritime sector will continue to be the driving force in international supply chains. Shipping will continue to be the most cost-effective way of transporting cargoes over distance and ports will provide the hub for a seamless international supply chain. Ports will adapt to incorporate new developments in transport technologies and automation. The port estate and surrounding environments will host advanced warehousing solutions that unpack, sort, and load or store goods ready for Just In Time (JIT) distribution to retailers.

There will be enhanced transparency within the supply chain and the availability of real-time data will allow shortened decision-making cycles, providing greater resilience. Similarly, real time data will allow greater transport planning and contingency, with a greater focus being placed on departure and journey times to avoid congestion. There will be advanced manufacturing interests with the aim of applying cutting edge technologies – such as 3D printing component parts for assembly, or combining with ready-made parts arriving by sea – to produce end-products and enhancements.

Within the technologically advanced ways of distribution, there will be a greater focus on the environment and congestion caused by freight transportation, which will lead to greater use of alternative and less polluting methods of transport – such as ultra-low and zero emissions vehicles, rail, and coastal shipping.

Future transport methods, such as drones and hyperloop technologies, will be integrated as they come online, with ports and the supply chain pioneering the use of these modes. Big data, distributed ledger technology and smart contracts will facilitate much more efficient supply chain operations – the truck, train, ship, barge and/or drone will be in place in time to expect cargo, being informed on a continuous basis by real-time data. Ports will still be at the centre of supply chain, not only facilitating imports and exports by sea, but also functioning as logistics, manufacturing, and multimodal freight clusters.

How we get there

Changes to manufacturing, retailing and transport sector

In terms of development, the maritime sector has had a slower pace of change compared to other industries, but this has changed in recent years. Challenges from changing markets and rapid developments in ship size have transformed the sector. Emerging digital technologies have also seen ports move quickly to take advantage of efficiencies and opportunities alike.

With the ambition to have fully integrated supply chains, the maritime sector will need to keep pace with change, matching the faster adoption of new technologies in connected sectors. This will require the maritime sector to: explore new business models, work with third parties, ancillary services and SMEs, and where possible move to be a test bed for new ideas and concept development.

Maritime infrastructure will also have to adapt to developments within wider sectors such as manufacturing, global supply chain factors (such as labour markets), and more widely to technological enhancements which change the way supply chains operate. These aspects include: re-shoring, near-shoring, enhanced supply chain transparency, mass customisation, 3D printing, big data, Internet of Things, artificial intelligence adoption, distributed ledger technology and a sharing economy. All of these present significant challenges but at the same time, significant opportunity.

As a result, there is potential for some market re-adjustment in terms of reshoring and near shoring¹⁷². There are a number of factors for choosing to re-shore, including quality and labour costs, but of most relevance to maritime is improving the performance (e.g. shortening lead times) and resilience of the supply chain.

There are implications for the maritime element of the supply chain. If this trend were to continue, a reduction in the quantity of finished goods arriving by sea might be seen, and if the other tiers of the manufacturing supply chain also relocated, then there might also be a decrease in component parts. However, there would continue to be requirements for raw materials, which could even increase if there was large scale re-shoring.

Regarding manufacturing, the advent of 3D printing technology, mass customisation, and JIT processes are ideally suited to the role ports can play in the supply chain. Despite consumer-level 3D printing equipment being available and increasingly common in industrial prototyping and mould-making processes, the capabilities for mass complex manufacturing or displacement of that to the home environment remain minimal, and costly at present. A solution to both these issues would be printer-pools, comprising multiple printer types in one location and making a large volume of printers

¹⁷² Re-shoring is the process of bringing manufacturing back to a domestic market from a (usually distant) overseas location, whilst near shoring is relocating manufacturing capability closer to the domestic market.

available. Similarly, volumes of the various additives would need to be easily accessible.

Locating a manufacturing site at a port, with ready access to space, material supply chains and storage facilities, minimising both the time and cost of production is highly feasible. Combining this with good access to logistics networks and retailers mean that there is a strong case for ports being at the forefront of the 3D printing supply chain – potentially serving off-shore markets with replacements parts, and building key components on site for existing sectors such as commercial boat building.

3D printing will also potentially feed into a growth in mass customisation – also known as “delayed product configuration/differentiation” or “late-stage customisation”¹⁷³. In effect this provides for standardised mass production on shared platforms to a certain level of finish, but then allows leeway for final product customisation. A port which can offer both reception facilities for a near final product, plus access to components arriving from different sources, represents a perfect point in a supply chain for a manufacturer to offer this service. Indeed, a number of ports already host facilities that undertake such minor customisation works for the automotive industry. In the future, for ports to become fully embedded in the supply chain, they will need to ensure they are engaging closely with manufacturers and technology companies in order to identify opportunities to offer these value-added services.

Retailing and distribution

Ports have already established themselves as ideal locations for a consolidation of retail and other supply chains through port-centric distribution. This offers significant efficiency benefits by removing a leg of the logistics chain, reducing multiple handling stages, and minimising “dead time” where product is awaiting distribution to market. UK ports are seeking to maximise the adoption of this approach by investing in logistics parks and warehousing sites at their facilities nationwide. As such, facilities at ports are increasingly undertaking the role of regional distribution centres, or in some cases, national distribution centres.

The port-centric distribution model operates in different ways. Sometimes with the port providing full services acting as either landlord or tenant, or via a leasehold arrangement with services provided by the partners, or co-funding of facilities between port and third parties. Whatever the model, the maritime and ports sector will need to be prepared to respond to developments in retailing and distribution, either directly or in conjunction with distribution partners as part of a successful journey to 2050.

There are likely to be significant developments in this sector as pressure from consumer preferences pushes retailers to enhance efficiency and provide ever faster service. This will range from increasing levels of automated warehousing where unloading, packing and loading will be undertaken by

¹⁷³ Trends in manufacturing and global supply chains and their impact on freight.” Future of Mobility, Government Office of Science. To be published.

machine, to new methods of onward distribution potentially involving autonomous and electric vehicles. Where ports and warehouses are near major conurbations, the extent of this role could allow port sites to operate as origin locations for direct same day deliveries. However, as with other aspects of port-centric distribution this will require ports to maintain ever closer links with potential customers and partners.

Supply chain transport and port side equipment

Efficiencies will need to be sought on the quayside, from automated cranes that can operate in any weather to electric automated straddle carriers, guided by sophisticated IT systems that enable the most effective routing and stacking of containers. The mode of transport that carries goods out of a port will also potentially be very different. Ports have invested heavily in building multi-modal terminals to date.

Further investment may be necessary in due course if autonomous vehicles and new transport modes (e.g. drones) become a reality to incorporate these into their operations.

One of the most significant developments could be the platooning of trucks which is estimated to be emerging from 2030 and widespread by 2040. There are obvious benefits of capacity, reliability and environmental performance to be gained on the wider transport networks, but they could also provide significant benefits to terminal operations. If there is greater certainty of the arrival time of trucks, and in batches, then it may be possible to maximise the efficiency of container stacking by minimising the need for repositioning.



Ports will need to be prepared to handle truck platoons, both physically and digitally. Receiving and dispatching multiple trucks will be more complicated, particularly if the efficiency savings of a platoon are not to be hindered by the dwell time taken to put a platoon together. Multi-modal cranes may need to handle more than one vehicle simultaneously, or in quick succession.

Accommodating these developments will be challenging in a busy port environment, however there are advantages to facilitating their operations. It is easier to test and deploy such technologies in a closed environment on private land – and port estates provide such an opportunity. This is already being explored in Singapore where a trial of platooned autonomous vehicles

is already being expanded¹⁷⁴ following early successes. To maintain their place at the heart of supply chains up to 2050, UK ports need to embrace technological advancements for deployment in their own operations. Similarly, they will need to be preparing to facilitate and handle the developments that will be taking place in the transportation elements of the supply chain outside of their gates.

Supply chain connectivity

Despite many transformational changes in technology, the inland infrastructure that connects the elements of the supply chain (i.e. road and rail links) will continue to be a constant and important factor. The PCS set out the case for investing in infrastructure to enhance access to ports. This case focussed not just on the potential positive impact for ports, but instead majored on the wider economic benefits of such investment, due to the efficiency increases for the supply chain.

In the short term DfT will continue to implement the recommendations of the PCS, meaning that we expect to see port related infrastructure enhancement considered during the forthcoming investment periods on rail and road. Beyond these, the principles championed in the study, regarding the sharing of information and closer liaison between ports and infrastructure delivery bodies, will be firmly embedded.

As such there will be a greater shared understanding of supply chain connectivity needs and movement of freight for economic benefit will continue to be a factor in transport investment, up to and beyond 2050.

Those investment programmes will also need to take into account the advent of the technologies and the impact this has on the distribution of freight. Electric vehicles, first in light goods vehicles, and then later in the heavy goods vehicles will serve major supply chains. Such electric vehicles coming on stream will reduce the negative externalities of road freight transport in terms of noise and emissions so that traffic to ports will be more environmentally friendly than ever before. This will however require ports' input to provide appropriate facilities, such as for refuelling/charging.

Our road and rail data systems will also be smarter and traffic flows will be responsively managed and traffic patterns more predictable. However, to maximise the benefits of this, the supply chain will need to integrate its information and data to inform decision about arrival/ departure and routing. Dependent on the degree to which this succeeds there may still be benefits in considering methods of prioritising supply chain access to ports – government is willing to explore this option.

Internationally, this is already being explored and implemented. In California there is a scheme currently which designates two truck-only lanes where road gradients are steep and truck traffic volume is high. Separately, Canada has

¹⁷⁴ <https://www.ship-technology.com/news/singapore-ports-expand-fleet-driverless-vehicles-2021/>

adapted support for dedicated freight trade corridors, as the following case study sets out.

The Canada Model - Supporting Trade Corridors

The Trade and Transportation Corridors Initiative (TTCI) will invest \$2 billion over 11 years for the National Trade Corridors Fund, a merit-based program to make Canada's trade corridors more efficient and reliable. The program will:

- Support the flow of goods and passengers by reducing bottlenecks, and address capacity issues.
- Address the unique transportation needs in Canada's territorial north to improve safety and foster economic and social development.
- Build on investments made by a variety of public and private sector partners.
- Well-functioning trade corridors will allow Canadians to compete in key global markets and trade more efficiently with essential partners.
- increase the flow of Canadian trade around the world through our ports, airports, roads, railways, intermodal facilities, bridges and border crossings.

If congestion continues to rise, the UK may need to look towards freight prioritisation activity to protect the supply chain. There are a number of potential ways to do this, from management of freight traffic priority during certain times of the day, to dedicated freight lanes. As part of the journey to 2050 consideration of the feasibility of these options, will need to be explored and tested.

Land-based interventions are not the only option and coastal shipping, as well as short-sea shipping, also have potential, facilitated by technological advancements, to benefit supply chain connectivity.

The DfT is also committed to exploring the possibilities for using traditional transport funding to support coastal and short-sea shipping where a significant, and defined, quantum of traffic could be moved off key routes – reducing emissions and reducing congestion on roads and rail. The potential for positive environmental benefits was explored in more detail in the Environment chapter.

Recommendations

Short term (1-5 years)

- Government expects full implementation of the Port Connectivity Study recommendations in the short term.
- Building on UKMPG's "Dragons den", DfT will host jointly with industry, an annual seminar bringing together key stakeholders in the maritime and technology sectors to showcase best practice.
- Government will support the work of industry, including the BPA, UKMPG and Maritime UK as they produce their visions of the future.
- Government will continue to consider the needs of the maritime sector as part of rail and road infrastructure funding to support the onward transportation of freight and passengers from maritime infrastructure.
- Government anticipates the maritime sector will continue investing to integrate and provide added value to the wider supply chain and associated industries.

Medium term (5-15 years)

- Industry, with government support aims to explore the wider benefits of port centric development and, if backed by evidence, government will publish a policy statement indicating a presumption of support for such developments, consistent with the National Policy Statement for Ports.

Long term (15 years and beyond)

- If future congestion levels impact on freight movements despite infrastructure investment, the UK will explore the evidence base for a system of dedicated freight routes for the import and export of goods.

10.6 Sectoral infrastructure

The vision for 2050 in this area is:

Maritime infrastructure will provide a vital transport link and act as a hub to offshore assets which will act as centres for developing and delivering solutions in partnership with other industries. Maritime infrastructure will exploit the most significant opportunities to support the expected major increase in offshore wind generation, evolving energy sectors and subsea

infrastructure. Maritime infrastructure will continue to support the oil and gas industries, through decommissioning, and will represent a critical node in UK energy supply. It will also retain traditional maritime industries important to local and regional economies, such as fishing, and continue to support the growth in marine leisure activities as well as the cruise and ferry sectors.

Where we are now

Sectoral infrastructure covers a wide range of activities including offshore oil and gas, renewable energy, communications, marine aggregates, fishing and leisure and recreation industries such as sailing and water sports. While some of those industries are longstanding, such as boatbuilding, others have developed more recently, such as the offshore wind supply chain.

Fishing provides a vital source of food to UK markets and is supported at the quayside with the requisite infrastructure to deliver the catch of the day to the markets and retailers of the UK. The total weight of fish landed at UK ports in 2017 was 482,500 tonnes with an estimated value of £789m. Although relatively small in terms of the national economy, the fishing sector plays a significant role in local economies, particularly in terms of helping to address the socio-economic difficulties faced by a significant number of our coastal communities. The largest UK fishing port by some margin is Peterhead in Scotland, followed by Lerwick in the Shetland Islands. In England, the largest fishing ports are in the South West, at Newlyn, Brixham and Plymouth. After leaving the EU, the UK will be an independent coastal state. We will be able to control who may fish in our waters and on what terms, and manage fisheries more effectively and sustainably. We will control access to UK waters, be able to set fishing opportunities, and protect the marine environment.

Much like the fishing industry, the marine aggregates industry may not make a huge contribution to our national economy directly when compared to some other sectors, but it continues to provide the vital raw materials for the development of major infrastructure across the country making it still hugely significant. Away from traditional sectors, we have seen significant development of renewable energies in response to enhanced climate change ambitions and energy generation policy. This already presents a significant business area across the maritime sector but perhaps more pertinently, is a significant medium to long term market as the UK drives towards the target of an 80% reduction in emissions as set out in the Climate Change Act.

The contribution ports have made to these activities is integral to their success. Namely, ports have worked with third parties to invest in new facilities to support offshore wind development, for example Siemens and ABP's investment at Green Port Hull in a plant to manufacture wind farm turbine blades. In a similar vein, a number of other ports, such as those in East Anglia, have set up and adapted their business models to support the operations and maintenance for established wind farms.

However, these endeavours are not without challenge. UK ports face international competition from other countries and regions like Scandinavia, and have not always been successful in securing this business.

There is also increasing demand for energy storage facilities. Port sites represent a suitable location for energy storage facilities, and whilst this is an emerging market, early uptake of this opportunity is prevalent. For example, the Port of Tyne is proposing to develop a 25MW waste to energy facility in north Tyneside. Energy storage facilities are key enablers for the integration of renewable energy, particularly wind, into the energy network, and the ports infrastructure can increasingly serve these sectors.



Source: Energy projections, BEIS; 2017 Offshore wind report, Crown Estate

Figure 31 - Renewable energy and wind turbines

Apart from ports, maritime subsea infrastructure in the form of communication cables play a vital role in digital connectivity. These structures carry copious amounts of data on trade, health and finance, to name but a few of their functions. The market for subsea cables is a dynamic one where the private sector has been instrumental in delivering the infrastructure to date. Traditionally, this has seen large infrastructure providers such as Hibernia delivering the physical assets required, with private companies then buying up the bandwidth they required. This has led to over 60 subsea cables originating and terminating in the UK.

Recent changes in the market have seen new actors (Facebook, Amazon, Google and Microsoft) moving into the infrastructure delivery market for subsea cables. A collaboration and joint ownership between Microsoft and Facebook has seen a new subsea cable (MAREA) laid between Spain and the USA. Similarly, Google are developing a new cable (DUNANT) between the French Atlantic coast and the USA which will come online in late 2020.

At present the last cable laid to/from the UK was in 2015 (Hibernia Express), with the AEC Connect, which lands on the West Coast of Ireland but provides connectivity back to the UK via a number of Ireland – UK subsea cables, laid in 2016. These were both subsequent to a more than 10-year gap without any additions. With the millennial cables coming to the end of their active life in the next 5 – 10 years, a reduction in cable numbers and thus bandwidth and resilience will be forthcoming.

Although it is important to recognise that commercial, technical and support rationale will play a part in whether the system should be extended after end of life or retired, this presents a challenge to ensure appropriate resilience for our communications infrastructure and to attract new cables to the UK. In addition to subsea fibre optic cables, there are also the subsea interconnector cables transferring electricity between the UK and the continent – one is currently being laid between Norway and the UK which will come ashore at Blyth harbour. Another between the UK and Belgium is also being built.

Ports and Offshore Energy – Port of Blyth¹⁷⁵

The Port of Blyth has developed as a leading UK offshore energy support base serving the renewables industry.

Port of Blyth hosts numerous leading companies in the sector and is home to both DeepOcean's major support base and Royal IHC who relocated their UK manufacturing and assembly capability in 2016. Long term deals with both companies have shown their commitment alongside other industry leaders such as Global Marine and Osbit, to working with the port. It is also the location for EDF's internationally significant Blyth Offshore Demonstrator Wind Farm which was officially launched in 2018, while the ORE Catapult test facility is based on the River Blyth.

In recent years the Port of Blyth has supported clients to deliver some world leading projects including: the construction of Royal IHC's J-Lay tower system, DeepOcean's delivery of the Nemo Link interconnector project; the North Sea Link interconnector project with Norway; the port's first mobilisation of jack up vessels for the Hornsea One wind farm; and the development of Northumberland Energy Park, which offers the sector one of the largest and most attractive quayside development sites in the UK.

Blyth's success can be attributed to four key factors: the port's significant energy sector experience; three large scale, ISPS compliant deep-water terminals with over 1.5km of working quayside, strengthened to accommodate multiple offshore vessels with heavy lift crane capacity; availability of significant land development opportunities, modern warehousing/workshops and large open-storage areas; and a mature onsite engineering supply chain that helps to create a one stop shop for all required services.

Both subsea structures present a two-fold opportunity. Firstly, as physical assets in their own right which need building, operating, repairing, maintaining

¹⁷⁵ <https://investnortheastengland.co.uk/news/royal-ihc-commits-to-blyth/>;
<http://portofblyth.co.uk/offshore-ihc-relocates-to-port-of-blyth/>

and renewing to ensure the UK has adequate capacity and resilience. Secondly in delivering this physical asset there is opportunity for other maritime and marine industries to benefit, such as the building of special vessels to carry out operations and maintenance. Likewise, there are opportunities for ports, harbours and marinas to develop new business opportunities as these cables need an egress point to the UK.

The marine and leisure sector is also a key industry requiring specific infrastructure to support the recreational activities. This sector of 'blue tourism' and marine leisure is a buoyant and fast-growing market at present. It is diverse, ranging from the manufacturing of motor yachts and their supply chain to the services and facilities that enable approximately 4 million people to enjoy boating each year, contributing to the strong and growing 'Blue Economy' in the UK.

In the marine sector we have seen advancement in the development of marinas for recreation and leisure. This has seen traditional marina infrastructure moving from a storage operation into a destination in itself, with waterfront developments for retail and food as well as maritime and ancillary services. The Port of Milford Haven is a prime example of this type of infrastructure coming online, alongside traditional port capacity and capability enhancement. Growth in the leisure sector has already seen some previously commercial ports, such as Weymouth, switching to being leisure facilities.

By the same token there are approximately 1,500 clubs and commercial training centres in the UK, which provide sailing and power boating activities to the people of UK and abroad to enjoy the seas. This is just the start of encouraging more people to interact with the sea for leisure and this training infrastructure is key to getting this across.

The cruise sector represents a substantial leisure market which is showing significant growth. Nearly 2 million people took a cruise which started or ended in the UK in 2016, very close to double the number that did so in 2006¹⁷⁶. The UK is well set-up to support the cruise sector facilitating the egress of significant passenger numbers. Southampton is currently Europe's busiest port for starting a cruise. Similarly, Dover, the Port of Harwich and other smaller ports in England and Scotland, act as departure or calling ports. At present, the UK is an important calling point for cruises starting in the Mediterranean, Caribbean or other parts of the world and hosts a number of key cruises liners such as Cunard, P&O Cruises, Royal Caribbean, Saga, TUI and Virgin.

While the number of passengers are growing so is the size and amenity of vessels. The number of cruise ships accommodating 4000+ passengers has increased significantly and the on-board facilities are becoming ever more sophisticated. The cruise sector provides significant economic benefits to port cities from the arrival and departure of passengers joining or leaving cruises as well as tourism benefits from port of call visitors. Increased passenger

¹⁷⁶ <https://www.gov.uk/government/statistics/final-sea-passenger-statistics-2016>

numbers, as has been seen in recent years, will only enhance this economic benefit. However, the advent of bigger cruise ships necessitates investment in more, large cruise berths and facilities to manage greater volumes and peaks of passengers. More widely, this has impacted on the local areas around ports causing negative factors such as increased congestion.



Equally, many cruise calls are close to cities and urban areas, and unlike a cargo ship, the energy requirements of a cruise ship at berth that must continue to provide amenities for thousands of passengers, are substantial. This is already leading to environmental issues and concerns at some ports from emissions from cruise ships whilst in port. This was considered in more detail in the Environment chapter.

