UNIVERSITY OF PLYMOUTH

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TRAILBLAZING CLEAN MARITIME INNOVATION

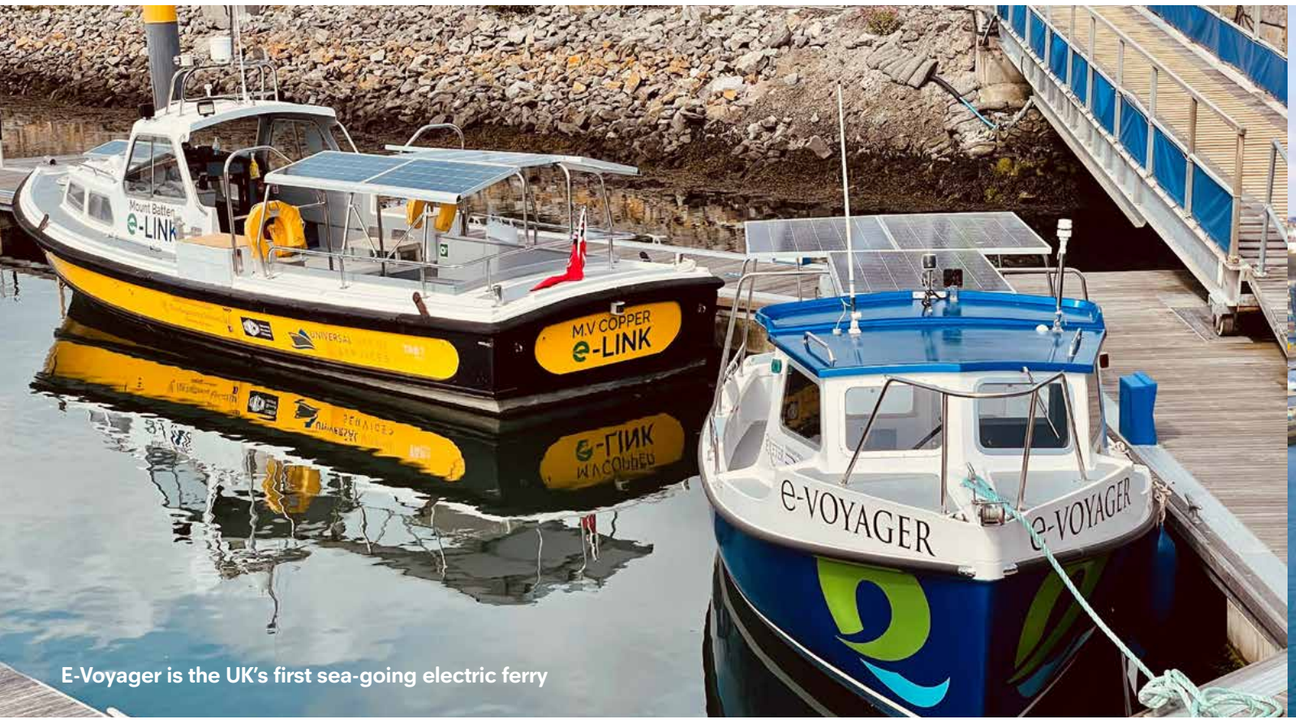
Summary

The Maritime 2050 strategy sets out how the UK can take a proactive role in driving the transition to zero emission shipping in its waters. The fuel used in shipping is one of the most polluting across all transport modes; it releases several pollutants into the atmosphere that are harmful to human health. Ports, vessel owners and operators are reluctant to invest in cleaner technology because the cost of doing so is prohibitive. This is particularly an issue for smaller ports who are less able to access significant investment. In addition, a broad range of propulsion solutions need to be developed to suit the diverse range of vessels afloat. Projects such as E-Voyager, the UK's first sea-going electric ferry[1] which is operating in Plymouth Sound, may be part of the solution. A lack of charging infrastructure currently presents a barrier to demand for electronically powered vessels. Offshore wind could be one solution; another potential idea is the installation of shore-side charging facilities, currently being trialled in Plymouth.