At present, the UK is well served by international ferry passenger services. Dover is by some way the largest ferry passenger port with services to Calais and Dunkirk. This is followed by Holyhead with services to Dublin, Portsmouth to ports in Western France and services from Hull to the Netherlands. Passenger ferry services are operated on a fully commercial basis by P&O, DFDS, Brittany Ferries and other operators. Services are generally mixed with heavy goods vehicles and/or their trailers also being carried, in addition to passengers and their vehicles. Since 2006, passenger numbers on international route have fallen by around 15% from 23.5m to 20m. The reduction has generally been seen across all routes, although there is variability by route and from year to year. A small number of routes have ceased operating in this time, for example Harwich to Esbjerg in Denmark.

Domestic passenger services, including river ferries, are also very important to the economic and social life of the country. These include links between Great Britain and Northern Ireland, the Channel Isles, Orkney and Shetland, as well as those serving the Isle of Wight and other routes to Scottish Isles amongst others. River ferries play an important role in some locations, such as Clipper services on the Thames in London and the ferry across the Mersey. Taken as a whole, there has been little change in domestic sea passengers between 2006 and 2017 with 44m passengers travelling in

2017¹⁷⁷. A number of companies provide domestic passenger and ferry services including Condor Ferries, Red Funnel, the Isle of Man Steam Packet and Stena Line.

While most domestic passenger ferry services are operated on a commercial basis, a number of services in Scotland are subsidised by the Scottish Government. The subsidy the Scottish Government provides to support ferry services in the highlands and islands is undertaken on the basis that it is unlikely such services would be commercially viable without financial support. These are “lifeline” services to small and remote communities in Scotland which support their sustainability.



The accessibility of passenger services is also of vital importance. Maritime passenger accessibility is underpinned by comprehensive and well regarded EU legislation on passenger rights that will be transferred into UK law upon our exit from the European Union. Inspection and enforcement of our passenger rights legislation is undertaken by the MCA. The maritime sector also has a set of voluntary complaint handling bodies which tackle passenger rights and accessibility concerns. More comprehensive detail on the government’s maritime accessibility activity was set out in the DfT’s Inclusive Transport Strategy published in summer 2018. This set out the priority actions we will take and associated timescales

Where we are going

By 2050, maritime infrastructure will provide a vital transport link to offshore assets which will, in turn, act as centres for developing and delivering solutions in partnership with other industries. UK ports will exploit the most significant opportunities to support the expected major increase in offshore wind generation and other evolving energy sectors so as to be recognised as European leaders in this area. Ports will cooperate with developers of new offshore activity such as floating wind farms, tidal and wave energy, and ancillary industries, to identify requirements to support the implementation of these new technologies, as and when they become commercially viable.

Ports will continue to support the oil and gas industries including decommissioning of offshore installations, for example in the North Sea. As a result, ports will be a critical node in UK energy supply and generation. Equally, they will be hubs for the trial, review and development of new fuelling options providing infrastructure such as bunkering for LNG, and/or connection

¹⁷⁷ <https://www.gov.uk/government/statistical-data-sets/sea-passenger-statistics-spas>

to the energy structures (e.g. the National Grid) to meet the needs of arriving vessels. Ports will also retain traditional maritime industries important to local economies, such as fishing.

More widely, marina developments will present new opportunities for the maritime sector to attract interest in coastal land and property, from retail, food, associated maritime and other ancillary services such as recreational and small commercial marine interests. This will make these areas destinations in themselves, adding value to the sector and building regional economies. This alongside other recreational activities in the smaller commercial sector will see the government, maritime and marine sector driving 'blue tourism' in the UK.

The UK will remain a major cruise centre, both as a start and end point but also as a calling point for cruises around the world. This will be achieved to a backdrop of port and cruise ship activity becoming increasingly environmentally sustainable, reflecting the sub-themes and ambitions of the Environment chapter.

Domestic and international ferry passenger services will continue to play an important role in moving passengers within the UK and to and from neighbouring countries. Ferry services will be provided by modern, efficient, accessible and environmentally advanced vessels and ferry companies will continue to invest in vessels that seek to meet passenger's expectations, providing additional capacity and incorporating key environmental technology. In some locations, river services will play an increasing role as an alternative to road transport as passengers seek to avoid traffic congestion or overcrowding on other types of public transport. In principle, government is supportive of this approach and will look to support industry where there is compelling evidence of the benefits. A good example of this approach can be seen through the Port of London Authority's Thames Vision, which seeks to move more goods and materials between wharves on the river taking over 400,000 lorry trips off roads. Government will also remain cognisant of balancing the use of rivers and waterways for various users to maintain appropriate provision for safety.

How we get there

The government's Clean Growth Strategy (2017) sets out the potential for significant growth in offshore energy capacity in the 2020s and envisages £557m of funding through 'Contracts for Difference' to support this. The first auction to allocate this funding is expected to be in 2019, with further auctions at two-year intervals. This provides a clear vision of the development of offshore wind over the next 15 or so years, with the potential for an additional 1 to 2 gigawatts (GW) of capacity per annum in the 2020s.

The certainty this provides to developers and the supply chain should give a very clear opportunity for ports and other companies (such as specialist shipbuilders) to increase further their involvement and investment. The offshore wind supply chain is a significant opportunity in the short to medium

term. It will be important of course to ensure navigational safety issues are taken fully into account in the development of new wind farms, as well as any other potential effects.

The potential expenditure on offshore installation decommissioning on the UK continental shelf is estimated at £17bn up to 2025. This could be a significant area of opportunity for some ports, ancillary maritime services and shipbuilders alike, depending on the facilities required and how decommissioning progresses. UK ports particularly, although not exclusively, on the east coast are well placed to take advantage of this opportunity, and indeed some are already doing so.

Access to an ultra-deep-water port is seen as a potential capability gap for attracting some of this work to the UK, where it involves semi-submersible heavy lift vessels. There is competition from ports outside the UK, such as in Norway, for this work. The Department for Business, Energy and Industrial Strategy (BEIS) have recently begun a study into the case for government intervention to establish an ultra-deep-water port in the UK, which would have the potential to handle this type of work. This is a first step to exploring potential in this area.

The development of commercially viable floating wind farms and tidal energy generation are at an early stage. Commercial deployment of these technologies, including the involvement of ports and potential investment is more likely in the medium to long term. Equally, there will be opportunity for specialist ship and boat builders to tender for, and develop the necessary vessels to service this industry. The maritime sector – including ports and ship builders - should be engaged with developers to understand and potentially shape what these requirements are.

Alongside the development of renewable energy technologies are emerging markets in ancillary and support technologies such as energy storage. Ports will need to ensure that they are engaged in the development of this market and that the opportunities for the utilisation of port infrastructure is recognised.

The Fisheries white paper¹⁷⁸ and the subsequent bill¹⁷⁹ set out government's plans to promote a more competitive, profitable and sustainable fishing industry across the whole of the country as we leave the EU.



Fishing ports will have an important role to play in securing this ambition,

¹⁷⁸ ¹⁷⁸<https://www.gov.uk/government/consultations/fisheries-white-paper-sustainable-fisheries-for-future-generations>

¹⁷⁹https://publications.parliament.uk/pa/bills/cbill/2017-2019/0278/cbill_2017-20190278_en_1.htm

including continuing to invest in the infrastructure that supports the fishing sector. In recent years the European Maritime and Fisheries Fund (EMFF) has helped fund a number of such projects and has proved popular in the sector. The current EMFF programme ends in 2020, and the government is working with the sector both on short and long term successor arrangements.

In the marine and leisure sector, there is continued opportunity for growth in 'blue tourism' but this will require requisite infrastructure: at marinas to drive commercial endeavours; more widely to develop training facilities to allow casual and leisure mariners of tomorrow the opportunity to learn new skills; and at harbour fronts and in coastal communities to facilitate other recreation activities such as powerboating, surfing and sailing.

Government is committed to exploring opportunities to promote a more diverse maritime sector and looking at the needs – physical, financial and promotional – to support the leisure sector and the regional 'blue' economies it supports.

On subsea infrastructure we expect to see increases in this development of both fibre optic cables and interconnectors. Greater use of data in all aspects of our everyday lives, from communication and social media to financial trades and navigation, is only likely to increase. The use of automation, big data and the Internet of things across the globe, will see data requirements continue to rise. This digital and information connectivity will require increased bandwidth, delivered through increased numbers and utilisation of cables. There will also need to be greater focus on increased resilience against events - accidental and deliberate - which may bring outages, and connectivity cut to cables carrying key data. The ability to transfer, re-route and ultimately build contingency into this sector, will see the need for the development of new cables. In the same vein, while life extending technologies will prolong the use of existing cables, decommissioning and new technologies will see the development of new cable infrastructure.

Similarly, we will need to maintain resilience as a country on energy generation to continue to meet the growing demand. Increased links and connectivity in this sense will remain vital and there is opportunity for the traditional maritime sector to partner with these industries to deliver the infrastructure required.

As a first step to attracting new subsea communications and fibre optic cables to the UK, the government is committed to working with the various industries to explore how this might be best achieved, including looking at new models and delivery agents for this work. In a similar timeframe the government is committed to taking an active role in the development of increased resilience in subsea infrastructure to ensure there is sufficient contingency in place as this market place continues to grow. As a further long term step, the government in collaboration with industry, will seek to develop foreign partnerships and best practice alliances to ensure the UK is at the forefront of future sub-sea infrastructure and maintains connectivity to the wider world.

For cruises and ferries there is significant investment in the short to medium term as new vessels and service enhancement planned for international and domestic services come online such as:

- Brittany Ferries LNG powered 'Honfleur'.
- Wightlink and Red Funnel investment in new vessels serving Isle of Wight.
- Increased capacity vessels for use on Irish Sea routes by Stena Line.
- MBNA's Clipper services on the Thames aim to increase to 20 million passengers by 2030, as set out in Port of London Authority's Thames Vision.

As vessel size and service levels increase it is likely that infrastructure such as ports, harbours, riverside pontoons and more widely dry docks, will need to see commensurate investment to facilitate larger vessels, and potentially also supply new types of fuels as environmental sustainability of these services becomes more important. The government will work with the cruise industry, through bodies such as CLIA, Cruise Britain and Visit Britain, to identify and propose ways to support the development of the sector. This would include tackling barriers such as the need for facilities to handle large cruise ships and supporting environmental improvement in the sector.

Recommendations

Short term (1-5 years)

- The maritime sector, with government support where appropriate, will identify and explore opportunities for the development of new and existing markets.
- The maritime sector, including ports, will actively engage the energy sector to understand the primary (generation) and secondary (manufacturing, servicing and storage) market needs, promote collaboration and identify new market opportunities.
- Industry will identify specific barriers to ports serving the energy sector and jointly with government, will actively develop and propose solutions.
- Government will explore with the maritime and marine leisure sectors where barriers to development exist and to identify opportunities to grow the sector.

- Government and the cruise and ferry sectors will have increased interaction, to better understand concerns and any barriers to growth.
- Government will support industry to proactively seek opportunities for maritime infrastructure to access existing innovation programmes and funds, making the case for inclusion commensurate with the economic profile of the maritime sector.
- Government will meet its maritime accessibility responsibilities through correct implementation of the passenger rights legislation and the delivery of the Inclusive Transport Strategy.

Medium term (5-15 years)

- Government expect ports and the wider maritime sector to build on current successes in working with developers to secure contracts for offshore work, competing on a global scale.
- Government expects to lead on attracting new subsea communications cables to the UK.
- Government expects to take an active role in the development of increased resilience in subsea infrastructure.

Long term (15 years and beyond)

- The ambition is for the UK to enhance international relationships on sub-sea cable infrastructure by collaborating with global partners and adopting best practice.

10.7 Ship building and boat building

The vision for 2050 in this area is:

The UK shipbuilding sector will maintain its capacity and capability to meet the needs of the UK Navy. However, there will be greater focus on developing an export model and there will be continue collaboration between industry and government, more widely, in the delivery the National Shipbuilding Strategy for all future ship procurements. Domestically, there will be continued development of the current UK ship and boat building, and marine engineering sectors to enhance existing strengths in retro-fitment, fitment of advanced technology, and the design and development of luxury and leisure

vessels, and other specialised craft. Furthermore, the UK will focus on markets, domestically and internationally, where it will successfully compete at a world-leading level.

Where we are now

The UK has a proud ship building history with yards around the isle building vessels such as the Royal Yacht Britannia, which served the Royal family, and the Cutty Sark, which is perhaps the most famous tea clipper to be built and sail from UK shores. These vessels are synonymous with our maritime shipbuilding history and while these achievements should not be forgotten, today's market place is very different.

The ship building sector has seen dramatic change with production significantly shifting from the west to the Far East. South Korea and China in particular have established themselves as significant players in this market. Regarding the UK ship building sector, a number of shipbuilders (e.g. BAE Systems, Babcock, Cammell Laird, A&P Group and Harland and Wolff) continue to operate, designing and delivering vessels of all shapes and sizes for a number of markets.

Ship and boat building are still vital for the UK maritime industry as it has been estimated that the shipbuilding and repair sectors alone contribute around £1.6bn to the UK economy.¹⁸⁰

The UK has a vibrant boatbuilding¹⁸¹ and shipbuilding¹⁸² industry, from the development of superyachts and high-end pleasure crafts which serve a growing leisure market, to a smaller number of larger shipyards which have built specialist vessels such as the RRS Sir David Attenborough - which will allow scientists to carry out advanced polar research.

The National Shipbuilding Strategy¹⁸³

published in 2017, sets out a commitment from government to develop the foundations for a modern and efficient sector, capable of meeting the



¹⁸⁰<https://www.maritimeuk.org/value/marine-industry/>

¹⁸¹ Boatbuilding is the term used for the construction of smaller vessels from materials such as wood, steel, aluminium, glass fibre or new composite materials.

¹⁸² Shipbuilding is the business of building large ocean-going vessels, usually of steel.

¹⁸³https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/643873/NationalShipbuildingStrategy_lowres.pdf

country's future defence and security needs, while making the UK shipbuilding sector more competitive and increasing industry resilience. The strategy commits to maintaining a vibrant shipbuilding sector, capable of designing and building complex warships such as the new Type 26 frigates which will enter service from the mid-2020s.

Underpinning the commitment is a two-fold vision:

- A Royal Navy with more ships, which are modern and capable of being incrementally modernised and improved, are exportable, and can work with allies.
- A shipbuilding enterprise that encouraged by clearer commitments and with greater certainty about the Royal Navy's procurement plans, has the confidence to invest for the long term in its people and its assets to raise productivity, innovation and improve its competitiveness in domestic and overseas markets. In this way, the sector can become more resilient to the peaks and troughs of Royal Navy business, bringing more sustained growth and prosperity to the regions in which those businesses are based.

The strategy provides a commitment from government to work with industry to further develop a strong, vibrant and globally competitive UK shipbuilding and maritime engineering industry, capable of winning business in the military and commercial markets, both at home and overseas.

A strong commercial sector is key to developing this capability and competitiveness. At present, the UK commercial ship and boat building sector has a global reputation for design, innovation and quality. This reputation provides the UK with a strong selling point in a sector which relies on overseas sales for one third of industry turnover, but more could be done. Lucrative foreign markets such as India and Brazil, which do not have such a natural affinity with using the sea for pleasure but do have growing economies, present a significant opportunity for the export of products and expertise.

Beyond this we have a superyacht and a marine manufacturing sector which is competing with other world leading countries, showing full order books in this lucrative market.



The UK also has a leading role in the definition and development of safety and vessel standards. The MCA is a key part of this endeavour, providing guidance on standards for vessel construction and safety. This highly respected level of expertise and quality assurance is a further UK strength when selling into this key export market.

This sector is not without its challenges. On a global scale we have seen the effects from downturns in economies, and on a domestic level, issues such as waterfront property prices and changes in environment regulations, have potentially limiting effects on the boat building sector, which has the demand and ambition to grow. There is also general acceptance that the marine leisure sector may not always get the recognition it deserves and there could usefully be more government support to drive further export successes.

Where we are going

The UK shipbuilding sector will maintain its capacity and capability to meet the needs of UK Naval contracts in the short and longer term. There will be greater focus on developing a flexible export model, exemplified by the Type 31e frigate, which is currently in the process of being procured. The Type 31e is a pathfinder for the new approach to designing in exportability from the outset for all future ship procurements, as described in the National Shipbuilding Strategy

Domestically, we will focus on the current UK ship building strengths and capabilities in retro-fitment, value-added fitment of advanced technology post build, and the building and fit-out of luxury and leisure vessels. This will maintain a high quality and specialist skills and engineering base within the maritime sector. Furthermore, the UK will focus on markets and specific segments where it can successfully compete at a world-leading level and fully exploit domestic and niche market opportunities.

There is also opportunity and ambition for the development of low emissions shipping - with a number of projects underway to investigate the possibilities of a variety of fuel sources. For instance, the government is funding a prototype which will demonstrate the commercial and functional viability of small wind powered autonomous surface vessels (WASV) for cargo transport; and in Scotland a project, led by Ferguson Marine Engineering Ltd, called HyDIME (Hydrogen Diesel Injection in a Marine Environment) project will involve the design and integration of a hydrogen diesel dual fuel injection system on board an existing commercial ferry.

Furthermore, the UK's expertise in marine systems, equipment, design, manufacturing, engineering and naval architecture is recognised throughout the world. This is evidenced by the fact that the UK is a major exporter of maritime equipment and systems¹⁸⁴. A recent example of export success has been the Type 26 frigate design which has been selected by the Australian and potentially Canadian navies; although the ships will not be built in the UK,

¹⁸⁴<http://ec.europa.eu/DocsRoom/documents/4233/attachments/1/translations>

the value of the sale of the design, build support and systems will be very significant. The Australians are procuring 9 vessels (at a cost of AUD 35 billion) and the Canadians potentially 15 vessels (at a cost of CAD 60 billion). This illustrates that the value of the shipbuilding industry to the UK economy goes well beyond the value of the ships built in the UK. Furthermore, the maritime industry has continuously innovated to maintain its competitive edge to successfully export its goods and services around the globe. The UK is already good at hi-tech ship building, providing a good platform for more advanced technologies to be developed here too and this advancement will continue to be supported in principle by the government.

How we get there

To continue delivering against the needs of the UK military, the benefits of a thriving commercial sector delivering innovation and expertise and smoothing out the variability in demand cannot be understated. Successful shipbuilding sectors in other countries are predicated on a strong domestic market to drive order books, funding innovation, skill development and training.

As a first step, the UK leisure and commercial boat building sectors will need to develop a greater understanding of the demand for UK domestic boat building, as well as opportunities in international markets for which they can compete successfully. At present no forecasts exist and this needs to be rectified so greater focus can be given to long term planning which will ensure we have a sector with the appropriate capability. On the shipbuilding side, the Maritime Enterprise Working Group (MEWG) has commissioned a market evaluation and competitiveness study, to identify those market opportunities for which the UK has the required capabilities, and what needs to be done to be competitive in these markets.

This will allow the sector to deliver the UK military capability while being aspirational in the development of new shipbuilding markets. The government remains committed to implementing the vision in the National Shipbuilding Strategy through significant investment and to provide greater certainty in the military supply chain through the development of 30-year shipbuilding forecasts.

To provide certainty to this sector while retaining the required operational flexibility, the government has committed to a Royal Navy with more ships. This commitment is covered by monetary funding of at least £63 billion over the next decade (from 2015) for the procurement and support of surface ships and submarines. The MEWG, set up as part of the National Shipbuilding Strategy, is a group of industry figures, academics and government representatives. It has developed an ambitious programme of work to better understand competitiveness, skills and productivity. Work is ongoing with full delivery is expected in the longer term.

A further step would see greater work with academics, SMEs and maritime colleges to develop the skilled professionals of the future. This will allow UK companies to build the ships, boats and accompanying technologies which

drive innovation. Considering the UK's research and development, and hi-tech manufacturing expertise, there is a significant opportunity for the UK to position itself as a world leader in maritime technology¹⁸⁵. The government is supportive of this ambition and is committed to working with the sector to achieve this goal.

In the first instance this will see backing and support for SMEs to export and explore opportunities to enhance their impact in the boat and shipbuilding sectors. While other countries may be able to outcompete the UK in terms of larger shipbuilding, stakeholders have highlighted that the comparative advantage of the UK is the provision of technological systems used within vessels. It is the development of this specialisation which presents an opportunity for the UK to stand out. Greater co-ordination and collaboration within the sector will be essential in becoming a world leader in this area.

Equally there is significant opportunity to look for 'twinning' projects to combine with shipyards in Europe (such as in Poland and Spain). Government has already built strong relationships with key shipyards in priority markets as well as systems integrators and design houses.

Government will now seek to build on that by enhancing relationships with the major fleet owners and operators of high value vessels to better share, sell and export British expertise. In servicing both domestic and overseas markets, a greater focus will be placed on the use of existing centres of excellence (such as the National Composite Centre) and where necessary, on the development of additional specialised centres in the fields of engineering and parts manufacturing. This industry-wide approach will help to make UK ship yards more competitive – buying in what they need – but also putting the UK at the centre of research and development. Government will support these endeavours by acting as an introductory mechanism.

Building on the successes in the superyacht sector and on the back of increasing order books, the UK will seek to explore opportunities to raise productivity and secure a truly competitive, sustainable and globally successful UK ship and boat building, and marine engineering industry.

¹⁸⁵<https://www.gov.uk/government/publications/industrial-strategy-building-a-britain-fit-for-the-future>

Recommendations

Short term (1-5 years)

- Government will continue to look for appropriate means of support for SME's to export, attend tradeshows and explore opportunities to enhance their impact in the boat and shipbuilding sectors.
- Government will work with the leisure, superyacht and small commercial marine industry to ensure their needs are factored into the strategic growth agenda for the maritime sector, in the context of government's Industrial Strategy.
- Government will work with industry to review and understand any issues which might prevent UK businesses and ship builders from being competitive in bids for UK-based contracts. And if necessary, look for options to provide appropriate support.

Medium term (5-15 years)

- Government expects industry to utilise existing centres of excellence and where necessary develop new centres focused on specific areas of ship and boat building, and marine engineering in order to maximise international competitiveness.
- Government expects the UK ship building sector to maximise its flexibility to be able to respond to openings in niche markets, such as a rise in short-sea or coastal shipping, and the opportunities this may bring in a changing market.
- Government will work to enhance its strong relationship with key ship yards, and augment this with major fleet owners and operators of high value vessels to better share, sell and export UK expertise.
- Working in collaboration with government, we expect industry to focus action and capability development on specific, targeted markets to achieve world leader status and look for greater opportunities to export.

Long term (15 years and beyond)

- Government and industry will work towards successful implementation of the National Shipbuilding Strategy.
- Government aspires to support the Maritime Enterprise Working Group to raise productivity and secure a sustainable and globally successful UK ship and boat building, and marine engineering sectors.

10.8 Shipping in the supply chain

The vision for 2050 in this area is:

The UK remains a “must-call” destination for all types of shipping activity, delivering the goods and products that serve the UK economy. The requirement for different types of shipping will continue and the UK will maintain its ability to handle the largest vessels – for freight and passengers – as well as tapping into the likely potential in growth markets such as feeder services. This will see greater uptake of technological advancements and continued infrastructure investment by shipping companies and ports.

Where we are now

The development of shipping and maritime infrastructure has always been intrinsically linked. From the early days, the depth of natural harbours shaped the size of vessels that could call at that port. In time, when the arrival of steam enabled larger and more powerful vessels, ports had to grow, reinforce their quaysides, and provide new fuel bunkering services. More recently, the advent of containers was transformational both for shipping and the global economy whilst ro-ro ferries allowed for easy vehicular access to new destinations. The infrastructure that makes up our ports has always been influenced by the wider shipping trends. As we approach the third decade of the 21st century, technology evolves rapidly and our maritime infrastructure needs to be able to continuously adjust. At present the UK is host to all types of commercial shipping: deep-sea services, short-sea shipping and coastal shipping between UK ports.

Deep-sea shipping

Deep-sea shipping mainly consists of large vessels carrying volumes of cargo between the UK and the rest of the world (excluding European/Mediterranean ports). Many different vessel types ply these routes: dry bulk vessels carrying timber and grain from the Americas, tankers carrying oil products from the Middle East, containerships and other general cargo vessels carrying consumer goods and ro-ro vessels transporting cars from Asia.

These have all grown in size to benefit from economies of scale and meet market demand. However, since the tanker growth boom of the 1970s, the most dramatic growth corresponds to the modern container and cruise ships. These vessels are pushing the constant development of port facilities to match their own, as larger vessels require greater depth of water, greater air draft above them to wider span cranes on longer quaysides, and also advanced cargo-handling capabilities. Making these adjustments comes at high capital cost.

The UK is a direct stop for many of these deep-sea services on the major European loops - often as the first stop in northern Europe while the competition between the largest European ports is fierce. For the UK, the competition is based on the comparative costs of a direct call or transshipment from another European port, by feeder, road or rail.



Short-sea shipping

Short-sea shipping largely consists of activity in intra-Europe and Mediterranean basin/north Africa trade. Ships are increasing in size due to a cascade of vessels from some older deep-sea markets (using the container trade as a benchmark, the average vessel size in 2017 was 1400 TEU¹⁸⁶).

Short-sea shipping can provide a strong alternative to road and rail transport and there have been numerous initiatives - including at EU level “Motorways of the Sea” - to promulgate short-sea shipping further, due to the potential congestion and environmental benefits it offers over those modes. Whilst there is potential for further development of this market, it is already relatively successful with 56% of the container services calling at UK ports being short-sea shipping¹⁸⁷.

¹⁸⁶ Government Office for Science – Understanding the UK Freight Transport System – Not yet published

¹⁸⁷ Ibid

The potential of Short-sea Shipping

Short-sea shipping refers to the use of shipping instead of an inland/overland transport leg for the movement of goods. It can also be thought of as a “hub-and-feeder” arrangement where deep-sea cargos are then transhipped by feeder or coastal shipping to other ports closer to the final destination, rather than multiple deep-sea port calls. In commercial term, short-sea shipping is competing with land transport primarily in terms of costs, speed, and reliability/frequency.

Encouraging short-sea shipping is often highlighted as a transport priority, particularly as a mechanism to: reduce land transport congestion; improve environmental performance since shipping has better carbon footprint per tonne of goods; increase seafarer employment; increase port traffic and in turn, enhance regional growth and employment; boost shipbuilding activity as UK shipyards could be well-placed to build modern, green, feeder ships.

Apart from those easily identifiable benefits, there exist significant disadvantages and barriers for short-sea shipping: a hub and feeder model may incur higher total costs than direct calls by deep sea-services; there is destination inflexibility as importers do not always know in advance the final destination of cargoes which means that delivering to a major port makes more sense than waiting to deliver to a local port; it is potentially counter to today’s international container business model; feeder services typically have a lower priority at ports than deep-sea ones and the resulting delays could completely undermine a regular and frequent feeder service. However, once a critical supply of feeder ships is reached, increased feeder services could provide direct lines to a consolidated number of deep-sea hub ports which in turn, would boost frequency of services but also time savings (stemming from a reduction in handling delays compared to multiple deep-sea calls).

How those pros and cons fall is currently reliant on route and cargo type and the existing global maritime business models. However, this has potential to change as technology advancements and landside congestion could tip the scales towards short-sea shipping - in terms of both cheaper and cleaner ship movements that are efficiently managed by means of enhanced data and information between parts of the supply chain. As such, the case for pursuing a more active short-sea shipping policy should be regularly reviewed by government and industry between now and 2050.

Coastal shipping

While 15% of domestic freight is already carried by coastal shipping, this market has further potential – though industry views can be divided as to the extent of its usage¹⁸⁸. Coastal shipping competes directly with road and rail

¹⁸⁸<https://www.gov.uk/government/statistical-data-sets/port-and-domestic-waterborne-freight-statistics-port>

transport: it is advantageous regarding both volume and types of product that can be carried while being disadvantageous in terms of speed and flexibility.

The government runs two freight grant revenue schemes to encourage modal shift from road to both rail and water. The scheme for coastal and short-sea shipping operates on a different basis to the one for rail and inland waterways, largely due to the state aid rules applying to the maritime sector. Unlike rail freight, applications for water freight funding are few and far between. Notwithstanding this low take up, government wishes to continue to explore the opportunities for water freight. Recent research considered the possibility of a coastal shipping scheme similar to intermodal rail in the Mode Shift Revenue Support scheme, estimating the cost of coastal shipping compared to road and rail grant rates. Additional research has been commissioned on the barriers and opportunities for coastal shipping, as recommended by the PCS. This will also look at the market potential for increased inland waterway freight on our major rivers and estuaries.

Where we are going

In broad terms, that the UK maritime infrastructure facilities and connected supply chain capability has evolved so that UK ports remain in a world leading positions; that the UK continues to be an attractive and proportionate maritime operating environment; and that the UK's role in international trade continues to be high profile. In this way the UK will continue to be a global shipping destination on both international deep-sea and more regional short-sea shipping rotations. Through the adoption of new technology, on both ship and port side, to accommodate autonomy, new fuels and heightened logistics efficiency, short-sea and coastal shipping will increase in volume, becoming a default alternative to land transport, and provide opportunities for a wide range of ports.

How we get there

To successfully ensure the continuation of valuable shipping calls, the UK's ports will have to continue to adapt to both the infrastructure and technology trends of both ships and shipping lines. This will include accommodating changes in ship size and vessel operational demands. Today's so-called "megaships" are those with current capacities of 20-21,000 TEU. This is a size that a decade ago was largely unthinkable. Indeed, a ceiling for the viable physical, operational and economies of scale, for container vessels has been predicted at much lower levels on a number of prior occasions. Similarly, views continue to be split as to whether there will be vessels that significantly surpass this generation – whereas some commentators have suggested that 28,000 TEU vessels are feasible in future. There is a good degree of uncertainty here, but given that previous predictions against growth have largely been proved wrong, it is likely that vessels will increase further in size. This is also being reflected in other parts of the shipping sector where ferries are getting larger.

This growth will require significant upgrades to physical infrastructure, for example, dredging, quays and cranes to accommodate these vessels which requires a capital-intensive programme of investment.

As emissions and air quality issues rise further up the domestic and international agenda - see the Environment chapter for more detail - there will also be continued pressure on ships and their reception facilities to move to and provide alternative fuels. Until these emerging markets stabilise, ports are likely to find themselves being required to provide bunkering for multiple different fuel types, and similarly the inclusion of facilities that allow for less polluting methods of powering ships at berth.

As noted in the supply chain sub-theme, ports will also need to continue to adopt technologies being utilised by the wider supply chain for greater efficiencies. This will also extend to the adoption of wider shipping technologies, and how to handle pilotage and berthing of potentially autonomous vessels for example.

The flipside to this is that ships will also need to retain a degree of flexibility in order to successfully engage with the variety of port, technology and regulatory arrangements across their various ports of call, which are unlikely to be standardised. Ships wishing to call in the UK will have to continue to be cognisant of meeting local requirements and preferences, for example emissions and methods of reducing them, or other safety or environmental concerns.

In relation to short-sea and coastal shipping, the adoption of new technology is likely to be a vital component of their future success. In the short and medium term, we are unlikely to see a significant shift in traffic levels to this type of shipping, as moving freight over these shorter distances faces stiff competition from land-based transport. The same technology coming online for maritime transport – autonomy, lower emissions – that can make maritime more competitive in isolation, will also be implemented in these competitor sectors and increase or maintain their current advantages of speed and flexibility. However, the longer term may present greater opportunity. If shipping and ports have continued to invest in more efficient, environmentally friendly ships with lower operating costs, then this could provide the requisite economies of scale and operational performance, to swing the competitive advantage back to water from other modes of transport on short-sea routes.

Similarly, advanced vessels, employing such technology and operating on a variety of scales and sizes, could also have a positive effect on coastal and feeder shipping. The comparative benefits of water transport across the volume/speed/reliability/cost spectrum for choice of freight mode could be improved so that it becomes a default option for a greater number of journeys. For example, in rural or remote areas such as the southwest or parts of Scotland, a small regular autonomous coastal vessel could be preferable to a road or rail transport equivalent, and also present local and regional ports with continued freight handling opportunities that might otherwise not exist.

The changes to shipping will have a large impact on ports. The capital-intensive nature of the investment needed to meet these challenges will likely mean that the largest, most successful ports (or groups) with significant financial leverage, are those best able to adapt. There is already a pattern in the UK of only a few ports being able to handle the largest, most advanced, vessels. This trend is likely to be further consolidated in future.

The next tier of major ports and smaller ports will also face both opportunity and challenges. A potential growth in feeder and short-sea shipping services, both domestically and from larger continental ports, as an alternative to land transport over the longer term, will provide growth opportunity. There is also likely to be further regional specialisation as ports seek a unique position and competitive advantage such as being the timber and construction port for an area, for example. Smaller ports will also see new opportunities if developments in autonomous technology and congestion proceed as projected.

However, the period to 2050 will be highly competitive across all segments of shipping and the supply chain, but by 2050, the UK will remain a “must-call” destination for all types of shipping activity.

Recommendations

Short term (1-5 years)

- UK maritime sector will maintain its attractiveness for vessel calls on global shipping routes and the effectiveness of UK maritime infrastructure through continued investment, in step with improvements in technology and vessel types.

Medium term (5-15 years)

- Government expects that shipping companies, particularly those involved in short-sea and coastal shipping markets, will adopt technology developments that can increase their competitiveness versus land-based freight modes.

Long term (15 years and beyond)

- Government anticipates that ports will embrace such technological changes in shipping, and invest to take advantage of viable alternatives to land-based transport.

Summary of future maritime infrastructure

Maritime infrastructure will remain a key focus for the operations of the wider maritime sector, and developments until 2050 will significantly enhance productivity and efficiency, to deliver an enhanced positive impact on national economic growth and business performance. Maritime infrastructure will remain a fundamental part of the economic, transport and industrial fabric of the country. By 2050 increases in global trade, population growth, consumer purchasing power, technology advances and energy needs will ensure that maritime infrastructure is central to achieving national goals and prospering on the international stage.

Goods and raw materials, food and finished products, will still need to be transported by sea and moved through our ports, before entering the wider supply chain. Energy products will need to be moved and sea-based energy infrastructure supported, passengers will continue to travel, whilst leisure and commercial maritime activities such as fishing will remain important.

On the surface maritime infrastructure in 2050 will largely be recognisable as the industry of today, where the essential components have been honed by centuries of experience. However below the skin, it will operate as an industry of tomorrow. It will interact and respond differently due to developments across the full spectrum of innovation, from design, development and delivery to operations, maintenance and land use that can revolutionise the efficiency, productivity and scale of maritime infrastructure.

Maritime infrastructure will remain, in most cases, a long term asset but there will be a greater need to be agile, adaptable and open to change to take advantage of life extending technologies and ever shorter development cycles.

The UK's maritime infrastructure will need to match the level of modern technology in comparable industries such as: aviation to embed best practice; the wider supply chain for integrating with shared technology platforms; and working with business incubators and SMEs to embrace innovative, new technologies, that provide added value and place maritime infrastructure at the forefront of the fourth industrial revolution. Maritime freight traffic will be changed by technologies such as 3D printing as well as increased unitisation. Autonomy, interconnected smart systems and big data will bring the shipping, cargo handling and inland logistics elements ever closer together, maximising efficiency, reliability and reducing costs.



11. Security

UK vision for maritime security in 2050

To advance and protect the UK's national interests, at home and abroad, through the active management of risks and opportunities in and from the maritime domain, in order to strengthen and extend the UK's prosperity, security, and resilience and to help shape a stable, rules-based, world -National Strategy for Maritime Security, 2014.

11.1 Introduction

The maritime domain

The UK considers 'maritime security' to be the advancement and protection of the UK's national interests, at home and abroad. We achieve this through the active management of risks and opportunities, in and from the maritime domain. This enables us to strengthen and extend the UK's prosperity, security and resilience and to help shape a stable world¹⁸⁹.

While the sea is the lifeblood of our economy, conveying the vast majority of our trade and many of our vital resources, it can also be exploited by nations placing their own interests above the global good, criminals and terrorists as evidenced through history. For the maritime sector in the UK, security is about ensuring business continuity, allowing businesses to operate free from interference or disruption.

The maritime domain is a complicated international system requiring both national and international policing and regulation, strong global partnerships to address areas of common interest, and to strike an appropriate balance between facilitating legitimate movement, and countering hostile activity.

The UK is a leading player in this international system, using diplomatic, military and law enforcement levers to drive cooperation and build capacity. In order for us to continue to influence and intervene where necessary, we must carefully assess and prioritise the maritime risks and opportunities we face and allocate resources accordingly.

Scope and objectives

Maritime 2050 is fully aligned with the government's 2010 National Security Strategy (NSS)¹⁹⁰, the 2014 National Strategy for Maritime Security and the 2015 Strategic Defence and Security Review. Collectively, these strategies reflect that the UK wishes to be a prosperous, secure, modern and outward-

¹⁸⁹ <https://www.gov.uk/government/publications/national-strategy-for-maritime-security>

¹⁹⁰ https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/61936/national-security-strategy.pdf .

looking nation promoting its values and ideas globally. Maritime 2050 also draws on strategic trends as identified by the government¹⁹¹. This chapter does not seek to reanalyse the threat outlook and geo-political landscape but aims to identify some of the main trends and drivers that are most likely to affect maritime security out to 2050 and explore possible policy options to counter them.

Whole-of-government approach

The maritime domain is complex and involves multiple sectors and actors. Therefore, managing security and resilience in this environment requires a whole-of-government approach, incorporating multiple government departments and agencies, including DFT, Home Office, Foreign and Commonwealth Office (FCO), MoD, Department for Environment, Food and Rural Affairs (Defra), Royal Navy, Royal Air Force, Border Force, the Police, National Crime Agency (NCA), MMO, MCA, National Maritime Information Centre (NMIC), Joint Maritime Operations Coordination Centre (JMOCC) and the Intelligence Agencies.

The nature of global trade means UK security interests extend beyond our own jurisdiction. To meet the future requirements of maritime security and resilience will require collaborative working with multiple nations, partners, alliances and international organisations, thus maintaining and underpinning the International Rules-Based System.



As identified in the 2018 National Security Capability Review,¹⁹² the *Fusion Doctrine* which promotes a holistic approach in tackling security issues (see case study later in this chapter) will improve the UK's collective approach to national security.

Many capabilities that contribute to maritime security lie outside traditional national security departments of government, such as MCA assets and

¹⁹¹ <http://www.ssri-j.com/MediaReport/Document/GlobalStrategicTrendsOutTo2045.pdf>

¹⁹² <https://www.gov.uk/government/publications/national-security-capability-review-ns-cr>

personnel. Collaboration with private industry is crucial in delivering a secure, resilient maritime sector as industry ultimately deliver maritime services.

National security challenges to the UK – as identified in the Strategic Defence and Security Review

Increasing threat posed by terrorism, extremism and instability

The protracted nature of conflict in places such as Yemen has devastated basic social infrastructure (health, water and sanitation systems) and stalled education and economic development. Densely populated urban areas in Syria and Iraq have also been directly affected by intense fighting. Conflict and instability create large-scale humanitarian and development needs and hamper economic growth which in turn drives migration, providing criminals with the opportunity to exploit the vulnerable through human trafficking and modern slavery. Conflict and instability can also allow terrorists and organised crime groups to thrive¹⁹³.

Terrorism continues to pose a threat to the UK and our interests overseas. Terrorism is one of a number of threats the UK maritime domain faces and could include attacks on shipping and ports, but also could facilitate the movement of groups and individuals. Attacks could range in sophistication and groups continue to exploit the internet and social media to radicalise and recruit members.

Some nation states have also threatened the stability and integrity of the Rules Based International System, which is founded on relationships between states and through international institutions and frameworks, with shared rules and agreements on behaviour. This in turn threatens freedom of navigation as well as the respected mechanisms and structures across the maritime world.

Resurgence of state-based threats, intensifying wider state competition and the erosion of the rules-based international order, making it harder to build consensus and tackle global threats

Competition between states, and the threats they pose to each other, can have a significant impact on UK maritime security and interests. The resulting uncertainty can affect our prosperity, and the prosperity and security of some of our closest allies. At the extreme end, those risks might draw the UK and our allies into military conflicts.

Impact of technology, especially cyber threats and wider technological developments

Malicious cyber activity knows no international boundaries and has grown in terms of intensity, complexity and severity. There are several established and capable hostile states that seek to target and exploit UK networks and devices to gather intelligence and intellectual property. Indiscriminate disruptive

¹⁹³<https://www.gov.uk/government/publications/national-security-capability-review-nscr>

incidents also affect our partners, as exemplified by the 'NotPetya' cyber incident in June 2017 (considered in more detail under the cyber security sub-theme). The proliferation of low-cost high-end commercial capabilities, novel weapons and sophisticated data-driven technologies, including autonomous systems are also changing the security environment¹⁹⁴.

Ongoing growth in serious and organised crime and its impact

Serious and organised crime presents an increased and sustained threat to UK maritime security and prosperity. Criminal actors often use the maritime domain to facilitate the importation of illicit goods, such as narcotics and firearms but also human trafficking. Serious and organised crime is inherently transnational and many of the threats we face within the UK emanate from overseas¹⁹⁵.

Diseases and natural hazards affecting the UK¹⁹⁶

One or more major hazards can be expected to occur in the UK in every five-year period which can significantly test the country's resilience, the most serious of which are pandemic influenza, national blackout and severe flooding. Climate change will also have a significant impact on maritime operations by increasing the occurrence of extreme weather events. The maritime industry will need to assess their preparedness and adapt to new working terrains. These issues are discussed in greater detail in the Infrastructure and Environment chapters. All of these national security challenges to the UK, and our interests overseas, have a maritime dimension, whether it be as a conduit or target of activity.

Overall recommendations

Short term (1-5 years)

- Government will lead on the assessment of risk, analysis and emergence of new threats to shipping and port operations in the global shipping sphere.
- Government will improve the processes to address security threats and target methodologies to implement proportionate mitigations to new tactics as needed.
- The UK will broaden our already strong alliances, both diplomatic and military, to maintain and build consensus for an open and stable maritime domain.

¹⁹⁴ <https://www.gov.uk/government/publications/national-security-capability-review-nscr>

¹⁹⁵ <https://www.gov.uk/government/publications/national-security-capability-review-nscr>

¹⁹⁶ <https://www.gov.uk/government/publications/national-security-capability-review-nscr>

Medium term (5-15 years)

- The UK will ensure that - working with the IMO, other institutions and on an inter-country basis – future development of maritime security regulations and standards aligns with potential risks and threats.
- We will be agile to the changing world environment, targeting support not only where it affects UK interests but also where it is most needed.

11.2 Security of UK waters – including Overseas Territories

The vision for 2050 in this area is:

The whole of government approach in partnership with industry and coupled with technological advances will be capitalised upon to build maritime domain awareness in UK waters as well as those of our overseas territories. We will also continue to build on our joint working arrangements with our NATO and international partners to burden share and maintain situational awareness in international waters. This proactive intervention will make our waters a prohibitive place to operate for those involved in serious organised crime, threats from state actors and terrorism.