"The challenge is encouraging smaller ports to decarbonise. Helping a hundred small harbours de-carbonise could potentially deliver the same impact as a large port de-carbonising."

1 Funded through the £1.4million Clean Maritime Call: a Maritime Research and Innovation UK (MarRI-UK) initiative supported by the Department for Transport (DfT) and launched to support the UK's goal of zero emission shipping.

Image above: The UK's first 75kw charging site at Queen Anne's Battery for electric vessels

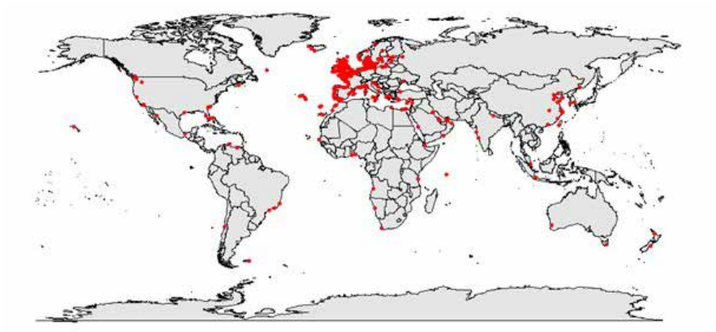


E-Voyager is the UK's first sea-going electric ferry

Queen Anne's Battery Marina in Plymouth

Key points

- Installing a newer, clean engine is not presently a commercially-viable option for boat owners and operators; more work is required to explore how this transition will be funded. This could include the provision of grants, making diesel and/or engines prohibitively expensive or increasing the taxation levied on polluting vessels;
- The UK's first sea-going electric ferry, e-voyager, is currently being trialled in Plymouth Sound. It could reduce the environmental impact of maritime transport on coastal waters using a potentially scalable approach applicable to 24 million commercial vessels worldwide.
- The first network of shore-side charging facilities has been installed around Plymouth Sound. This network offers multiple, flexible sites that can be easily linked to the National Grid with an array of sensor technologies that can assess the environmental and operational impacts of e-charging.
- A collaborative approach between government, industry, regulators, academics and researchers is vital. Developing technical solutions is only one part of the answer; vessels will need to be signed off by the regulators and insurers in a way that complements more innovation and development.



The Port of Plymouth sees over 80 different types of vessels with an average of over 4000 port calls per year. With 450 ports linked for onward journeys

Context

Globally, the maritime sector needs to do more to reduce greenhouse gas (GHG) emissions and air pollutants. The government has made clear that it wants the UK to lead the way in taking action in the growth of clean maritime . In 2018 the UK was a leading voice in the agreement of the Initial International Maritime Organisation Strategy on the reduction of GHG from Ships. This strategy commits the maritime sector globally to halving GHG emissions from shipping by 2050 (compared to 2008). It also calls on the sector to work collaboratively to phase them out.

The Maritime 2050 strategy sets out how the UK can take a proactive role in driving the transition to zero emission shipping in its waters. It also explores how the UK can become a role model globally in this field whilst successfully capturing a significant share of the economic, environmental and health benefits associated with this transition.

In March 2022, the Department for Transport launched a new unit, the UK Shipping Office for Reducing Emissions (UK SHORE). Tasked with tackling shipping emissions and helping advance the UK towards a sustainable shipping future, it will distribute £206 million of new funding to implement a comprehensive research and development programme. This includes a multi-year Clean Maritime Demonstration Competition (CMDC), to accelerate research into the development of clean maritime technologies whilst also creating skilled jobs in this sector across the country.

In addition, UK SHORE will support the development of zero emission technologies, as well as the physical infrastructure needed to power these vessels, utilising a range of technologies including hydrogen, electric and ammonia. This funding underpins the UK's place as one of the world leaders in the development of new and innovative vessels and port infrastructure and represents the biggest single investment in green shipping for a century.