Where are we now

The monitoring and controlling of UK waters, including the Overseas Territories, involves a multi-agency response – from naval and law enforcement assets to the use of various sources of intelligence and engagement with industry partners. Namely:

- Maritime Domain Awareness (MDA) is supported through the NMIC. UK government vessels and aircraft are coordinated via the JMOCC. Both are multi-agency centres of excellence. Due to the sheer size of the maritime domain, operations are typically intelligence-led.
- We work closely with the Overseas Territories who have regulatory responsibility for port security and ships flagged under their registry, and the UK has responsibility for protection of their maritime zones and ships flagged under their registries.
- NATO and EU allies are essential for burden-sharing, information sharing, and responding to incidents that cross maritime boundaries – both from state and non-state actors.

The UK supports the rules-based system from which we derive international norms and activity undertaken by nation states.

Fusion Approach

The 2010 Strategic Defence and Security review established a National Maritime Information Centre.

The NMIC brings together information and intelligence provided by Border Force, the MCA, the police, the Armed Forces, the FCO, the MMO, the NCA and other agencies, and supported by its international partnerships, incorporates additional global information to provide the UK with a unified situational awareness of maritime activity in UK and international waters.

The NMIC is tasked with:

- Producing maritime situational awareness information by means of coordinating national maritime surveillance data in a secure and timely manner.
- Identifying current and future threats and vulnerabilities in light of the comprehensive security picture the organisation has at hand.
- Providing recommendations and advice to government in times of crisis, including providing a coherent picture of the maritime domain to the Cabinet Office Briefing Room.
- Working in partnership with government, industry, and the public to leverage all sources of information.
- To act as a single point of contact for EU and international partners developing similar situational awareness capabilities.

The ethos behind this initiative is known as the Fusion Doctrine, which stresses the need for a holistic approach in tackling security issues and comprises a key concept behind the government's recent National Security Capability Review.

In ensuring information is easily and securely shared across government, the NMIC is an example of government proactively taking steps to guarantee it is in the best possible position to respond to current and emerging threats. Hence, while the NMIC's focus is on the here and now, rather than longer term analysis, its establishment is a clear example of how broader strategic thinking can lead to clearly identifiable outcomes, and its effects have been seen in the provision of data to support security operations at the 2012 Olympic Games, and in the protection of civilians in Libya in 2011.

Where we are going

Advances in technology will render the monitoring of the totality of UK territorial waters (TTW) more effective and efficient. NATO will remain a cornerstone of our collective defence, and strong security relationships with the EU will allow for transfers of information and responding to trans-national

criminal activity. The UK will be a world leader in MDA and a standard bearer in MDA operation and supporting services.

The UK has the fifth largest EEZ in the world. This encompasses our offshore energy generation capability and other resources within our geographical remit. Both here in the UK and within the Overseas Territories, there is the potential to exploit seabed resources or generate renewable energy via wind and wave. While this provides an economic opportunity for the UK, it also presents an opportunity for criminal actors to operate in areas that are less frequently monitored. We need to maintain and strengthen our maritime domain awareness involving a whole-of-government approach, in partnership with industry. We must build on emerging technologies and joint working, in order to make UK waters a prohibitive place to operate for those involved in serious organised crime.



We must be alive to potential threats posed by state actors in our waters, including the Overseas Territories, and develop the capabilities required to detect and deter such threats. Responding to such threats in an international environment means we must continue to work with our NATO and

European partners, in order to burden share and maintain situational awareness. We will also maximise the use of our world class intelligence.

The UK should position itself to take advantage of developments in automated systems and technology that could offer more effective ways of providing surveillance of the UK maritime domain and special UK interests. For example, with increased incidences of exploitation of war graves in remote maritime locations, the use of remote monitoring technology may prevent further disturbances.

How we get there

A mix of government and private investment in technology would enhance the capability to achieve total MDA in UK waters. The UK will continue support of the RBIS, supporting international institutions to uphold freedom of navigation, enabling unimpeded lawful commerce, and the peaceful resolution of differences based upon international law. The UK will actively participate in, and encourage the development of, our security alliances in order to counter and deter threats in our maritime domain, and that of our allies.

Recommendations

Short term (1-5 years)

- The defence of UK waters and those of our Overseas Territories from all threats will remain a standing commitment.
- The UK will maintain a cross government research and development programme to find innovative solutions to detect, monitor, and respond to threats and protect UK maritime interests including Overseas Territories and Crown Dependencies.
- Government will continue to maximise its use of capabilities by securing a long term delivery plan for the NMIC and the JMOCC. We will provide world class maritime domain awareness and deliver effective asset disposition.
- Government will continue to support the rules-based international system to build and deepen our relationships with emerging global markets by strengthening alliances and building partnerships.¹⁹⁷ We will encourage rational behaviour by states and support the peaceful settlement of disputes.
- Government will reflect on the changing maritime security landscape and review our approaches in coordination with future defence reviews.
- Government will maintain an exchange of intelligence with our closest partners including the US and Europe and continue NATO participation to deter and adapt to threats as the maritime security picture evolves.

11.3 Security and resilience at ports and on ships

The vision for 2050 in this area is:

Ports and ships will be transformed through the development of technology on increasingly automated operations. New practices will drive new ways of inspecting cargo and passenger vessels at ports and will mitigate against the threats posed by domestic and international terrorism. Improved cargo screening will help to prevent the importation of illicit goods for criminal purposes but also reduce the threat posed by terrorist actors importing or exporting dangerous articles. The UK will, with its partners, work to understand any changes and lead the way in developing suitable global standards and regulations so that security keeps pace with future changes and adapts to ensure that vulnerabilities are minimised.

The UK will develop an approach that understands the effects of possible disruption caused by natural hazards and environmental change. We will build resilient measures that bring a quick, robust and well connected response.

Where are we now

UK maritime security involves adherence to EC regulation 725/2004, enhancing ship and port facility security which includes mandatory requirements of the International Ship and Port Security code. This code contains detailed security-related requirements for governments, port authorities and shipping companies.

UK port infrastructure can be susceptible to flooding (particularly east coast storm surge events, but also other severe weather events like space weather), with redundancy, and protection of systems determined by historic flood events (i.e. 1-100-year events). The maritime sector benefits from resilient infrastructure but it is vulnerable to disruption to connected services such as electricity, telecommunications and hinterland connections. Both the Environment and Infrastructure chapters consider the importance of future resilience to climatic events.

The DfT's overseas capacity development team works with priority countries, to advise and assist in building capability in order to raise their implementation of the International Ship and Port Facility Security (ISPS) code at key facilities.

Raising Maritime Security Standards at Global Seaports

The UK Department for Transport, along with international allies, works directly with priority countries to raise their level of implementation of the ISPS Code at key commercial ports in those countries.

DfT will do this through four key programmes:

- Surveys of the level of ISPS implementation at foreign ports by highly trained inspectors.
- Counter-terrorism Partnership Visits into the UK by foreign delegations to learn and observe UK best practice on ISPS security.
- Capacity development assistance including security equipment and specialist training.
- Partnership activity with our international allies to make best use of each-others' expertise.

Fusion Approach

In addition to lowering the risk of a successful terrorist attack on global maritime seaports, the *Fusion Doctrine* will help underpin regional stability and complement counter-terrorism programmes in other areas as part of a comprehensive, whole-of-government, approach to tackling the scourge of international terrorism.

Where we are going

The significant developments in technological change will challenge future international regulations and standards. The UK will look to lead in the development of these regulations so that they best reflect the complexities of new technologies and threat vectors.

Developments in technology will drive new ways of inspecting cargo and passengers at ports, and are expected to improve the security of passenger vessels from the threat posed by domestic and international terrorism. Improved cargo screening will not only help prevent the importation of illicit goods for criminal purposes, but also reduce the threat posed by terrorist actors illegally importing or exporting dangerous articles. Ports also act as a critical entry point for vital substances such as LNG or crude oil which is piped on to shore, and food and other resources upon which the UK is reliant. Increased security and protection at ports and on ships, will protect this vital trade.

To protect the maritime industry and UK trade interests against the threat of piracy, we have already implemented a number of measures including the introduction of armed guards on UK flagged ships that transit through high risk areas. We will routinely assess and update the guidance issued to the shipping industry and monitor the area where armed guards are currently permitted.

The use of automated systems will improve the efficiency of port and shipping operations but may also increase the vulnerability to outages in these connected systems. Development of appropriate working practices and the training of highly-skilled professionals in step with these changes, will be needed to maintain resilience in such systems and to mitigate threats in the cyber domain and system errors.

Challenges to shipping and port operations will evolve over the coming decades – the complex nature of technological advances and geo-political changes will be difficult to predict. The UK must lead in understanding these changes and shaping responses in cooperation with the international community to develop suitable standards and regulations.

As an island nation, we are vulnerable to climatic changes and the next few decades will likely bring increased instances of severe weather events. We must understand these challenges and their effects in order to develop optimal infrastructure and working practices so as to protect the maritime sector in the most efficient way.

In a global, inter-connected world, we should maintain our approach to capacity development to improve the security capability and maturity of developing countries, in order to reduce the vulnerabilities of shipping-related activities corresponding to these countries.

How we get there

Targeted investment in research, based on assessment of future threats will be needed. Finding innovative solutions to encourage industry investment in the protection of infrastructure from severe weather events and its resilience to natural hazards is discussed in more detail in the Infrastructure chapter.

The UK will take a measured response to changing security threats to ensure that regulations remain effective and proportionate. The UK will work with the IMO and other international institutions and partners to ensure that a globally consistent approach is considered.

By adopting an “all risks” approach to security and resilience of critical national infrastructure, the government will also take all necessary steps to ensure hostile actors cannot use ownership of, or significant influence or control over, businesses and assets in a way that may harm the country.

Recommendations

Short term (1-5 years)

- Government will provide information to encourage and enable informed investment to protect critical port infrastructure from future hazards such as severe weather events.
- Government will work with ports to review their understanding and implementation of climate change adaptation measures and encourage periodic reporting on preparedness through the adaptation reporting power.
- To maintain and increase port throughput efficiency, government will support industry in seeking emerging technologies and systems to deliver screening of goods and people more efficiently and effectively.
- Government will assess the feasibility of undertaking a systems approach to identifying single point of failure for maritime infrastructure – that is looking “beyond the fence” to identify interdependencies of connected infrastructure, supply chains, and their levels of redundancy.

- Government will monitor investment activity in UK maritime infrastructure to protect national security against hostile actors who may wish to harm the UK.

11.4 Global shipping route security

The vision for 2050 in this area is:

The UK depends on open trade routes for the supply of critical energy, raw materials, food, and manufactured goods. This will continue out to 2050. In a more volatile, contested, and nationalistic world these trade routes and key points of vulnerability (strategic chokepoints) may no longer be as open to navigate freely.

Where we are now

The UK adheres to the rights and responsibilities underpinned by UNCLOS on the use of the world's oceans, including the rules for shipping, the environment, and the management of marine natural resources. This common understanding and cooperation allow for a stable and secure maritime domain. Global sea lanes are open and can be navigated freely although insecurity and regional tensions do exist in global hotspots owing to criminal activity, non-state actors, and hostile nation states. For example, maritime criminality in the Gulf of Guinea, terrorism in the Sulu and Celebes Sea, and regional tensions in the South and East China Seas exist over sovereignty claims.

Where we are going

The centre of gravity of global economic power is likely to continue to shift further towards Asia, resulting in a change in the balance of power and an increasingly multipolar world. The US is likely to remain the world's leading military power, although its military advantage is likely to be challenged increasingly by foreign powers. Growing proliferation will allow a wider range of actors to access more sophisticated weapons, while the previous technological advantage enjoyed by Western militaries will continue to be reduced.

Sea lanes are likely to continue to play a major role in the global economy, with the most important maritime security challenges likely to centre on exclusive economic zones bordering major sea routes. There will be greater summer use of Arctic sea routes, in particular the Northern Sea Route giving some states more influence over the movement of trade. Use of the Arctic is covered in the Environment and Trade chapters.

The UK will remain heavily reliant on imported energy, food and industrial resources. The security of trade routes along with the stability of the environments these resources originate from will remain vital.

Increasing nationalist agendas could risk principles upheld under the rules-based international system. This erosion of agreed rules, regulations and norms will weaken the authority of international institutions such as the UN. In the maritime domain this could restrict access to international sea lane and strategic sea routes. Nationalist agendas could also risk the unity of standing alliances and weaken the ability for like-minded nations to support the principles underpinned by the rules-based international system.

Strategic Energy Chokepoints

The **Strait of Hormuz** is the world's most important chokepoint, with an oil flow of 18.5 million barrels per day (bpd) in 2016. The daily flow of oil through the Strait accounted for 30% of all seaborne-traded crude oil and other liquids. More than 30% of global LNG trade also transited the Strait of Hormuz in 2016. UK imports of Qatari LNG accounted for 93% of LNG imports to the UK in 2016 – LNG made up 31% of all gas imports in 2016.

There are limited options to bypass the Strait of Hormuz. Only Saudi Arabia and the United Arab Emirates have pipelines that can ship crude oil outside of the Persian Gulf and have additional pipeline capacity to circumvent the Strait of Hormuz. At the end of 2016, the total available crude oil pipeline capacity from the two countries combined was estimated at 6.6 million bpd, while the two countries combined had roughly 3.9 million bpd of unused bypass capacity.

The **Bab el-Mandeb Strait** is a chokepoint between the Horn of Africa and the Middle East. Most exports from the Persian Gulf that transit the Suez Canal and the SUMED Pipeline also pass through Bab el-Mandeb. An estimated 4.8 million bpd of crude oil and refined petroleum products flowed through this waterway in 2016 toward Europe, the United States, and Asia.

Closure would require sailing round the Cape of Good Hope, adding time to sailings and reducing capacity in supply.

Source EIA and Digest of United Kingdom Energy Statistics, 2016, BEIS

How we get there

The UK will continue support for international institutions and the rules-based international system - maintaining strong and effective representation in the key organisations. We will work to ensure compliance by other states with UNCLOS and promote complementary agreements. In collaboration with partners and allies, the UK will monitor situations where the rules in UNCLOS are not being complied with and use best efforts to bring states into compliance.

We will also broaden our already strong alliances, both diplomatic and military, to maintain and build consensus for an open and stable maritime domain. The UK will work with other like-minded nations to collectively deter (via soft and hard power) acts of aggression in the maritime domain. The UK will continue investment to ensure the Royal Navy can support UK aims as a global maritime nation, counter current and emerging threats, working with allies and partners, with the ability to project force when required.

Recommendations

Medium term (5-15 years)

- Government will support international efforts to maintain freedom of navigation across shipping routes. Where nation states ignore rules-based International System norms, or pose threats to the freedom of navigation (such as blocking strategic international chokepoints or making excessive geographic jurisdictional claims) we will affirm the RBIS framework and requirements of international laws.
- In the changing geo-political landscape, government will monitor contraventions of UNCLOS rules, collaborating with nation states to ensure rules and requirements of international laws are adhered to.

11.5 Cyber - security of technology

The vision for 2050 in this area is:

The coming decades will herald dramatic developments in technology – particularly around automated and connected systems. There are vulnerabilities to these systems that could be exploited from a range of state and non-state actors for financial, disruptive and violent ends.

Where are we now

Supply chains and support services are underpinned by data systems and internet-based connected systems. Port and shipping operations can function independently of connected (networked) systems but are becoming increasingly reliant upon these, from the internet to space-based systems, for safe and efficient operation. Regardless, a human interface is still required. Codes of practice have been issued by government providing information on implementing and maintaining good cyber security practices on maritime vessels¹⁹⁸, at ports and for port systems¹⁹⁹. They provide a framework for operators so that cyber security can be considered as part of a holistic approach to wider risk management.

¹⁹⁸ <https://www.gov.uk/government/publications/ship-security-cyber-security-code-of-practice>

¹⁹⁹ <https://www.gov.uk/government/publications/ports-and-port-systems-cyber-security-code-of-practice>

The Network and Information Systems (NIS) Directive applies to operators of essential services, compelling them to consider their security requirements and take appropriate and proportionate technical and organisational measures to manage the risks posed to such systems, with the aim of preventing and/or minimising the impact of any incident(s). Cyber security is also being built into ship safety by 2021 with the inclusion of cyber risk management in the IMO's International Safety Management code.

Cyber Security

In June 2017 the world's largest container shipping business A.P. Moller Maersk was the victim of a cyber-attack caused by the NotPetya ransomware.

The malware **affected** its global network and shut down the shipping company, forcing it to halt operations at 76 port terminals around the world, costing a reported USD 200-300 million.

The Maersk attack demonstrated the vulnerabilities of connected systems to cyber-attack. The UK's transport sector aims to remain safe, secure and resilient in the face of cyber threats, and able to thrive in an increasingly interconnected, digital world.

This will be achieved by:

- Understanding the cyber threat and the vulnerabilities for the transport sector.
- Mitigating cyber risks and taking appropriate action to protect key assets.
- Responding to cyber incidents effectively and ensuring that lessons are learnt.
- Promoting cultural change, raising awareness and building cyber capability.

DfT has set-up a dedicated Cyber Security Team which has a remit to consider the cyber security aspects within the UK transport industry. DfT also works closely with the National Cyber Security Centre (NCSC) on cyber security for key assets within the UK. The NCSC is able to provide technical guidance and advice to ports on cyber security.

While the onus is for industry to ensure their systems are suitably protected against a cyber-attack and that a robust risk assessment is undertaken, government will play a supporting role in the provision of advice and guidance.

Where we are going

Critical national infrastructure in the UK may become increasingly vulnerable to remote attack, particularly from cyberspace. The coming decades will herald dramatic developments in technology – particularly around automated and connected systems. There are potential vulnerabilities to these systems that could be exploited by a range of state and non-state actors for financial, disruptive and violent ends.

The security challenges associated with information and infrastructure are likely to be significant in 2050, with anticipated growth in the scope, frequency and impact of cyber-attacks. While the scale cannot be predicted, computers and networks will continue to be compromised, either by delivering malicious software to penetrate and damage information systems, or by corrupting the electronic component supply chain. The rate of change in technological fields, such as autonomous and connected systems, is likely to be particularly dramatic for shipping and port operations alike, requiring them to keep pace with potential security threats and to implement protective measures.

How we get there

Change will be dramatic and fast-paced – this will require a concerted effort by government and industry to ensure regulations and guidance keep up, and that there is a workforce with the necessary skills to lead the development of these systems and their security. Building on the UK's existing reputation, we should position ourselves to lead in the development of appropriate standards, regulations and guidance.

The UK will be recognised as a centre of excellence for the provision of maritime cyber security

solutions. This will be delivered in partnership: private industry has responsibility for protecting themselves and ensuring resilience to cyber threats across the supply chain but with support from

government. Government will assist through technical expertise in the form of threat and risk assessments, as well as the provision of regulation and guidance. Government will be supported by the National Cyber Security Centre and work closely with industry, sharing real world experiences to inform policy decisions.



Recommendations

Short term (1-5 years)

- It is unlikely that every maritime organisation will have the resources to employ dedicated cyber security specialists so industry should consider exploring models that could provide the maritime industry with cyber support services more effectively.
- Government will continue its approach to assessing cyber threats through the National Cyber Security Centre and closely liaise with industry to warn, inform and advise of such threats.

Medium term (5-15 years)

- The UK will lead in the development of regulation for the security of automated vessels and connected systems.
- In a future where the use of autonomous vessels and connected systems are progressively used, government will provide cyber security advice to industry to warn, inform, and advise on threats.

11.6 Terrorism

The vision for 2050 in this area is:

With terrorism still present in 2050, the UK will continue to keep an ever vigilant watch on risks and threats. Best use will be made of intelligence gathered through the whole-of-government approach in the UK and through international partners. Regulation will be applied proportionately and technology developed as threats evolve and to keep pace and counter any changes to attack methodologies of terrorist actors. Government will work in lock-step with industry to deliver effective mitigation solutions.

Where are we now

The threat from international terrorism to the UK, our allies and our interests persists. Chaotic and poorly governed conflict zones are breeding grounds for terrorism and safe places for terrorist groups to operate. This may involve attacks on vessels where areas and groups are in close proximity to shipping lanes. The International Ship and Port Facility Security code serves to mitigate the threat of maritime terrorism by requiring industry to take steps to mitigate the risk of attack. The response to, and assessment of, terrorism involves cooperation and coordination from multiple government departments and agencies as well as from international partners and industry. Attack methodologies vary in range from coordinated and sophisticated attack

methods, to simple “lone wolf” attacks using bladed weapons or vehicles in crowded spaces.

Where we are going

It is highly likely that terrorism will continue to threaten the security of the UK, our allies and our interests for the foreseeable future. There will still be safe places for such groups to operate in, most likely in conflict zones and failed states. The internet will continue to provide a platform for terrorists to communicate, recruit and direct action. Attack methodologies are likely to evolve as new vulnerabilities are discovered by terrorist actors and exploited.

Technology is likely to be utilised by terrorist groups to facilitate attacks – this may involve use of drone technology for example. Coordination of multiple agencies, domestic and international, will continue to disrupt and deter terrorist groups and actors. Close cooperation with maritime industry is essential to implement the most effective mitigations. Capacity will need to be developed in those countries where terrorist groups operate, or may operate due to weak governance or other vulnerabilities.

How we get there

The UK will ensure regulations and standards keep pace with the threat in a proportional manner – continuing to be informed by assessments of the risk by government and international partners. Working with the IMO, other institutions, and bi-laterally with specific countries, we will ensure compliance and the development of regulations and standards to counter terrorism.

Investment in developing technology to assist in the identification of prohibited items and terrorist individuals in the maritime domain, will be needed. In this, a whole-of-government approach is required - from the identification and assessment of threat and related mitigation options, delivered by industry to the pursuit of domestic and foreign-based terrorists by the police, intelligence agencies and our armed forces. Government will work closely with other countries to improve their counter-terrorism capability in the maritime domain, especially those where there are British interests.

Recommendations

Short term (1-5 years)

- UK will continue to be alive to evolving terrorist threats – in both their identification and the mitigation options required – working closely with industry to deliver solutions.
- Our policy and inspection regimes continue to ensure that UK ports, and those of the Overseas Territories, are compliant with the current legislation and responsive to current and emerging threats.

- The UK will maintain highly effective operational counter-terrorist capabilities in policing, intelligence, and defence so that terrorist actors will have no safe place to operate.
- The UK supports the development of security regimes at foreign ports through a targeted programme of partnerships to deliver security capacity development.

Medium term (5-15 years)

- Overseas, government expects to continue to develop capacity within the most vulnerable states and assess the risks to tackle instability and prevent terrorist groups operating in safe places.

11.7 Maritime crime and piracy

The vision for 2050 in this area is:

With changes in the climate, economic vulnerabilities and poor governance likely to affect fragile nations the likelihood of further failed and poorly governed states is likely to increase over the coming decades. Such environments are fertile breeding grounds for organising criminality, piracy and terrorism – this will continue to challenge shipping where these areas meet major shipping areas.

Where are we now

Piracy is an ongoing issue globally with particular hotspots in the Gulf of Guinea, Indian Ocean, Strait of Malacca, and Sulu and Celebes seas. A coalition of nations including EUNAVFOR, provides naval assets to police the Indian Ocean and deter piracy. Industry has developed specific guidance for ship owners to mitigate against the threat of piracy and wider maritime security threats. Armed guards are used on merchant ships as a deterrent to pirate groups in restricted areas²⁰⁰. The government works closely with UK and Red Ensign Group industry members to warn and inform of current piracy and maritime security threats.

Capacity building initiatives are underway, led by the FCO, to build capability (legislative and law enforcement) to tackle the problem of piracy and other maritime crime around the globe. The provision of aid to build economic development seeks to tackle the root causes of (crime and also) piracy.

²⁰⁰ <https://www.gov.uk/government/publications/interim-guidance-to-uk-flagged-shipping-on-the-use-of-armed-guards-to-defend-against-the-threat-of-piracy-in-exceptional-circumstances>

Where we are going

The global nature of maritime trade traffic will continue to be exploited by criminal groups – for example, smuggling of goods and people. The increased use of connected systems will present an opportunity for criminal actors to interfere with and steal goods or data. Stronger international laws and agreements will allow us to prosecute individuals regardless of the jurisdiction the activity takes place in, while technological development will allow us to monitor areas of concern across the globe.

With changes in the climate, economic vulnerabilities and poor governance likely to affect fragile nations, the likelihood of further failed and poorly governed states is likely to increase over the coming decades. Such environments are fertile breeding grounds for organising criminality, piracy and terrorism – this will continue to challenge shipping where these areas meet major shipping routes.

The response to maritime crime and terrorism will require a whole-of-government approach as well as significant international cooperation to assist with capacity development of the most vulnerable nations and naval task forces, where appropriate and affecting international shipping lanes.



How we get there

The UK will continue engagement with overseas law enforcement agencies – including in new areas/states where we do not have agreements in place - in order to advance cooperation and exchange of information. We will continue to work closely with industry to ensure they have the correct regulations, guidance, standards and procedures to mitigate the risk posed by piracy and maritime criminal actors, as tactics evolve and geographic regions change.

Recommendations

Short term (1-5 years)

- Government will continue engagement with foreign partners to improve law enforcement and legislative capability and capacity in those areas that suffer from organised criminality and piracy. Interim measures, like the use of armed guards and naval engagement, will continue and we will remain alive to changes in the locality of threats as well as methodologies of such groups.

ANNEX 1

Maritime 2050 recommendations

UK competitive advantage

Fiscal competitiveness

Short term (1-5 years)

- Government and industry to work together to ensure we have the best possible fiscal regime in place, including through taxation and the business environment.
- Government and industry to better promote the existing fiscal regime and to engage directly with both SMEs and international maritime companies.

The UK's maritime cluster

Short term (1-5 years)

- The UK, as host of the IMO, will seek to maximise our leadership role in the organisation.
- Government and industry to work together to maintain and enhance the attractiveness of the UK's regional maritime clusters and London as a global maritime professional services cluster.
- Government will support, enhance and promote the strength of all regional clusters in the UK, and their importance to the economy.
- Strengthen the ties between government, industry, and academia to build on

existing cluster success and identify new opportunities.

Thought leadership

Short term (1-5 years)

- Strengthen the UK profile as the place for maritime thought leadership through government and industry hosting top academic maritime conferences and shipping events.
- Maximise our leadership role in the IMO and other international bodies through continued and enhanced thought leadership.
- Invite leading figures from the UK maritime academic sector to work with government, industry and social partners to create a blueprint for future maritime thought leadership collaboration, including cluster success.
- To ensure that the most innovative companies and ideas are brought to market for the benefit of UK maritime, government will explore further opportunities to continue to support maritime innovation.

Strong partnership

Short term (1-5 years)

- Government and the maritime sector will put in

place the most appropriate mechanisms for the delivery of Maritime 2050 and its route maps.

- Government will continue to support Maritime UK and its international impact.
- Government will seek to increase its direct interaction with UK maritime companies including both SMEs and large globally successful organisations.
- Government and industry will review the governance structures supporting the UK maritime sector and consider potential rationalisation.

A modern approach to UK regulation

Short term (1-5 years)

- Government will develop proposals for a new Merchant Shipping Act 1995, in the next 5 years.
- Government will consider if the existing secondary regulatory regime is fit for purpose on an ongoing basis and explore opportunities to reduce burdens to business.
- Government will play a leading role in setting an appropriate and proportionate global maritime legislative regime through the IMO and other international bodies.

- The MCA is the leading government agency responsible for the development of, implementation of and enforcement of key elements of UK maritime legislation. The Agency will not compromise its safety principles but continue to recognise the need for proportionality and commercial delivery.

Safety

Short term (1-5 years)

- Government will ensure the UK continues to provide a significant contribution to the development of international frameworks on safety measures through the IMO organisations.
- Government will continue to support the GLAs in safeguarding shipping and seafarers, and encourage further improvements at international level through IALA.
- Government will develop a Safety Action Plan to explain what it is doing to improve safety, highlighting future actions and priorities.
- Government will continue to develop Maritime Safety Week in partnership with industry and other stakeholders, celebrating the work already underway, and encouraging innovation and sharing of best practice.
- Government will provide a significant contribution to the

IMO's working groups on the development of a Universal Maritime Data Model.

Medium term (5-15 years)

- Government will support industry to further develop and expand the HiLo system.
- Government will review its mariner training and certification regimes to ensure they are fit for purpose and reflect the realities of roles on modern ships whilst maintaining a basis in traditional mariner skills and facilitating continuous improvement.
- Government will continue to support the GLAs to research innovative e-Navigation solutions and improve resilience where possible, as well as working in the IMO to ensure that regulatory requirements, guidelines and training regimes recognise developments and are continuously improved.

Long term (15 years and beyond)

- Government will consider either through the creation of a body, similar to RSSB, or utilising existing maritime agencies, a dedicated focus can be brought to researching accident precursors, driving continuous improvement and applying lessons learned from other sectors, to safety performance.

UK flag

Short term (1 –5 years)

- The UKSR will keep under constant review the capability and services it needs to provide a high-quality customer service.
- The UKSR will put in place a communications and marketing strategy to increase its promotion globally and attract companies to the UK flag.
- The UKSR will develop a 'horizon scanning' capability working with the government and maritime sector as appropriate. This will anticipate and lead the way in implementing changes in registration and in the global shipping fleet.

Long term (15 years and beyond)

- Through the MCA, the UK will lead the way in any future changes to the way in which the global shipping fleet is surveyed and inspected and future flag state responsibilities

Technology

Future of shipping

Short term (1 –5 years)

- Government and industry will deliver three flagship projects, developing technological proofs of concept and provide demonstrations of use cases for smart shipping.

Medium term (5-15 years)

- The UK will legislate for a domestic framework for autonomous vessels to attract international business and allow testing in UK's territorial waters.
- Government will lead efforts to establish a new proactive and adaptive international regulatory framework for autonomous vessels at the IMO.

Long term (15 years and beyond)

- Government and industry to work together to achieve the first multi-modal autonomous freight movement through a UK port.

Smart ports

Short term (1 –5 years)

- Industry and government collaboration to find use cases and develop proof of concepts for new and existing technologies.
- Government will work with industry to develop a 'Maritime Innovation Hub' in a UK port as a result of an open competitive process. The hub will bring together expertise, support technology development, and boost regional productivity.

Medium term (5-15 years)

- The UK will consider the need to establish the maritime equivalent of the Aerospace Technology Institute to help

commercialise British R&D in the maritime sector or how to ensure the functions that the ATI perform are captured in existing maritime bodies.

- Building upon expertise gained through developing UK's existing Maritime Innovation Hub, develop a network of regional R&D clusters based in UK ports.

Digitalisation

Short term (1 –5 years)

- Government will work with industry to understand the benefits to the maritime sector of innovative new technologies and government's role in supporting their development and use.

Medium term (5-15 years)

- UK will achieve full paperless governance of the maritime sector in the UK by 2030, including creating a fully-digital UK Ship Register by 2025.
- Government will put in place regulations and standards to ensure open data through systems like blockchain, allowing transparency, competition, and improved efficiency.

Long term (15 years and beyond)

- Through to 2050, the UK will lead efforts to set international standards at the IMO for digital technologies in the maritime sector to ensure interoperability.

Communication, navigation, and exploration

Short term (1-5 years)

- Government will commission a study into the potential for 'Future Navigation', understanding what information the sector requires and UK capabilities to provide it.
- UK to commence charting its own seabed and EEZ seabed using autonomous vessels to understand the potential economic benefits of the seafloor.

Medium term (5-15 years)

- Working together, government and industry will link existing UK space manufacturing and R&D capabilities to the maritime sector, considering how relevant technologies and facilities can be used to unlock cross-sector potential.

Long term (15 years and beyond)

- UK will be at the forefront of international efforts to chart the international seabed area, helping us to understand how to sustainably manage and benefit from the global ocean environment and creating exportable hard technology and soft skills.

People

Maritime workforce

Short term (1-5 years)

- Ensure the UK tonnage tax regime has a training element which continues to support UK maritime workforce ambitions while also supporting growth of the UK tonnage tax regime.
- Raise awareness of the maritime sector in schools by having a single industry body overseeing a more coordinated cross-sector in-school awareness and ambassador programme.
- Task a single industry body for bringing greater coherence and coordination to the promotion of maritime careers sector wide.

Medium term (5-15 years)

- Ensure there is greater harmonisation of certification standards within the UK for different maritime sectors.
- Put in place a clear and universally supported careers promotion plan that achieves an outcome of UK employees being listed in the top five maritime nations' listings.

Diversity in the maritime workforce

Short term (1-5 years)

- Government will fund the production of the 'people like me' maritime industry project to help address the image and perception of the industry and demonstrate how we can effectively showcase its value to a wider diversity of people.

- Joint delivery between government and industry of the Women in Maritime Charter.
- Widening the scope of the Women in Maritime Taskforce to consider diversity as a whole, including undertaking a short study assessing the diversity data of trainees across the UK maritime sector.

policy and regulatory direction needed to support further roll out of UK maritime training institutions/programmes overseas.

- UK will develop cutting edge seafarer training maximising the use of future technologies such as virtual reality and augmented reality.

Maritime skills and promotion

Short term (1-5 years)

- Government will support Royal Navy efforts to enhance training facilities and delivery, developing assured and accredited maritime training centres which will use their capacity to support the training of all maritime enterprise skills.
- Government will introduce appropriate regulatory changes to realise the benefits of new technologies to seafarer training.
- Government aims to establish a Maritime Skills Commission bringing existing leading maritime skills experts together, to report on the existing and future skills needs of the industry on a 5-yearly cycle, to inform the maritime training curriculum and keep it up to date with the evolving needs of the sector.

Medium term (5-15 years)

- Government to increase UK global influence on seafarer training by providing the

Long term (15 years and beyond)

- Through to 2050, the UK to play a leading role at IMO and ILO, in setting the global framework for maritime training and skills, and positioning the UK as the world leader.

Need for continuous education and training

Short term (1-5 years)

- The Maritime Skills Commission will be tasked with overseeing the identification of opportunities for the UK maritime sector to access reskilling programmes, ensuring the workforce can take advantage of a wide range of initiatives.
- Government, industry, and academia to jointly establish an internet connectivity working group to identify action needed to drive internet connectivity at sea in support of social care and continuous education.

Medium term (5-15 years)

- The Maritime Skills Commission will, working with maritime training bodies, consider how to ensure professional development plans are built into training programmes across all roles so trainees know from the outset the routes available to them and the qualifications needed.

Considering the human in the face of technological change

Short term (1-5 years)

- Develop a social framework that lays out UK expectations for the welfare of the UK maritime workforce.
- Government and industry to push for worldwide recognition and standardisation of seafarer ID cards through the ILO.
- Government to introduce a National Minimum Wage for all seafarers working in the UK territorial waters, affording them the same protection as land-based workers.
- Government and industry to produce mental healthcare guidelines and develop mental resilience testing for seafarers.

Medium term (5-15 years)

- Push for a limit on hours per shift through IMO and ILO to combat seafarer fatigue.

Long term (15 years and beyond)

- The UK will lead on exploring opportunities to encourage greater cooperation between the ILO and IMO on seafarer welfare issues.
- Lead the way in addressing modern day slavery concerns within the industry with the aim of eradicating it.

Environment

Towards zero emission shipping

Short term (1-5 years)

Existing commitments

- In line with proposals in the UK Clean Air Strategy:
 - Major ports will publish Port Air Quality Strategies in summer 2019. Government will produce guidance for ports on this.
 - Government will publish consultations on the extension of SO_x and NO_x ECAs around the UK, and a call for evidence to explore options for standardising environmental regulations for vessels operating domestically with the UK, including inland waterways.
 - Government will publish the UK Clean Maritime Plan by spring 2019.
- Government will continue to actively participate at the IMO, working with industry and other key stakeholders, to support the smooth transition to new environmental standards.

New proposals

- 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.
- Government will consider options to promote the UK flag as the flag of first choice for vessels adopting low or zero emission technologies.
- 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.
- 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.
- Government will assess how economic instruments could support the transition to zero emission shipping in the medium to long term.
- 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.
- 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 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.
- 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 work in partnership with the British banking sector to encourage the provision of finance

towards zero emission shipping technology development and manufacturing.

- Government will review the environmental and economic case for coastal shipping, and whether the government should play a greater role in encouraging modal shift.

Medium term (5-15 years)

- 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:
 - A group of hydrogen or ammonia powered domestic vessels in operation
 - 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).
- Government will work to ensure maritime GHG 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.

- 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.

- 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.

Long term (15 years and beyond)

- 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.
- 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.

Minimising wider environmental impacts

Short term (1-5 years)

- Government will ratify international conventions which reduce the environmental impact of maritime including the Ballast Water Management and Hong Kong Conventions.
- UK will continue to advocate for the designation of scientifically-based spatial management measures, provided for under international law, to protect the most vulnerable environments, for example, around Antarctica.
- Government will work to bring the UK's penalty structures into line with international best practice to ensure we effectively tackle ships which break the law. This could include a wider range of sanctions including "on-the-spot" fines.
- Government will apply a new ship recycling regime from 1 January 2019, and work with industry to improve compliance. By 2023, conduct a post implementation review to assess how effective the new regime has been in improving the sustainability of end of life shipping.
- Government will cooperate with other States in the development and application of new technologies (e.g. remote sensing, fuel

sampling kits, use of drones, airborne sensors), which could be used to help industry and streamline enforcement arrangements.

Medium term (5-15 years)

- Government will work with our Overseas Territories to ensure there is a consistently firm approach to tackling maritime pollution across British waters.
- UK will play a leading role in international discussions to promote consideration of market-based solutions for wider (non-air emission) environmental issues.
- Government will consider further alignment between the UK regime for ship recycling with the Hong Kong Convention, and whether any further measures are needed to discourage non-compliance.

Adapting successfully to the impacts of climate change

Short term (1-5 years)

- Government will work with ports to review their understanding and implementation of climate change adaptation measures, and encourage periodic reporting on preparedness through the adaptation reporting power.
- Government will work on the international stage to ensure effective governance and environmental protections are in place to regulate ships

operating in Arctic waters as they become more accessible.

Achieving our goals through continued international leadership

Short term (1-5 years)

- UK will continue to maintain an active presence in developing the global maritime environmental regulatory framework at the IMO, ensuring that the UK ratifies international environmental conventions to which we are a signatory, in particular the Ship Recycling Convention and Ballast Water Conventions.
- UK will ensure that there is meaningful progress at the IMO GHG negotiations to take forward an action plan and pursue early implementation of specific Short term measures ahead of 2023, and progress work on mid and longer-term measures to meet the targets in the Initial IMO Strategy.
- UK will take advantage of its experience on carbon pricing and market-based measures from other sectors. We will work hard to achieve this at a global level through the IMO but if progress isn't sufficiently rapid, we will need to consider options for taking additional steps with other like-minded partners.
- UK will play a leading role in the development of an

action plan at the IMO on marine litter and plastics.

- UK will continue to use its influence across international and regional bodies to enhance the conservation and sustainable use of ocean resources, such as the suppression of illegal, unreported and unregulated (IUU) fishing and the development of appropriate frameworks to manage deep sea mining and biodiversity beyond national jurisdiction (BBNJ).

Medium term (5-15 years)

- UK will promote the establishment of an objective and globally recognised body of evidence in the field of shipping emissions as an important step towards monitoring progress and assessing solutions towards the temperature goals of the Paris Agreement on climate change.
- By 2030, in line with the UN Sustainable Development Goal 14, the UK will have supported the poorest and most vulnerable countries, in particular Small Island Developing States (SIDS) and Least developed Countries (LDCs), to pursue wider benefits from growth in zero emission shipping, and will encourage other countries major economies to do likewise

Long term (15 years and beyond)

- UK will push for a significant and sustained global increase in investment for new infrastructure, capacity building and technical co-operation for the poorest countries and those most affected by climate change (in particular LDCs and SIDS) for effective global implementation of the IMO Initial Strategy on the Reduction of Greenhouse Gases from Shipping.

Trade

Supply and demand

Short term (1-5 years)

- Government has already committed to helping create a network of Export Champions across the UK who offer expertise and guidance to support other companies on their exporting journey. This initiative will be fully supported and implemented in the near term.

Global rules-based trading framework

Short term (1-5 years)

- Government will seek opportunities to pursue an ever more ambitious free trade agenda with the rest of the world, while ensuring continuity of existing EU third country free trade agreements to maintain their benefits and provide certainty to businesses.

Medium term (5-15 years)

- Government will develop new free trade agreements with like-minded countries – with a view to opening up trading opportunities and new markets

Long term (15 years and beyond)

- Government will pursue strategic development of a transparent and fair regulatory playing field through the IMO and the ILO to enable trade to continue to grow.
- The UK will maximise its trade opportunities globally and across all countries by boosting trading relationships with old friends and new allies.
- Government will continue to pursue economic prosperity for the UK and lead by example through its liberal economy and pursuit of free trade. Government will work towards developing, supporting and enforcing a fair and proportionate rules-based system for trade, domestically and internationally.

Competition in a globalised world

Short term (1-5 years)

- Government will work with the maritime services industry, to commission and deliver a study into the competitiveness of the sector.
- Government will engage with the ports and the manufacturing industry to

consider the case for free ports in the UK.

New technology and future modes of transportation

Short term (1-5 years)

- UK will partner with like-minded nations to coordinate mutual understanding of how to successfully develop the services and technology necessary for safe, secure, environmentally sound and reliable Arctic maritime activity in order to maximise mutual benefit from new shipping routes.

Trade promotion

Medium term (5-15 years)

- Government will comprehensively consult with industry on the direction of UK trade policy, how it can best serve the maritime sector, and the mechanisms for involving them during negotiations
- Government will collaborate closely with industry to increase UK exports, as a proportion of the UK's GDP from 30% to 35%, supporting the maritime sector in its role as a key facilitator of trade.

Infrastructure

Ports and harbour infrastructure

Short term (1-5 years)

- Government will monitor the availability of funding to

ports through commercial lending, identifying any market failures and developing plans to address these, together with the ports.

- Government will review Port Master Plans Guidance, identifying opportunities to better support the sector across planning, environmental and connectivity issues.
- Government will consider renewing the National Policy Statement for ports, to provide additional support if needed.
- Government will implement a targeted programme of Port Economic Partnerships, for ports meeting specific scheme and success criteria, leveraging the maximum benefits from both government and industry investments.

Medium term (5-15 years)

- Government will explore the feasibility of new infrastructure models (e.g. floating offshore ports) to support ambitious future development, and ensure these are responsive to land use and transport network challenges.
- Government will create an environment conducive to the testing and researching of all technologies that would enhance our maritime

infrastructure, initially holding a competition for ports to bid to be designated the UK 'National Port for innovation and testing'.

Long term (15 years and beyond)

- By 2050, government anticipates that all commercially available land around UK ports will be in use or have a clear plan for future use.
- The maritime sector will explore, within the framework provided by government, the business opportunities for greater confluence of transport modes to help drive cost effectiveness and time efficiency.