2 https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/815664/clean-maritime-plan.pdf page 4

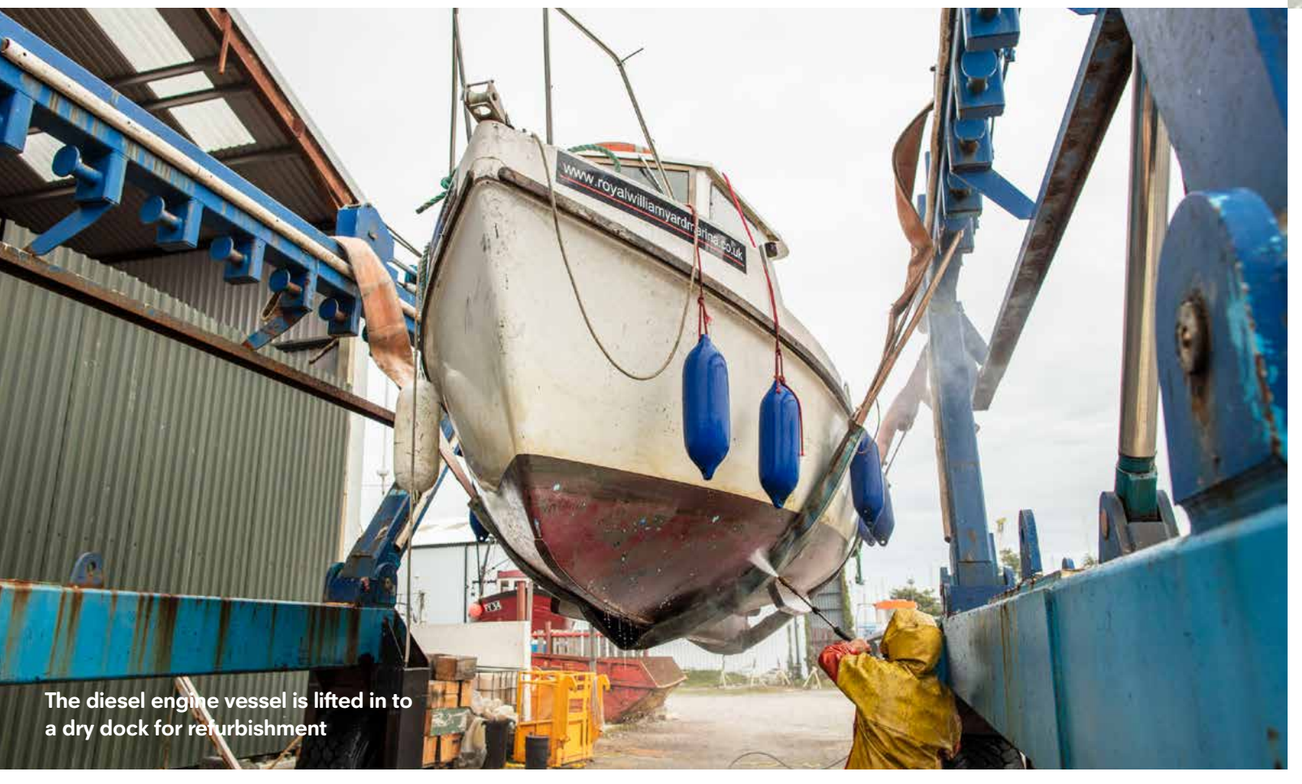
Issue

The fuel used for shipping has historically been some of the most polluting fuel used across all transport modes. The impact of pollutant emissions from shipping and wider port activity, and their effect on air quality, is clear. Shipping generates emissions into the atmosphere of several pollutants harmful to human health: nitrogen oxides (NOx), sulphur dioxide (SO2), particulate matter (PM2.5 & PM10), volatile organic compounds (VOCs) and ammonia (NH). In 2016, domestic shipping alone accounted for 11% of the UK's total domestic NOx emissions. The introduction of Emission Control Areas (ECA) has helped limit the sulphur content of marine oil but it is still typically an order of magnitude higher in these fuels than in those used in, for instance, road vehicles[3].