Port connectivity, the supply chain, and logistics

Short term (1-5 years)

- Government expects full implementation of the Port Connectivity Study recommendations in the short term.
- Building on UKMPG's "Dragons den", DfT will host jointly with industry, an annual seminar bringing together key stakeholders in the maritime and technology sectors to showcase best practice.
- Government will support the work of industry, including the BPA, UKMPG and Maritime UK as they

produce their visions of the future.

- Government will continue to consider the needs of the maritime sector as part of rail and road infrastructure funding to support the onward transportation of freight and passengers from maritime infrastructure.
- Government anticipates the maritime sector will continue investing to integrate and provide added value to the wider supply chain and associated industries.

Medium term (5-15 years)

- Industry, with government support aims to explore the wider benefits of port centric development and, if backed by evidence, government will publish a policy statement indicating a presumption of support for such developments, consistent with the National Policy Statement for Ports.

Long term (15 years and beyond)

- If future congestion levels impact on freight movements despite infrastructure investment, the UK will explore the evidence base for a system of dedicated freight routes for the import and export of goods.

Sectoral infrastructure

Short term (1-5 years)

- The maritime sector, with government support where appropriate, will identify and explore opportunities for the development of new and existing markets.
- The maritime sector, including ports, will actively engage the energy sector to understand the primary (generation) and secondary (manufacturing, servicing and storage) market needs, promote collaboration and identify new market opportunities.
- Industry will identify specific barriers to ports serving the energy sector and jointly with government, will actively develop and propose solutions.
- Government will explore with the maritime and marine leisure sectors where barriers to development exist and to identify opportunities to grow the sector.
- Government and the cruise and ferry sectors will have increased interaction, to better understand concerns and any barriers to growth.
- Government will support industry to proactively seek opportunities for maritime infrastructure to access existing innovation programmes and funds, making the case for

inclusion commensurate with the economic profile of the maritime sector.

- Government will meet its maritime accessibility responsibilities through correct implementation of the passenger rights legislation and the delivery of the Inclusive Transport Strategy.

Medium term (5-15 years)

- Government expect ports and the wider maritime sector to build on current successes in working with developers to secure contracts for offshore work, competing on a global scale.
- Government expects to lead on attracting new subsea communications cables to the UK.
- Government expects to take an active role in the development of increased resilience in subsea infrastructure.

Long term (15 years and beyond)

- The ambition is for the UK to enhance international relationships on subsea cable infrastructure by collaborating with global partners and adopting best practice.

Ship building and boat building

Short term (1-5 years)

- Government will continue to look for appropriate means of support for SME's to export, attend tradeshows and explore opportunities to enhance their impact in the boat and shipbuilding sectors.
- Government will work with the leisure, superyacht and small commercial marine industry to ensure their needs are factored into the strategic growth agenda for the maritime sector, in the context of government's Industrial Strategy.
- Government will work with industry to review and understand any issues which might prevent UK businesses and ship builders from being competitive in bids for UK-based contracts. And if necessary, look for options to provide appropriate support.
- Government expects the UK ship building sector to maximise its flexibility to be able to respond to openings in niche markets, such as a rise in short-sea or coastal shipping, and the opportunities this may bring in a changing market.
- Government will work to enhance its strong relationship with key ship yards, and augment this with major fleet owners and operators of high value vessels to better share, sell and export UK expertise.
- Working in collaboration with government, we expect industry to focus action and capability development on specific, targeted markets to achieve world leader status and look for greater opportunities to export.

Medium term (5-15 years)

- Government expects industry to utilise existing centres of excellence and where necessary develop new centres focused on specific areas of ship and boat building, and marine engineering in order to maximise international competitiveness,

Long term (15 years and beyond)

- Government and industry will work towards successful implementation of the National Shipbuilding Strategy.
- Government aspires to support the Maritime Enterprise Working Group to raise productivity and secure a sustainable and globally successful UK ship and boat

building, and marine engineering sectors.

Shipping in the supply chain

Short term (1-5 years)

- UK ports will maintain their attractiveness for vessel calls on global shipping routes and the effectiveness of UK maritime infrastructure through continued investment, in step with improvements in technology and vessel types.

Medium term (5-15 years)

- The expectation is that shipping companies, particularly those involved in short-sea and coastal shipping markets, will adopt technology developments that can increase their competitiveness versus land-based freight modes.

Long term (15 years and beyond)

- The ambition is for smaller ports to also embrace technological changes in shipping, and invest to take advantage of viable alternatives to land-based transport.

Security and resilience

Overall recommendations

Short term (1-5 years)

- Government will lead on the assessment of risk, analysis and emergence of new threats to shipping and port

operations in the global shipping sphere.

- Government will improve the processes to address security threats and target methodologies to implement proportionate mitigations to new tactics as needed.
- The UK will broaden our already strong alliances, both diplomatic and military, to maintain and build consensus for an open and stable maritime domain.

Medium term (5-15 years)

- The UK will ensure that - working with the IMO, other institutions and on an inter-country basis - future development of maritime security regulations and standards aligns with potential risks and threats.

Security of UK waters – including Overseas Territories

Short term (1- 5 years)

- The defence of UK waters and those of our Overseas Territories from all threats will remain a standing commitment.
- The UK will maintain a cross government research and development programme to find innovative solutions to detect, monitor, and respond to threats and protect UK maritime interests including Overseas Territories and Crown Dependencies.
- Government will continue to maximise its use of

capabilities by securing a long term delivery plan for the NMIC and the JMOCC. We will provide world class maritime domain awareness and deliver effective asset disposition.

- Government will continue to support the rules-based international system to build and deepen our relationships with emerging global markets by strengthening alliances and building partnerships. We will encourage rational behaviour by states and support the peaceful settlement of disputes.
- Government will reflect on the changing maritime security landscape and review our approaches in coordination with future defence reviews.
- Government will maintain an exchange of intelligence with our closest partners including the US and Europe and continue NATO participation to deter and adapt to threats as the maritime security picture evolves.

Security and resilience at ports and on ships

Short term (1-5 years)

- Government will provide information to encourage and enable informed investment to protect critical port infrastructure from future hazards such as severe weather events.

- Government will work with ports to review their understanding and implementation of climate change adaptation measures and encourage periodic reporting on preparedness through the adaptation reporting power.
- To maintain and increase port throughput efficiency, government will support industry in seeking emerging technologies and systems to deliver screening of goods and people more efficiently and effectively.
- Government will assess the feasibility of undertaking a systems approach to identifying single point of failure for maritime infrastructure – that is looking “beyond the fence” to identify interdependencies of connected infrastructure, supply chains, and their levels of redundancy.
- Government will monitor investment activity in UK maritime infrastructure to protect national security against hostile actors who may wish to harm the UK.

Global shipping route security

Medium term (5-15 years)

- Government will support international efforts to maintain freedom of navigation across shipping routes. Where nation states ignore rules-based international system norms, or pose threats to the freedom of navigation (such as blocking strategic

international chokepoints or making excessive geographic jurisdictional claims) we will affirm the RBIS framework and requirements of international laws.

- In the changing geo-political landscape, government will monitor contraventions of UNCLOS rules, collaborating with nation states to ensure rules and requirements of international laws are adhered to.

Cyber - security of technology

Short term (1-5 years)

- It is unlikely that every maritime organisation will have the resources to employ dedicated cyber security specialists so industry should consider exploring models that could provide the maritime industry with cyber support services more effectively.
- Government will continue its approach to assessing cyber threats through the National Cyber Security Centre and closely liaise with industry to warn, inform and advise of such threats.

Medium term (5-15 years)

- The UK will lead in the development of regulation for the security of automated vessels and connected systems.
- In a future where the use of autonomous vessels and connected systems are

progressively used, government will provide cyber security advice to industry to warn, inform, and advise on threats.

Terrorism

Short term (1-5 years)

- UK will continue to be alive to evolving terrorist threats – in both their identification and the mitigation options required – working closely with industry to deliver solutions.
- Our policy and inspection regimes continue to ensure that UK ports, and those of the Overseas Territories, are compliant with the current legislation and responsive to current and emerging threats.
- The UK will maintain highly effective operational counter-terrorist capabilities in policing, intelligence, and defence so that terrorist actors will have no safe place to operate.
- The UK supports the development of security regimes at foreign ports through a targeted programme of partnerships to deliver security capacity development.

Medium term (5-15 years)

- Overseas, government expects to continue to develop capacity within the most vulnerable states and assess the risks to tackle instability and prevent

terrorist groups operating in safe places.

Maritime crime and piracy

Short term (1-5 years)

- Government will continue engagement with foreign partners to improve law enforcement and legislative capability and capacity in those areas that suffer from organised criminality and piracy. Interim measures, like the use of armed guards

and naval engagement, will continue and we will remain alive to changes in the locality of threats as well methodologies of such groups.

ANNEX 2

Our maritime history

Human activity upon the world's seas and oceans has had such a transformative impact upon our planet that it has reversed ecological changes wrought by the creation of the continents. Maritime activity has played a critical role in helping to globalise ideas, species, and commodities. From the time that humanity took to the seas over 100,000 years ago²⁰¹ the maritime sector has been the connective tissue in the development and advancement of our species.

The British Isles have played a critical part in this global maritime story, and the UK has a rich maritime history stretching back centuries. From ship design and construction to regulation for the safe operation of ships at sea, the UK has been at the forefront of establishing the framework of the global maritime sector as it exists today.

Throughout our nation's maritime past, the only constant has been change, and the story of maritime is the story of constantly shifting environments (be they natural, legal, commercial, political). This section illustrates a number of major trends evident throughout the history of maritime, and which – in their modern forms – continue to characterise the sector today. Maritime 2050 is the government's answer to how the sector can continue to adapt and grow in light of these trends.

Technological development

Since the early days of shipbuilding, new designs, materials, and propulsion methods have constantly been invented to make ships faster, safer, and able to carry more cargo. Advances in shipbuilding opened up the world, eliminated distance, saved time, and generated new economic possibilities to those trading by sea.

In 1497 the explorer John Cabot (Giovanni Caboto) took three months to sail from Bristol to the north American coast. The First Fleet left in May 1787 and took the best part of a year (252 days) to arrive in January 1788 at the new penal colony. In 1885, the former tea clipper *Cutty Sark*, one of the last and greatest commercial sailing ships, made the journey from Australia to London in 73 days. In 1936 the RMS *Queen Mary*, on her maiden voyage, took six days to sail from Southampton to New York.

Technological shifts in the maritime sector were, for many centuries, relatively slow. Sailing ships ruled the seas for centuries, with three-masted ship designs making transatlantic voyages possible by the 15th century. Whilst pioneering vessels such as Isambard Kingdom Brunel's *SS Great Britain* began to appear as early as the 1840s, it was only in the 1860s that steam

²⁰¹ <https://news.nationalgeographic.com/news/2010/02/100217-crete-primitive-humans-mariners-seafarers-mediterranean-sea/>

power began to predominate. For decades thereafter although steam engines became commonplace, ship designs continued to include masts for sails. Though steam power soon became widespread, it was relatively short-lived; its demise in favour of fuel oil was facilitated by the Royal Navy. The then largest maritime fighting force in the world switched from coal to oil propulsion for its fleet in 1912. Today, over a century later, fuel oil continues to power the overwhelming majority of ships in the global fleet.

Another major technological shift was in navigational methods. Much like sailing ships, the fundamentals of navigational methods were in place in the Middle Ages. Britain played a key role in improving navigation at sea, passing the Longitude Act in 1714 to offer a substantial financial reward for accurately establishing longitude. The prize money was belatedly awarded in 1773 to a Lincolnshire clockmaker, John Harrison, for developing an accurate marine chronometer allowing sailors to know with a high degree of accuracy their position at any given time.

The purpose of Captain Cook's first voyage in 1768 was to chart the transit of Venus across the Sun. Cook's voyages in Europe's 'Age of Discovery' (15th to 17th centuries) encapsulate the combination of scientific curiosity and military power, responsible for numerous Western nautical developments, as the Royal Navy sought better knowledge of sea craft in order to dominate the world's oceans.

It would be over a century before radio communications were used on board vessels, with wireless telegraphs first appearing on ships in the late nineteenth century. These systems enabled ships to communicate with each other and with shore, improving navigational safety. Technological change in the maritime sector has been constant, but often slow and uneven. In the future, new ship designs, the availability and cost of new technologies, and new demands upon the global fleet will invariably affect construction methods, propulsion methods, and navigational safety measures.

New routes

The story of the UK's maritime sector is the story of searching for and adapting to new opportunities. Social, economic, and political shifts have driven and been driven by maritime trade.

In the 18th Century, growing demand for luxury goods in Britain made commodities such as sugar, tea, and spices, popular and valuable. At the same time, Britain's industrial revolution saw a huge boom in manufactured goods and growing demand for the fuel for industry: cloth from the mills of Manchester and Dundee, steel from Sheffield, armaments from Birmingham, and coal from the South Wales Coalfield were exported from British ports for consumers around the globe.

Lucrative 'spice routes' were opened to South-East Asia with the Dutch East India Company becoming the first modern corporation (selling shares in the company itself rather than the goods it traded). Its British counterpart became so powerful that it ruled India until it became a Crown Colony in 1857. The 'spice routes' ships headed to the East Indies facilitated the trade of a plethora of manufactured goods for raw materials and spices which shaped the geography of modern day South Asia. In 1819, Sir Stamford Raffles founded the city of Singapore as a trading post of the British East India Company.

Apart from consumer demand, where and how maritime trade was conducted was shaped by technological advances and improvements in infrastructure. The opening of the Suez Canal in 1869 vastly reduced the time of voyages from Europe to Asia, since vessels no longer had to transit around Africa and the Cape of Good Hope.

Demand and technology determined where global maritime power hubs were located, with implications that went beyond the sector. Namely, British colonial expansion around the world was partly predicated upon the strategic advantage conferred by controlling major sea lanes (and, in the age of steam, by the accessibility of coaling stations where ships could be refuelled). These broader considerations have continued to influence the sector as ship and port design, inland multi-modal connections (be they canals, rivers, railways or roads), and consumer demand have shifted the centre of global maritime trade from Europe to the Far East.

Sailing ships were inherently hindered by global wind patterns, the 'trade winds'. Steamships suffered no such penalties, meaning that ships around the world could use the same routes irrespective of the season. Steam navigation also made possible a whole range of river-based trading activities which were difficult for sailing ships.

At the same time ecological shifts have determined the location of ports and shipping routes. The City of Chester was the biggest port in northwest England until the fifteenth century when the silting of the River Dee rendered Liverpool a major port city. The 'Northwest Passage', once a nigh-impenetrable sheet of Arctic ice between the Atlantic and Pacific oceans, is now becoming a commercially viable trade route. Technology, ecology, and economy have always driven maritime trade.

Shifting cargoes

Since maritime trade began, goods have been carried in some form of container. Thousands of *amphorae* (a ceramic jug-like container first seen around 4800 BC but most commonly associated with the Romans and Ancient Greeks) have endured in shipwrecks long after timbers have rotted, making their way into many a museum display.

For centuries, commodities were shipped as 'break-bulk' – a myriad of barrels, crates, drums, bags, and boxes. Break-bulk commodities despite being costly in time and labour to load and unload dominated the global trade until the advent of the modern shipping container. The nature of these cargoes shaped ship design and port construction. The ubiquitous warehouses of London, Liverpool, and many other port towns in Britain were built to store and handle these types of goods.

Developments within cargo-handling, coupled with broader improvements in vessel speed, offered new opportunities to the inhabitants of Britain. The increasing connectedness of ports with their hinterlands, along with the spread of the railways in the nineteenth century, changed the British people's diet – with perishable goods such as fish, fruit, and vegetables easier to transport across the country than ever before.

In 1881 the clipper *Dunedin* completed the first successful shipment of refrigerated meat from Port Chalmers (in New Zealand) to London, keeping its cargo frozen for 98 days. This made the farming of lamb in New Zealand a viable economic prospect as it could now be exported to Britain, the colony's largest overseas market. Technological advances in shipping stimulated economies not just in the UK, but in its furthest-flung colonies around the world.

The most significant shift in maritime cargo-handling was the development of the standardised intermodal shipping container, whose ribbed steel sides have become a familiar sight in everyday life. Containers allowed for commodities cargoes to be parcelled together into single manageable units. First used in the late 1940s by some commercial shippers and the US Army, containers played a major role in the Vietnam war, where hundreds of thousands of Container Express (or CONEX) 'boxes' were used by the military as a way to quickly and efficiently load, unload, and store military hardware and supplies.

Containers in their current form are steel 'boxes', either twenty- or forty-foot long, pioneered by road-haulier Malcom McLean whose Sea-Land company sought to exploit the intermodal potential of the container. Whilst containers offered new opportunities for shipping, their multi-modal nature led to a decline in coastal shipping, as container-cargoes could more easily and cheaply be carried by road and rail.

Containerisation was a slow process. Strongly resisted by those working in ports, it forced the closure of or transformed many traditional ports initially built to handle bulk-break cargoes – such as London, New York, and Liverpool. Container terminals required more land and good inter-modal connections to road and rail. Many were constructed far from built-up urban centres, removing some ports from local communities altogether, reducing the visibility of the sector even as it became more efficient.

The shift to containers also revolutionised ship design and ownership, leaving the 'tramp steamer', a way of shipping designed to pick-up and drop-off cargo at multiple ports, as an inefficient, slower way to move commodities. New shipping routes between large container terminals replaced the world's tramp routes.

At the same time the movement of other commodities – dry and wet bulk cargoes, natural and petroleum gas, etc. – has been transformed by a growth in ship size that has allowed fewer, ever-larger ships to move more cargo than ever before. The desire to move ever-greater volumes has impacted upon trade routes with some ships, now too large to transit the Suez and Panama canals, returning to older routes around Cape Horn (in South America) and the Cape of Good Hope.

Noticeably, all these developments have taken place within an industrial economy largely unchanged for over a century. The adoption of new materials (such as graphene), new manufacturing techniques (additive manufacturing or 3D printing), and new economic models could transform what ships look like, what they move and where they move it to.

Labour conditions

Historically, labour conditions in the sector were harsh; characterised by isolation, violence, highly unsanitary conditions, and the threat of shipwreck. Though the numbers of employees in Britain's ports have fallen dramatically since containerisation, work was precarious and characterised by poor safety and corruption. Dockworkers in Liverpool amassed twice a day at the Mersey Dock and Harbour Board's control points (or 'pens' as they were more commonly known) in the hope of securing a day's work unloading the latest arrivals. Bribes and nepotism were often crucial to success.

Historically, training for seafarers was wholly 'on the job'; young men would join a ship and work their way up through the ranks having gained experience. Though most training remained experiential, technological advances in navigation necessitated the formal training of some seafarers in fee-paying 'navigation schools'. By the mid-nineteenth century a number of state-aided navigational schools were in operation. Britain introduced compulsory licensing for seafarers in 1851, standardising the syllabuses for seafarer training, but for the next century seafarer education remained patchy.

At the same time, medical and technological advances improved life at sea. Better understanding of the causes of ailments on board ships, particularly the discovery that scurvy resulted from vitamin C deficiency (which led to the Royal Navy stocking lemon juice on board all of its ships by 1800), improved mortality rates. Stronger steel hulls made ships more resilient and legal obligations such as compulsory inspections made ships safer to sail in -a far cry from the days of early marine insurance when ship owners would deliberately put unseaworthy ships to sea to recoup the insurance when they sank.

Employment in the maritime sector has historically been characterised by two trends – the reduction of workforces and the increase in skills required. These trends are mainly driven by the availability of new technology and cost considerations, neither of these being uniquely modern factors. In the 17th and 18th centuries the numbers of sailors in the British merchant fleet were reduced drastically to cut crew costs and lower freight rates. On transatlantic voyages in particular, crew sizes dropped between 30-40%. This trend continued with the automation of a number of ship-board processes in the 1970s.

In ports, the adoption of advanced equipment and the changes wrought by containerisation have resulted in a shift towards fewer, more highly-skilled workers operating advanced equipment, such as gantry cranes. These advances have made the global logistics system much more efficient. In Liverpool a conventional break-bulk cargo liner took 10,600 working hours to unload, compared to 500 for an 11,000-ton container ship.

From its inception, Britain has played a leading role at the IMO, hosted in London, is the UN body responsible for international regulation of the maritime sector) in developing international standards for watch keeping and certification. Seafarers today still face harsh conditions and isolation (internet connections to faraway homes remain patchy and unreliable). Despite new technologies and automation, ships and ports can be dangerous environments.

A major challenge for the maritime sector in the twenty-first century is to improve the quality of life and standards of training for seafarers, helping retain existing knowledge in the sector as jobs go through a period of transition, and to attract new and diverse talent.

Maritime business services

Alongside the growth of the maritime sector came a whole range of business services, such as insurance, finance, brokerage, and law, to support it.

Maritime insurance was one of the earliest kinds of insurance, developed in ancient Greece and Rome. Modern marine insurance emerged from the English 'law merchant' (or *Lex mercatoria*), developed in the medieval period.

In the late seventeenth century, Edward Lloyd's Tower Street coffee house in London became a hub of maritime knowledge, reflecting the city's position as the world's maritime capital. The reliable shipping news and information that could be obtained at Lloyds led it to become the world's first marine insurance market (which later became Lloyds of London). Another coffee house, the Virginia and Baltic of Threadneedle Street, led to the creation of the Baltic Exchange, a major market for trading maritime cargoes and vessels themselves, in the mid-nineteenth century.

The development of Lloyds, along with marine insurance companies and associated specialist bodies such as maritime lawyers, bankers, and

shipbrokers (those who negotiate contracts between ship owners and charterers/shippers), along with Britain's enormous merchant fleet and Navy, helped to ensure that British maritime practices became the template for the rest of the world.

Classification societies, which maintain technical standards for the construction of ships and offshore structures, also grew out of Lloyd's coffee house. Lloyd's Register, founded in 1760, was the world's first classification society publishing an annual register of ships detailing the condition of their hull and equipment (vessels were classified by letter and equipment by number with 'A1' being the highest classification awarded). Other classification societies, such as *Bureau Veritas* (founded in Antwerp in 1828), the Norwegian *Det Norske Veritas* (1864), and the Japanese *Nippon Kaiji Kyokai* (1899) emerged throughout the nineteenth and early twentieth centuries.

In 1968, the International Association of Classification Societies (IACS) was founded by seven of the leading organisations who were co-operating more closely since the Load Line Convention of 1930²⁰². Whilst there have always been a number of global classification societies, with over 50 operating today, there are measures in place to ensure that competition for business does not compromise vessel safety. In 2009, IACS introduced the Transfer of Class Agreement stating that no member would accept a ship that had not carried out improvements demanded by its previous class society.

Maritime law, or admiralty law, was first introduced to England in the twelfth century by Queen Eleanor of Aquitaine who was acting as regent for her son Richard I (more famously known as the 'Lionheart'). Admiralty courts in Britain, in operation since at least the fourteenth century, were often a source of innovative legal ideas and provisions to meet the evolution of Britain's maritime trade in the eighteenth and nineteenth centuries.

The development of maritime business services, many of which have their origins in Britain, have been characterised by the development of large numbers of parallel national or regionally-based organisations, which have slowly come to be rationalised into workable systems for an increasingly globalised world.

Conclusion

History shows that the maritime sector is no stranger to change. Facilitating global flows of trade, it also reflects the technological, strategic, economic, and ecological contexts in which it exists. New technologies, routes, cargoes, and labour conditions will all shape the sector in the decades to come. This strategy seeks to invoke that past not to rest on these achievements but to build upon and improve them. Not to look back with nostalgia, but to look forward with determination.

²⁰² This Convention sought to make societies work more closely together to apply universal safety standards.

Lessons from history

- The maritime sector is closely connected to wider global economic, environmental, social, and cultural developments and cannot be considered in isolation from them.
- The maritime sector often experiences long periods of limited or slowly evolving technological change.
- When major changes do come, they can be rapid and transformative.
- The location of global maritime hubs is often determined by a number of key factors such as the type of cargoes traded, consumer demand for particular goods, the state maritime technology, and the availability of onward links to inland transport networks.
- New types of cargo affect not only where maritime trade takes place, but how it operates, impacting upon ship design and trade routes.
- The conditions of seafarers have drastically improved over time, as safety has become enshrined in domestic and international law.
- The major trends in maritime employment are characterised by a reduction of workforces and an increase in the level of skills required for maritime jobs.
- Maritime has led the way in the development of fundamental business services, such as insurance, shipping finance, and maritime law.
- Britain has repeatedly enjoyed 'first mover advantage' from the development of new maritime business services such as insurance and classification societies.
- Maritime business services, often developed regionally or nationally, have been increasingly rationalised and standardised for international operation through bodies such as the UN within the last century.

ANNEX 3

Methodology

Maritime 2050 has been developed through a wide-ranging, extensive programme of engagement and consultation. Hundreds of organisations and individuals have had their views represented within the process. Contributions have come from inside and outside the maritime sector, and from within the UK and beyond. We have used the wealth of maritime knowledge and analysis that already exists, but we have also used cutting edge policy development techniques to challenge orthodoxy.

The first phase involved publication of a call for evidence in February 2018²⁰³. The call for evidence invited opinions on the proposed aim and objectives, as well as an initial set of six themes seen as being of fundamental importance throughout the life of the strategy: technology, trade, infrastructure, environment, people and security and resilience. The Government received over 100 responses to the call for evidence and is grateful to all those organisations and individuals who responded. Respondents included businesses, trade bodies, public sector bodies, academic or research organisations as well as charities and educators.

PA Consulting were commissioned to support the evidence gathering phase which underpinned development of the Maritime 2050 strategy. A series of stakeholder workshops were held to discuss what the long term strategy should look like, with the first set of workshops focussing on issues concerning trade, infrastructure, environment, people and security/resilience, being held in London. Alongside this, a number of workshops were held across the country specifically to gather regional views, as well as a session dedicated to the young professionals of the maritime sector. Structured interviews with senior industry professionals also took place.

A full list of the organisations and individuals who contributed to the strategy is included at Annex 5.

In line with government best practice, a ‘futures’ approach was applied to identifying the long term issues and challenges shaping the future of the UK maritime sector and to explore their implications for policy development. The Government Office for Science (GO-Science) futures toolkit²⁰⁴ was used as a resource as well as the Cabinet office policy lab²⁰⁵.

As part of the consultancy services provided by PA Consulting, a range of future world scenarios describing alternative ways the external maritime environment might develop in 2050 were produced. Using these scenarios, a ‘policy stress-

²⁰³ <https://www.gov.uk/government/consultations/maritime-2050-call-for-evidence>

²⁰⁴ <https://www.gov.uk/government/publications/futures-toolkit-for-policy-makers-and-analysts>

²⁰⁵ <https://openpolicy.blog.gov.uk/category/policy-lab/>

test' was applied to emerging recommendations, exploring how different conditions might support or constrain delivery of policy and strategy objectives. The full scenarios are described below.

Future world scenarios

Coastal Erosion – globalisation and low technology uptake

The year is 2050 and there are very high levels of equality in the world, in terms of access to goods and services, and the means to purchase them. Nations which had controlled much of the world's wealth at the start of the 21st century had at times looked like they would benefit significantly from new technologies, boosting productivity and quality of life. However, uptake was slow and lacked the critical mass of adoption required to truly transform the way people live and work.

This allowed developing economies to 'catch up' with the traditionally wealthy nations and in some cases their previous lack of investment in infrastructure meant that adopting new technologies was easier, without having to deal with the costs of scrappage schemes. Globalisation also helped, as financing was available across borders, skilled workers moved to meet market demands and sharing of data and experience meant that nations were on an increasingly level playing field.

That's not to say that there are not advancements. Where it was essential, such as in cleaning up the air in and around our cities, strong incentives or enforcement orders have played a role in driving the uptake in clean fuels. And even where it wasn't essential, there are pockets of technology changing the way things are done. Globalisation placed increasing importance on the value of data, for example the information that is now held for all the goods that enter and exit the UK has fuelled efficiencies in the way they are transported.

While air quality issues were addressed, there remains what many people consider to be too much of a reliance on fossil fuels for our energy. A greater awareness of the impact of climate change and environmental damage across the globe has encouraged a reduction in consumption. As people still want access to the global markets it is more a case of making small reductions through eliminating waste, not cutting back too much on travel or the importing and exporting of goods. Globalisation also means that, while technology uptake has been slow, organisations with popular technologies are able to export them to the global market with increasing ease. This can make it difficult to form a system that works with different technologies being knitted together as best they can, but that is a specialist skill in its own right, and also one in which the UK has a proven track record.

Digital Ocean – globalisation and high technology uptake

The year is 2050 and technology is transforming our day to day lives. Technology is shared across borders and nations are working together to solve some of the most complex challenges we face. Often this means sharing expertise, through data or talent exchange programmes, and is supported by mature finance industries which help provide the funding for further advances. The UK is a respected leader in the systems integration of global technologies. These technologies and the collaboration that brought them to us has also created a far more equal society. That said, there have been significant advances made in the countries which created an environment that supported innovation and agility. Clean maritime, and onward logistics, sophisticated distribution networks powered by vast amounts of data, and the openness to global trade has meant an incredible amount of consumer choice, be that for food produce, or manufactured goods.

This increasing volume of traffic has been met with high degrees of automation. Many of the roles of the services industry have been replaced or augmented by artificial intelligence. That has enabled growth in trade and created new roles in the shape of data scientists. Autonomous vessels are largely controlled from shore side control centres, even if a few roles remain on board. Slow fleet turnover means the industry is operating a mixed fleet, this brings complexities that regulation and policy work hard to manage. Overcrowded nations have created floating cities that are connected to the mainland while providing a very high standard of living for their residents. The use of our waters has become more and more innovative, with underwater homes being popular in some parts of the world. *Hyperloop* tunnels rest on the seabed and provide super-fast and affordable transport between centres of population and manufacturing. Combined with a society demanding significant quantities of green electricity, much of which is produced in the UK's coastal waters, the UK's maritime sector is even more diverse than it was at the start of the 21st century.

Aquacultural Revolution – localisation and high technology uptake

The year is 2050 and technology is a key factor influencing which nations and organisations prosper over others. Those that invested in the right technology and had the agility and supporting infrastructure to make them work have seen significant benefits. Aquaculture, for example, has been so successful that the UK's most important farms are now in the North Sea, not the fields and pastures of the North East. In some cases, this has freed-up valuable land near to ports, which are now more likely to be hubs of manufacturing, and 3D printing in particular, than transit points for goods in and out of the country. They are staffed by a highly skilled workforce that receives constant training through simulators, augmented reality and data-driven feedback. Some nations have created clean-fuel hubs for the refuelling of vessels. This draws ships to locations they may not otherwise have considered as stopping points. Sometimes this is nothing more than a quick *pit-stop* before continuing to their destination, but sometimes this means unloading and having their cargo redistributed from there. Countries such as the UK have used their

strategic positions, geographically speaking, to great advantage in seizing these opportunities in the Northern European market.

International organisations are playing a less significant role in global affairs, with most countries choosing to deal with global politics on an individual basis. Although the world is benefiting from new technologies, a lack of sharing is holding progress back somewhat. Sometimes this is due to political protectionism and if it isn't that it tends to be a lack of standardised systems or data that inhibits how much can be done. This in turn can narrow the number of trading partners and reinforces the preference for *localism*. These partners have become increasingly important. Not just because fewer partners means greater dependence on them, but that our imports are increasingly the niche consignments of materials we lack. It is one reason why the *circular economy* has become so important, keeping the need for imports of raw materials to a minimum.

Plain Sailing – localisation and low technology uptake

The year is 2050 and global trade is defined by well-established partnerships of great strategic importance to the nations concerned. In the lead up to 2050 countries took an increasingly inward view, focussing on addressing their own problems. Often this meant a greater focus on reacting to the impacts of global challenges. Flood defences and more resilient infrastructure was seen as the solution to rising sea-levels. Although a lack of progress addressing global challenges is a clear disappointment for the global community, nations and organisations that managed to establish strategic partnerships and make the right investments have prospered greatly. Technology is not playing as strong a role in our lives as it could have done. There are pockets of invention across the globe however the sharing of technology and data is limited. For global industries, such as maritime, this causes some problems and limits choice, stranded assets have certainly been an issue for some former companies.

Congested waterways are kept safe through the continued appropriate enforcement of rules, though these can differ from ocean to ocean and different rule-books must be followed. Choice is also an increasingly important issue in the food supply industry. In nations such as the UK, we actually have less choice in food now than we have had in the past. Increasingly scarce land for growing our own food has meant importing more and more of it. However, global instability has restricted supply at times in the past and in order to maintain food security we have gradually become more accustomed to importing our food from a smaller number of more reliable partners. At least we are eating more fish though!

We do still import fuel. However, we have also built a substantial number of wind farms and other providers of renewable energy. This has created a degree of fuel security, even if we still depend on the vital imports of some fossil fuels. Nations, including the UK, do continue to import raw materials. This is due to there being a preference for locally manufactured goods. Ports have responded to this by creating small manufacturing centres on or close to

their land, while also providing the infrastructure to help ship the goods around the country. With the UK's congested road and rail networks, and drone-delivery fleets having never taken off, short sea shipping has become increasingly popular as an environmentally friendly alternative to pushing further traffic over ground.

ANNEX 4

Maritime 2050 Expert Panel

An independent panel made up of academics, industry leaders, maritime business services providers and promotional bodies was established to offer advice and look strategically at issues of critical importance to the maritime industry to 2050. The Maritime 2050 Expert Panel was announced by the Secretary of State on 27 March 2018, to provide challenge to government and to review the development of the strategy.

Terms of reference

The members represent a wide range of views and bring a wealth of experience, and as such are well placed to lead the way for the future of the sector. They represent a variety of perspectives and are drawn from industry leaders, academics, maritime business services providers and promotional bodies.

Purpose

The panel will offer advice and look strategically at the issues that will be of critical importance to the maritime industry, and all the industries it sustains, up to 2050.

- ▶ Dual aims:
 - ▶ To review the process and final outputs, make recommendations and feed into the Maritime 2050 Project Board
 - ▶ To provide a strategic look into the future of the sector, how it will look in 2050 and propose an ideal maritime sector and how to get there
- ▶ How will this be achieved:
 - ▶ The panel will make a series of recommendations or comments at each meeting, which the Secretariat will minute and sign-off, and these will be presented to the Project Board.
 - ▶ The panel will review the final strategy document, and write a foreword/appendix to the final strategy document, detailing its position on Maritime 2050, its opinion of the final strategy and its view on the process of evidence gathering and analysis.

Panel Responsibilities

The Maritime 2050 Expert Panel has been appointed to provide challenge to government and to review the development of Maritime 2050 and its

documentation, providing recommendations and setting strategic direction where necessary. This will include:

Strategic oversight:

- Providing industry insight and strategic guidance on the vision of what the sector needs to deliver the optimum requirements for Maritime 2050;
- Reviewing work progress periodically and guiding the development of the programme as it progresses through the different work-streams.
- Providing a series of recommendations for the strategy to the DfT.
- Reviewing the final strategy document and writing a foreword/open letter as a group to be included in the final strategy document.

Practical oversight:

- Understanding the goals, objectives, and desired outcomes of the project.
- Treating discussions and material provided in the course of their duties and functions on the Expert Panel as official government business and therefore as being in-confidence.
- Giving their full commitment to delivering a positive outcome from the process, including by acting on opportunities to engage with external parties about the project.
- Actively participating in meetings through attendance, discussion, and review of minutes, papers and other Panel documents.
- Engage in communications with the media to promote the strategy where necessary as directed and cleared by the Maritime 2050 Secretariat.

Membership

- Chair: Hugh McNeal, Chief Executive, RenewableUK
- Dr Panagiotis Angeloudis, Senior Lecturer, Imperial College London
Professor David Lane, School of Engineering and Physical Sciences, Heriot Watt University
- Lucy Armstrong, Chair, Port of Tyne
- Tom Boardley, Secretary General, Cruise Lines International Association (CLIA) Europe (formerly Lloyd's Register)
- David Dingle CBE, CEO, Carnival UK (formerly Chair of Maritime UK)
- Professor Costas Grammenos CBE, DSc, Professor of Shipping Economics & Deputy Dean (UG) & Pro Vice Chancellor of PVC External Relations, CASS Business School
- Professor David Lane CBE, School of Engineering and Physical Sciences, Heriot Watt University
- Dr Grahaeme Henderson, Vice President, Shipping & Maritime, Shell International Trading and Shipping Company Limited
- Sarah Kenny, Chief Executive, BMT group

- David Loosley, Chief Executive, IMarEST (Institute of Marine Engineering, Science and Technology)
- Michael Parker, Global Head for Shipping, Logistics and Offshore Industries, Citigroup
- Neil Roberts, Lloyds Market Association (LMA)
- Martin Stopford, President, Clarkson Research

ANNEX 5

List of respondents

The following organisations responded to the Maritime 2050 call for evidence and contributed to development of the strategy.

ABB Group	Marine Enterprise Working Group
Apostleship of the Sea	Marine Society & Sea Cadets
Arup	Maritime and Coastguard Agency
Associated British Ports	Maritime London
ASV Global	Maritime Skills Alliance
BAE Systems Maritime	Maritime UK
BEIS	Maritime Volunteer Service
Belfast Harbour Commissioners	MDS Transmodal
Belfast Shipping Agents Association	Menter Mon
Blackpool and The Fylde College	Merchant Navy Training Board
BMT Group	Mersey Maritime
British Ports Association	Merseytravel
British Marine	Midlands Connect
British Maritime Aid Group	Milford Haven Port Authority
British Maritime Law Association	Ministry of Defence
British Standards Institution	Ministry of Housing, Communities and Local Government
Brodies LLP	
Brookfield Asset Management	MJM Group
Carisbrooke Shipping	MOR Group
Carnival UK	National Infrastructure Commission
Chevron Shipping	National Maritime
Citigroup	National Maritime Information Centre
City of Glasgow College	National Police Coordination Centre
City of Glasgow University	Nautilus International
Civil Contingencies Secretariat	Network Rail
Clarksons Research	Newlyn Pier and Harbour Commissioners
Clean Air Southampton	Nissan Technical Centre Europe
CMS Cameron McKenna Nabarro	Office of the Secretary of State for Scotland

Coltraco Ultrasonics	Oil Companies International Marine Forum
Commissioners of Irish Lights	Optimat
Cornwall and Isles of Scilly LEP	P&O Ferries
Cornwall Council	Peel Ports
Coventry University	Port of London Authority
Cummins (EUROMOT)	Port of Tyne
Department for Digital, Culture, Media and Sport	Port Skills and Safety
Defence Academy of the United Kingdom	Ports of Auckland
Department for Environment, Food and Rural Affairs	Portsmouth City Council
Denholm Shipping	Portsmouth International Port
Department for Exiting the European Union	Portsmouth University
Department for Infrastructure, Northern Ireland Executive	Rail Freight Group
DFDS	Ricardo Energy & Environment
Department for International Trade	RightShip
Dorset Police	RMT
Dover Harbour Board	Road Haulage Association
DP World	Rolls-Royce
Drax	Royal Institute of Navigation
Drone Major Group	Royal National Lifeboat Institution
Ecospeed Marine Ltd	Royal Navy
Environmental Defence Fund	Royal United Services Institute
EU NAVFOR	Seafarers International Research Centre
FCO	Seafarers UK
Fisher Associates	Security in Complex Environments Group
Freight Transport Association	Shell International
Geollect	Shipping in Changing Climates Consortium
H2Oceanjet Ltd	Society of Maritime Industries
Hadley Shipping Group Ltd	Solent LEP
	Solent University
	South Coast Marine Cluster
	South Shields Marine School
	Spinnaker Global
	Strathmay Maritime

Hapag-Lloyd	Swansea University
Haven Waterway Enterprise Zone	Tata Steel
Heriot Watt University	Team Humber Marine Alliance
Highways England	Thames Clippers
HM Treasury	The Bristol Port Company
Holman Fenwick Willan	The Corporation of Trinity House
Home Office	The Institute of Marine Engineering, Science and Technology
Honda Motor Europe	The London Nautical School
Hutchinson Ports UK	The Nautical Institute
Imperial College London	The Northern Lighthouse Board
Inchcape Shipping Services Ltd	The Schumacher Institute
Industrial Strategy Challenge Fund	Transport for the North
Innogy Renewables UK	Transport Scotland
Institute of Chartered Shipbrokers	Transport Systems Catapult
Institution of Mechanical Engineers	Tymor Marine Ltd
Intelligent Transport Systems ITS (UK)	UK Chamber of Shipping
International Dry Bulk Terminals Group	UK Major Ports Group
International Marine Contractors Association	University of Hull
ITM Power	University of Southampton
Jaguar Land Rover	University of Strathclyde
Law Society of Scotland	Visit Wales
Liverpool John Moores University	VolkerStevin
Lloyd's Market Association	Watson, Farley and Williams
Lloyd's Register	Wight Shipyard
London Maritime Arbitrators Association	WSP Group
Marine Design	

ANNEX 6

Glossary

A

Apprenticeship: a means by which a person can learn a trade while working alongside experienced practitioners.

Arctic trade route: in the context of this strategy this refers mainly to the Northeast Passage, a shipping route to the Pacific Ocean, along the Arctic Ocean coasts of Norway and Russia. The Northeast Passage is one of several Arctic maritime routes, the others being the Northwest Passage (going along the coasts of Canada and Alaska) and the Transpolar Route (going through the North Pole). It is seen as increasingly viable as a seasonal trade route due to the reduction in the Arctic ice shelf and includes the Northern Sea Route along the Russian coast, itself recently traversed by a specially designed container ship.

Autonomous Surface Vehicle (ASV): ASVs are robotic vehicles that sit on the sea surface recording oceanographic data across a range of variables. Different types of ASVs use various methods of propulsion, principally wave-powered or propeller driven.

B

Ballast Water Management Convention: under the convention, all ships in international traffic are required to manage their ballast water and sediments to a certain standard, according to a ship-specific ballast water management plan. All ships have to carry a ballast water record book and an international ballast water management certificate. The convention entered into force in September 2017.

Basel Convention on the Trans-boundary Movements of Hazardous Waste and their Disposal: an international treaty that was designed to reduce the movements of hazardous waste between nations, and specifically to prevent transfer of hazardous waste from developed to less developed countries. It does not, however, address the movement of radioactive waste.

Biodiversity Beyond National Jurisdictions (BBNJ): refers to a working group whose aim is to facilitate the provision of scientific and technical information to the United Nations process to develop a new international legally binding instrument for the conservation and sustainable use of marine biological diversity of areas beyond national jurisdiction.

Blockchain: a system in which a record of transactions made in bitcoin or another cryptocurrency are maintained across several computers that are linked in a peer-to-peer network.

Blue economy: according to the World Bank the blue economy is the "sustainable use of ocean resources for economic growth, improved livelihoods and jobs, while preserving the health of ocean ecosystem." This includes but is not limited to: maritime transport, tourism, renewable energy, climate change, fisheries and waste management.

Business services: a term usually used to describe those services that enable businesses to function such as finance, insurance and law. In the context of this study the term is used to describe those services as they relate to the maritime sector only.