Starting local

In order to de-carbonise, both small and large ports need access to finance. Large scale ports have the lobbying power to gain investment in green technologies. The challenge, and potential significant win, is encouraging smaller ports to decarbonise too. Helping a hundred small harbours de-carbonise could potentially deliver the same impact as a large port de-carbonising. All ports, harbours and fleets – and any UK local authorities with a coastline, or significant water body - will have to embrace cleaner technologies over the coming years. This presents an opportunity for ports and cities such as Plymouth to share their knowledge and experience together with the solutions that have been developed and which have the potential for national scalability. Other local authorities have already approached Plymouth to tap into its expertise around de-carbonising small harbour activities and fishing fleets.

The vessel is re-purposed with Nissan Leaf batteries and electric motor



The diesel engine vessel is lifted in to a dry dock for refurbishment

Energy mix

There is no 'one size fits all' when exploring greener ways to power marine vessels. The 'right' solution needs to fit the right vessel; variables include a vessel's size, type of use, infrastructure etc. Green propulsion solutions for cruise ships will not work for small and medium-sized passenger ferries. A broad range of propulsion solutions need to be developed.

Work is underway in Plymouth to support smaller harbours, fleets and vessels de-carbonise. E-Voyager is the UK's first sea-going electric ferry[4]. Designed and developed by Plymouth Boat Trips and Voyager Marine, Cornwall, in partnership with the University of Plymouth, the University of Exeter, Teignbridge Propellers and EV Parts, this pioneering vessel should reduce the environmental impact of maritime transport on coastal waters. With an advanced electric motor installed in the vessel, together with fly-by-wire controls, to replace the traditional diesel engine, this potentially scalable approach could be used on up to 24m commercial vessels worldwide. The vessel has also been re-purposed with Nissan Leaf batteries, requiring little ongoing maintenance and bringing potential commercial benefits for businesses in the marine sector.

Through duty cycle modelling and advanced simulation of propeller performance, Teignbridge Propellers have endeavoured to ensure every kilowatt hour of battery capacity is put to efficient use, ensuring maximum vessel range. Scientists from the University of Plymouth carried out research during the build, measuring emissions including noise pollution, air pollution and fuel consumption.

The vessel takes less than three hours to achieve a full charge; 22 KwH chargers have been installed on the Barbican Landing Stage and the vessel will be charged overnight when berthing, providing enough power to run for a full day and complete its journey requirements on a single charge.

E-Voyager has undergone rigorous trials – including assessments of its emissions – and is now carrying its first paying passengers. It is also the first vessel to have been recognised by both the Maritime and Coastguard Agency and a Classification Society as satisfying the exacting standards of both organisations. The project partners are now progressing with the conversion of larger passenger vessels in Plymouth Boat Trips' fleet of cruise boats and ferries, operating within Plymouth Sound including the Mount Batten ferry.

3 Air Quality Expert Group (2017) Impacts of Shipping on UK Air Quality: https://uk-air.defra.gov.uk/assets/documents/reports/cat11/1708081025_170807_Shipping_Report.pdf

4 Funded through the £1.4million Clean Maritime Call: a Maritime Research and Innovation UK (MarRI-UK) initiative supported by the Department for Transport (DfT) and launched to support the UK's goal of zero emission shipping.

Access to energy

Access to energy sources, and the infrastructure that delivers that energy, will need to be explored. Limited infrastructure currently presents a barrier to growth and the UK's national grid does not have sufficient additional capacity to power hundreds of boats. In addition, a readily available energy supply is often not in the same location where that energy is demanded. Thoughtful investment should be made into potential energy infrastructure solutions, with a focus on alternative and sustainable energy sources. Offshore wind farms present a potential opportunity; they can act as refuelling stations at sea, delivering energy via a floating charging unit. As an island nation this could work to the UK's advantage. Investing in this kind of solution, building on our research know-how, expertise and industrial base, could place the UK in a world-leading position. The government and others need to continue gathering data on these solutions and fund further research.