C

Catapult programme: Catapult centres are organisations set up from 2011 onwards by Innovate UK, to promote UK research and development through business-led collaboration between scientists and engineers to exploit market opportunities. They receive public grants but are also expected to seek commercial funding. The Transport Systems Catapult is the UK's innovation centre for intelligent mobility.

Certificate of competency: a certificate issued by a flag administration confirming that the holder has attained the level of competence required by national and international legislation for service in a certificated capacity on board a merchant or fishing vessel.

Classification societies: are independent organisations staffed by marine surveyors, which develop and monitor standards for the design, construction and maintenance of ships for the assistance of ship owners and underwriters.

Clean Air Strategy (CAP): the CAP is a government initiative that aims to tackle all sources of air pollution, making our air healthier to breathe, protecting nature and boosting the economy.

Cluster: a cluster is a geographical area (usually an urban development) that has attracted a number of businesses and other organisations with related interests to locate within close proximity of one another.

Coastal shipping: a term referring to vessels operating between two or more points of the same country.

Committee on Climate Change (CCC): an independent, statutory body established under the Climate Change Act 2008. Its purpose is to advise the UK government and devolved administrations on emissions targets and report to Parliament on progress made in reducing greenhouse gas emissions and preparing for climate change.

Crown Dependencies: the Crown Dependencies are the Bailiwick of Jersey, the Bailiwick of Guernsey (which includes the jurisdictions of Guernsey, Alderney and Sark) and the Isle of Man. They are not part of the UK but are self-governing dependencies of the Crown. This means they have their own

directly elected legislative assemblies, administrative, fiscal and legal systems and courts of law. They are not represented in the UK parliament.

D

Deadweight (dwt): a measurement of the size of a ship based on the weight of cargo, stores, fuel, passengers and crew carried by the ship when loaded to her maximum summer loadline.

Deep sea shipping: a term referring to the maritime transport of goods on intercontinental routes which cross oceans.

Development consent order: the means of obtaining permission for developments categorised as Nationally Significant Infrastructure Projects. This includes energy, transport, water and waste projects.

Distributed ledger technology: an information sharing system of which 'blockchain' is an example. It allows greater access to information for those subscribing e.g. it makes tracking of consignments much easier and can be applied to any kind of asset.

Drone: in technological terms a drone is an unmanned aircraft. Drones are more formally known as unmanned aerial vehicles (UAVs). Essentially, a drone is a flying robot that can be remotely controlled or fly autonomously through software-controlled flight plans in their embedded systems, working in conjunction with on board sensors and GPS.

E

Emissions control area (ECA): Sea areas where stricter controls were established to minimize airborne emissions from ships (usually sulphur based) as defined by Annex VI of the 1997 MARPOL Protocol. They are often but not exclusively, established around coastlines.

Environmental Shipping Index (ESI): the Environmental Ship Index identifies seagoing ships that perform better in reducing air emissions than required by the current standards of the IMO. It evaluates the amount of nitrogen oxide and sulphur oxide that is emitted by a ship and includes a reporting scheme on its greenhouse gas emission.

European Maritime and Fisheries Fund (EMFF): fund designed to support maritime and fisheries activity and help deliver the objectives of the Common Fisheries Policy. Support is available for projects that deliver on sustainable economic growth in the sea fisheries and aquaculture sectors.

Exclusive economic zone (EEZ): an area of coastal water and seabed within a certain distance of a country's coastline, to which the country claims exclusive rights for fishing, drilling, and other economic activities.

Exhaust gas cleaning systems: a diverse group of air pollution control devices that can be used to remove some particulates and/or gases from industrial exhaust streams. More commonly known as 'scrubbers'.

F

Flag state: a term used to describe the country in which a particular ship is registered.

Free trade agreement (FTA): a treaty between two or more countries to establish a free trade area where commerce in goods and services can be conducted across their common borders, without tariffs or hindrances but (in contrast to a common market) capital or labour may not move freely.

G

General Lighthouse Authority (GLA): There are three General Lighthouse Authorities:

- Trinity House: England, Wales, the Channel Islands and Gibraltar;
- Northern Lighthouse Board: Scotland and the Isle of Man; and
- Commissioners of Irish Lights: the island of Ireland.

They are non-departmental public bodies of the Department for Transport with statutory responsibility for the operation and maintenance of marine aids to navigation (lighthouses and buoys) as well as responding to dangers to navigation (such as wrecks) in the waters around the United Kingdom and Ireland.

Greenhouse gas (GHG): a gas that absorbs and emits radiant energy within the thermal infrared range. In the context of this report used mostly in relation to IMO emission reduction objectives.

Gross value added (GVA): gross value added is a measure of the value of goods and services. It is the value of the goods and services produced less the value of the intermediate goods and services used as inputs to produce it. In other words, it measures the value that a sector adds to its products. It is used here to demonstrate the value that the Maritime sector brings to the UK economy.

H

Habitats Directive: a European Commission initiative, the Habitats Directive ensures the conservation of a wide range of rare, threatened or endemic animal and plant species. Some 200 rare and characteristic habitat types are also targeted for conservation in their own right.

Heavy fuel oil (HFO): describes fuels that have a particularly high viscosity and density. In the MARPOL Marine Convention of 1973, heavy fuel oil is defined either by a density of greater than 900 kg/m³ at 15°C or a kinematic

viscosity of more than 180 mm²/s at 50°C. Heavy fuel oils have large percentages of heavy molecules such as long-chain hydrocarbons and aromatics with long-branched side chains. They are black in colour and mainly used as marine fuel.

Hybrid vessel: a vessel that can be propelled by diesel engine using conventional fuel but which also can use an electric motor powered by battery.

Hyperloop: a proposed mode of passenger and/or freight transportation that involves travel through tunnels at great speed powered by air cushions in a manner similar to that used on an air hockey table.

I

Innovate UK: Innovate UK is part of UK Research and Innovation, a non-departmental public body funded by a grant-in-aid from the UK government.

Inshore and Inland Rescue Boat Grant Fund: a fund administered by the Department for Transport to support the work of charities that operate lifeboats and other rescue boats in UK inshore and inland waters.

International Convention for the Prevention of Pollution from Ships (MARPOL): is the main international convention covering prevention of pollution of the marine environment by ships from operational or accidental causes. The MARPOL Convention was adopted on 2 November 1973 at IMO. The Protocol of 1978 was adopted in response to a spate of tanker accidents in 1976-1977. As the 1973 MARPOL Convention had not yet entered into force, the 1978 MARPOL Protocol absorbed the parent Convention. The combined instrument entered into force on 2 October 1983. In 1997, a Protocol was adopted to amend the Convention and a new Annex VI was added which entered into force on 19 May 2005. MARPOL has been updated by amendments through the years.

International Labour Organization (ILO): a United Nations agency that sets international labour standards and promotes social protection and work opportunities for all.

International Maritime Organization (IMO): the United Nations agency with responsibility for the safety and security of shipping and the prevention of marine and atmospheric pollution by ships.

International Ship and Port Facility Security (ISPS): a code including comprehensive set of measures to enhance the security of ships and port facilities, developed in response to the perceived threats to ships and port facilities in the wake of 9/11.

Internet of Things (IoT): the interconnection via the Internet of computing devices embedded in everyday objects, enabling them to send and receive data.

Illegal, unreported and unregulated fishing (IUU): This is an international issue around the world. Industry observers believe IUU occurs in most fisheries and accounts for up to 30% of total catches in some important fisheries.

J

Just in time manufacturing (JIT): also known as just-in-time production or the Toyota Production System, is a methodology aimed primarily at reducing flow times within production system as well as response times from suppliers and to customers.

L

Liquefied natural gas (LNG): LNG is normally warmed to make natural gas to be used in heating and cooking as well as electricity generation and other industrial uses. LNG can also be kept as a liquid to be used as an alternative transportation fuel. It is a composition of methane and some mixture of ethane used to convert natural gas to liquid form for ease and safety of storage transport. In its liquid state, natural gas takes up 1/600th of the space, making it much easier to ship and store when pipeline transport is not feasible.

M

Marine Accident and Investigation Branch (MAIB): an independent unit within the Department for Transport which investigates marine accidents involving UK vessels worldwide and all vessels in UK territorial waters. Its primary aim is to determine the cause of accidents and make recommendations to prevent reoccurrence and improve safety at sea. It also increases awareness of how marine accidents happen and improves national and international co-operation in marine accident investigation.

Marine Conservation Zones (MCZs): areas that protect a range of nationally important, rare or threatened habitats and species. There are 50 MCZs in waters around England.

Marine diesel oil (MDO): generally describes marine fuels that are composed of various blends of distillates (also called marine gasoil) and heavy fuel oil. Unlike diesel fuels on land that are used for cars and trucks, marine diesel oil is not a pure distillate.

Maritime Domain Awareness (MDA): defined by the International Maritime Organization as the effective understanding of anything associated with the maritime domain that could impact the security, safety, economy, or environment.

Marine gas oil (MGO): describes marine fuels that consist exclusively of distillates, usually a blend. Marine gasoil is similar to diesel fuel, but has a

higher density. Unlike heavy fuel oil, marine gas oil does not have to be heated during storage.

Maritime London: a not for profit promotional body for UK-based companies that provide professional services to the international shipping industry.

Marine pilot: a maritime pilot, marine pilot or harbor pilot, manoeuvres ships through dangerous or congested waters, such as harbors or river mouths. They are navigational experts possessing knowledge of the particular waterway such as its depth, currents, and hazards.

Marine Protected Areas (MPAs): are protected areas of seas, oceans, estuaries or large lakes. These marine areas can come in many forms ranging from wildlife refuges to research facilities. MPAs restrict human activity for a conservation purpose, typically to protect natural or cultural resources.

Maritime Research and Innovation UK (MaRI-UK): an industry-led initiative currently involving more than eight companies, one trade association, and four universities to address the lack of coordination and resource in the maritime research and development.

Maritime UK: a representative body that brings together the UK's shipping, ports, services, engineering and leisure marine industries to drive growth by promoting the sector, influencing government and fostering collaboration.

Master: The person having command of a merchant ship.

Merchant Navy: a country's commercial shipping as opposed to that which engages in military activity.

Merchant Navy Training Board (MNTB): the MNTB is the shipping industry's central body for promoting and developing sector specific education, training and skills. It is a voluntary body and a part of the UK Chamber of Shipping, the trade association for the UK shipping industry.

Modern day slavery: refers to institutional slavery that continues to exist in present day society. Estimates of the number of slaves today range from around 21 million to 70 million, depending on method used to estimate and the definition of slavery being used.

N

National Maritime Information Centre (NMIC): coordinates information concerning UK and international waters from across government and all agencies concerned with security and crime as well as international partners.

National Maritime Single Window (NMSW): enables the mandatory pre-arrival data provided by ships (including crew, passenger and cargo manifests) to be submitted to the relevant UK authorities in order to comply with the requirements of the wider EMSA directive. The aim of the NMSW is

to reduce costs and burdens on industry by simplifying and streamlining the submission of this data through a single electronic portal.

Near shoring: the process of relocating manufacturing capability closer to the domestic market.

North Atlantic Treaty Organization (NATO): NATO is an alliance of 28 countries bordering the North Atlantic Ocean. It includes Canada, the United States, Turkey, and most members of the European Union.

O

Officer: members of crew, other than the Master, holding a certificate of competency including both deck and engineering officers.

Organisation for Economic Co-operation and Development (OECD): the OECD is an intergovernmental economic organisation with 36 member countries, founded in 1961 to stimulate economic progress and world trade.

P

Paris Agreement: an agreement within the United Nations Framework Convention on Climate Change, dealing with greenhouse gas emissions mitigation, adaptation, and finance, starting in the year 2020.

Platooning: platooning involves a number of vehicles equipped with state-of-the-art driving or piloting support systems each closely following the one on front. This forms a platoon with the vehicles driven by smart technology and mutually communicating. The potential benefits include greater energy efficiency and a need for less space between vehicles.

Polar Code: the code is an international regime adopted by the IMO in 2014. It sets out regulations for shipping in the polar regions, principally relating to ice navigation and ship design.

Port Marine Safety Code: the code sets out a national standard for every aspect of port marine safety. Its aim is to enhance safety for everyone who uses or works in the UK port marine environment.

Port State Control (PSC): the inspection of foreign ships in other national ports by PSC officers (inspectors) for the purpose of verifying that the competency of the master and officers on board and the condition of its equipment comply with the requirements of international conventions.

Protection and Indemnity Insurance (P&I): a form of mutual maritime insurance provided by a P&I Club. Whereas a marine insurance company provides “hull and machinery” cover for ship owners, and cargo cover for cargo owners, a P&I Club provides cover for open-ended risks e.g. a carrier’s third-party risks for damage caused to cargo during carriage; war risks; and risks of environmental damage such as oil spills and pollution. A P&I Club is a

mutual insurance association providing risk pooling, information and representation for its members. Unlike a marine insurance company, which reports to its shareholders, a P&I club reports only to its members.

R

RADAR: Radar is a detection system that uses radio waves to determine the range, angle, or velocity of objects. It can be used to detect aircraft, ships, spacecraft, guided missiles, motor vehicles, weather formations, and terrain.

Rating: non-officer crew members including deck, engineering and catering crew.

Red Ensign Group: a group comprised of the UK shipping register together with those of the UK Overseas Territories and the Crown Dependencies. As the contracting government, the UK represents these at the IMO and the UK Secretary of State for Transport has ultimate responsibility for ensuring that they comply with required international conventions.

Renewable Transport Fuel Obligation (RTFO): is

Re-shoring: The process of bringing manufacturing back to a domestic market from a (usually distant) overseas location.

Royal National Lifeboat Institution (RNLI): the RNLI is the largest charity that saves lives at sea around the coasts of the United Kingdom, the Republic of Ireland, the Channel Islands and the Isle of Man, as well as on some inland waterways. Founded in 1824 as the National Institution for the Preservation of Life from Shipwreck, the RNLI was granted a Royal Charter in 1860. The RNLI is principally funded by legacies and donations, and most of the members of its lifeboat crews are unpaid volunteers.

Royal Navy: part of the armed services within the Ministry of Defence that aims to provide security at sea by being prepared to engage in military activity if required in support of UK defence objectives.

S

Sea Cadets: an organisation established in 1856 by local communities wanting to provide young people with instruction and training on a naval theme. Traditionally the instruction was provided by experienced seafarers with local businesses funding the unit building. The principle purpose of the Sea Cadets remains the same today.

Seafarer: a person who navigates waterborne vessels or assists as a crewmember in their operation and maintenance.

Shipbroking: a financial service, which forms part of the global shipping industry. Shipbrokers are specialist intermediaries/negotiators between ship

owners and charterers who use ships to transport cargo, or between buyers and sellers of vessels.

Ship register: a record of all merchant ships that sail under the flag of a particular country. International law requires that every ship be registered in a recognised country. This country is then referred to as the ship's 'flag state'. A ship's flag state exercises regulatory control over the vessel. It is responsible for inspecting the ship regularly and issuing documentation and certification in respect of the ship's safety, its crew and equipment and its adherence to existing pollution prevention legislation.

Short-sea shipping: a term applied for the purpose of this strategy to vessels operating between the United Kingdom and the Continent or the Republic of Ireland.

Small and medium enterprise (SME): the usual definition of small and medium sized enterprises is any business with fewer than 250 employees. This accounts for about 99% of all businesses within the UK.

Special Protection Area (SPA): a designation under the European Union Directive on the Conservation of Wild Birds. Under the Directive, Member States of the European Union (EU) have a duty to safeguard the habitats of migratory birds and certain particularly threatened birds.

Square Mile: a colloquial term for the City of London which is a historic financial district and home to both the Stock Exchange and the Bank of England. It covers an area of 1.12 square miles.

STEM subjects: In education parlance a short form of describing Science, Technology, Engineering and Mathematics and associated subjects.

Support for Maritime Training (SMarT): the government financial support scheme for Merchant Navy training to facilitate an adequate supply of UK maritime expertise to meet the UK's economic and strategic requirements.

T

3D printing: 3D (three dimensional) printing is any of various processes in which material is joined or solidified under computer control to create a three-dimensional object, with material being added together (such as liquid molecules or powder grains being fused together). 3D printing is used in both rapid prototyping and additive manufacturing.

Tonnage tax: an alternative means of calculating corporation tax (or its local equivalent) offered by many countries as an incentive to ship owners. It is based on the size and number of ships they operate instead of on the profits and gains set out in the company's accounts. Its exact implementation is dependent upon the taxation policies of the particular country concerned.

U

UK Overseas Territories: a term referring to the territories under the jurisdiction and sovereignty of the United Kingdom. They do not however form part of it. There are 14 British overseas territories: British Indian Ocean Territory, Gibraltar, Bermuda, the Falkland Islands, South Georgia and the South Sandwich Islands, British Antarctic Territory, St Helena and its dependencies (Ascension and Tristan da Cunha), Montserrat, the British Virgin Islands, the Cayman Islands, Turks and Caicos Islands, Anguilla, the Pitcairn Group of Islands, and the Sovereign Base Areas on Cyprus.

United Kingdom Ship Register (UKSR): the ship register that holds the records of all merchant ships sailing under the UK flag. It is currently administered by the Maritime and Coastguard Agency.

W

Women in Maritime Charter: The charter creates a framework to challenge companies to make progress on diversity, and will be supported by a suite of 'toolkits' or resources to help companies realise those targets. It was launched by the Women in Maritime Taskforce in September 2018.

Women in Maritime Pledge: the forerunner to the launch of the Women in Maritime Charter. Signatories to the pledge were invited to make clear their support for creating positive change within their respective organisations, and collectively, across the UK maritime sector.

Women in Maritime Taskforce: established by Maritime UK, the taskforce brings together leaders from across the maritime sector to identify practical steps to increase the number of women in maritime, and crucially within senior roles across its shipping, ports, marine and business services industries.

ANNEX 7

Photo credits

Section	Picture description	Photo credit
Front cover	Female marine engineer	Sunseeker International Ltd
Front cover	Azura Quayside	P&O Cruises
Front cover	Dockside worker	Associated British Ports
Front cover	Liverpool harbour with British flag flying	Department for Transport
First foreword	Secretary of State for Transport	Department for Transport
Second foreword	Minister for Maritime	Department for Transport
Maritime today	Container loading in a cargo freight ship	Shutterstock
UK competitive advantage – cover page	London rooftop panoramic view at sunset	Shutterstock
5.2 Fiscal competitiveness	British flag	Alamy
5.4 Thought leadership	International Maritime Organization	Alamy
5.7 Safety	Cantick Head Lighthouse	Northern Lighthouse Board
5.8 UK flag	UK red ensign	Shutterstock
Technology – cover page	Terminal for remote control of vessel	Rolls Royce
6.3 Future of shipping	Electronic Chart Display and Information Systems (ECDIS) simulator	Alamy
6.3 Future of shipping	SEA-KIT autonomous vessel	Hushcraft
6.4 Smart ports	Peel Ports deep water container terminal	Alamy
6.5 Digitalisation	Virtual reality representation	Shutterstock
6.6 Communication, navigation, and exploration	Drone flying over the sea	Alamy
People – cover page	Female marine engineer	Sunseeker International Ltd
7.1 Introduction	Royal Navy personnel	Alamy

7.3 Maritime workforce	Worker on aft deck, THV Galatea	Trinity House
7.3 Maritime workforce	Marine crew standing on supply vessel looking at oil and gas platform	Shutterstock
7.3 Maritime workforce	Lifeboat in action at sea	Adobe Stock
7.3 Maritime workforce	Apprenticeships, skills for life representation on chalkboard	Adobe Stock
7.7 Considering the human in the face of technological change	Mental stress representation	Shutterstock
Environment – cover page	Leaf boat on water	Shutterstock
8.2 Towards zero emission shipping	Victoria of Wight exits Portsmouth Gunwharf	Wightlink Isle of Wight Ferries
8.2 Towards zero emission shipping	Retrofitted Panamax ship	Smart Green Shipping Alliance
8.4 Adapting successfully to the impacts of climate change	Stormy ocean	Adobe Stock
8.4 Adapting successfully to the impacts of climate change	Inundation of the Port of Immingham	Associated British Ports
8.5 Achieving our goals through continued international leadership	Globe in human hand	Shutterstock
Trade – cover page	Deep sea cargo container	Shutterstock
9.1 Introduction	Cargo port with cranes in the background	Shutterstock
9.2 Supply and demand	International trade - slogan on container	Adobe Stock
Infrastructure – cover page	Port of Felixstowe cranes	Alamy
10.4 Ports and harbours infrastructure	International trade container ship being loaded/unloaded at Felixstowe	Alamy
10.5 Port connectivity, the supply chain, and logistics	Supply chain representation	Shutterstock
10.5 Port connectivity, the supply chain, and logistics	Checking container handling at Tilbury	Alamy

10.6 Sectoral infrastructure	Queen Mary 2 cruise liner, alongside berth at Southampton	Alamy
10.6 Sectoral infrastructure	Wightlink hybrid vessel	Wightlink Isle of Wight Ferries
10.6 Sectoral infrastructure	Offshore wind turbines with solitary fisherman	Shutterstock
10.7 Ship building and boat building	Ship yard	Maritime UK
10.7 Ship building and boat building	Spirit Yachts	Anthony Morris
10.8 Shipping in the supply chain	Deep sea container ship	Shutterstock
Security – cover page	HMS Portland	Alamy
11.1 Introduction	HMS Northumberland replenishes at sea with FS Somme during a NATO exercise	Ministry of Defence
11.2 Security of UK waters - including Overseas Territories	HMS Diamond and one of HMS submarines	Ministry of Defence
11.5 Cyber - security of technology	Cyber security representation	Shutterstock
11.7 Maritime crime and piracy	Royal marine boarding vessel	Ministry of Defence