Marine e-Charging Living Lab (MeLL)

Plymouth is the first UK city to install a network of shore-side charging facilities for its expanding fleet of electric maritime vessels. A consortium of city partners has joined forces to create Plymouth's Marine e-Charging Living Lab (MeLL)[5]. It will develop a network of charging facilities around Plymouth Sound, offering multiple, flexible sites and responding to the Maritime 2050 route map for maritime net zero. The project is being led by the University of Plymouth in partnership with Plymouth City Council, Princess Yachts Limited and Aqua SuperPower. From March 2022 suitable locations for charging facilities that can be easily linked to the National Grid will have been identified and an array of sensor technologies that can assess the environmental and operational impacts of e-charging will be deployed.

Role for academics and regulators

Multiple stakeholders, government, policymakers, the marine industry, academics and researchers, should be involved in developing solutions. It is not in commercial organisations' interest to fund research into holistic or wide-ranging solutions beyond the scope of their market activities. Universities and other research organisations are not as constrained by market forces; academics can act as advisors and consultants. They can gather data. Many can access state-of-the-art equipment in environmental sensing and super computers to gather environmental data and intelligence. Whilst academics can provide the broad brush, strategic context, universities can use their convening power to bring different stakeholders together. Developing technical solutions is only one part of the answer; vessels will need to be signed off by the regulators, insurers, Lloyds List etc. The University of Plymouth has played the role of 'critical friend' in the projects covered by this brief, working closely with regulators helping them develop and design the regulatory models and processes for the electric vessels being tested in Plymouth Sound. Regulators need to work in a way that complements more innovation and development; trailblazing projects and trials should not be extensively penalised so that they never leave the drawing board.

Conclusion

Efforts to decarbonise the maritime sector should not lose sight of the wider context. It is tempting to focus on vessels' environmental impact on and above the water but, increasingly, data is revealing how these operations impact life below the water: mammals, ecology, marine life. The potential of cleaning up maritime could have a much greater impact on ocean health than is currently realised. It will likely necessitate the cross fertilisation of technology and solutions from other sectors which will need to be integrated into existing marine industry operations.

5 The project has received more than £570,000 funding as part of the Clean Maritime Demonstration Competition, funded by the Department for Transport and delivered in partnership with Innovate UK.

UNIVERSITY OF PLYMOUTH
Sustainable Earth Institute

Evidence summary for policymakers

Relating to the following Global Sustainability Development Goals

A three-time winner of the Queen's Anniversary Prize for Higher and Further Education, the University of Plymouth is renowned for high quality, internationally-leading education, research and innovation.

The **Sustainable Earth Institute (SEI)** connects the University's world leading research expertise with the wider world to collaborate on creating a more sustainable future. We bring together researchers from natural and social sciences, engineering, arts, humanities, health and business, to take an interdisciplinary, systems-thinking approach to help tackle sustainability challenges.

This Policy Brief is part of a series aiming to inform policy-makers of our sustainability research, in particular around Net-Zero Carbon and Healthy Landscapes. To read more in the series visit: www.plymouth.ac.uk/sei-impact

Voice of a sustainable earth

Biography

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Sarah Fear is project and knowledge exchange manager at the University of Plymouth. She works across the Faculty of Science and Engineering (and specifically linked to the Sustainable Earth Institute) she leads on Environmental Intelligence and Sensors, as well as other activities around Clean Maritime. She is currently managing two externally-funded projects: The Environmental Futures and Big Data Impact Lab project gives Devon-based SMEs the opportunity to work collaboratively with our scientists and technologists to develop new products, services or processes with a focus on big data and safeguarding the environment. Plymouth's Marine e-charging Living Lab (MeLL) project, installing electric infrastructure across Plymouth Sound to support electric vessels.

The University of Plymouth has a national and international track record in specific areas of data acquisition as well as the interpretation and visualisation of environmental data. It is currently working draw these strengths together to deliver the next generation of environmental monitoring and assessment. Building on research bases within environmental monitoring and fate, sensors, agri-tech, and biology we have formed a University-wide Sensors group, which is already forging new collaborations and gaining funding.