Innovate UK

Department for Transport

Clean Maritime Demonstration Competition

Round 1: Project Overview

Published September 2022

Contents

Foreword

Welcome to the Clean Maritime Demonstration Competition Round 1 Project Overview. The following pages present the successes and achievements of 55 innovative clean maritime projects. Together they address the immense challenges and opportunities facing the UK's maritime sector in its efforts to reduce emissions.

The first Clean Maritime Demonstration Competition has built upon the UK's rich heritage of maritime innovation. In these pages, we see the outputs of clean maritime technology development that 209 organisations are pioneering for the UK.

The UK is a maritime nation. Over 95% of UK trade runs through our major ports, fuelling our supply chains that connect us to the global economy. The industry therefore plays an incredibly important part in the UK's economic landscape and with this comes the responsibility to innovate, ensuring the UK remains a global maritime leader.

Together with the wider transport network, the maritime sector faces significant change. UK and global net zero targets, shifting supply chains and greater connectivity all directly impact the industry. Within this changing landscape, the obligation to reduce maritime emissions has never been more important.

Innovate UK is the UK's innovation agency, and we work to inspire, involve and invest in UK business innovation.

With this overview, we want to inspire you by demonstrating how UK organisations can explore and exploit new opportunities in maritime. We have already involved many organisations in the rapid delivery and dissemination of this first competition and we hope to involve many more organisations in future competitions. We want your help to stimulate further innovation and invest in the exciting clean maritime technology that has already been developed.

Above all, the projects in this overview show the UK's maritime industry recognises the emissions challenge and is taking bold steps to address it.

I would like to thank all those that helped us deliver this competition including our partners at the Department for Transport and Innovate UK KTN. But most of all I'd like to thank the industry partners that worked day and night to make the first Clean Maritime Demonstration Competition a success.

Mike Biddle
Executive Director – Net Zero | Innovate UK

Innovation in maritime is needed now more than ever. The UK has a legislative target to reach net zero by 2050 across the UK economy and our maritime sector has an important part to play in achieving that goal. Our pioneering 2019 Clean Maritime Plan made clear that energy efficiency technologies will not be sufficient to reach net zero, but that low or zero-emission fuels and propulsion technologies will be necessary. As the globe moves towards a net zero future, the green revolution opens a new world of economic opportunity. Access to the global market for alternative maritime fuel technologies alone could result in economic benefits to UK businesses of up to £0.5 billion per year by 2050. We have a strong innovative maritime sector and by moving first we can ensure that the transition to net zero strengthens UK industry, levels up our coastal and local communities, and develops a more prosperous union.

That is why in March 2021, we launched the Clean Maritime Demonstration Competition (CMDC) Round 1, which allocated over £23m of research and development funding to 55 projects across the UK. This competition supported the design and development of zero emission shipping technologies and greener ports through a series of technology trials and feasibility studies to accelerate maritime decarbonisation. The competition ended on 31 March 2022.

The 55 winners in this brochure represent the true breadth of the UK, hailing from all four nations and supporting the development of a multitude of shipping technologies and fuels. From hydrogen, ammonia and methanol to batteries and shore power. From automated vessels and hybrid engines to storage facilities at ports and energy from offshore wind infrastructure. These projects have done truly amazing things and I would like to send my own thanks and admiration to each of the 55 projects who worked remarkably to test and develop these innovative clean maritime technologies.

It is due to the success of these projects that in March 2022, we announced a further £206m for a new UK Shipping Office for Reducing Emission (UK SHORE), a new division within the Department for Transport focused on decarbonising the maritime sector. UK SHORE will deliver a suite of interventions between 2022 – 2025 aimed at addressing different barriers to maritime decarbonisation over a range of technology-readiness levels. This includes further rounds of the Clean Maritime Demonstration Competition.

I look forward to showcasing the excellent success the UK achieves in decarbonising the maritime sector through CMDC and UK SHORE more broadly, ensuring decarbonisation is at the heart of the UK's maritime future.

Petra Wilkinson
Director of Maritime | Department for Transport

Introduction

Overview

This booklet provides brief summaries of each of the 55 innovative projects that were funded under Clean Maritime Demonstration Competition (CMDC) Round 1. The intention is to inform and inspire the maritime and transport industries, both in the UK and overseas, to develop and invest in clean maritime technology being advanced in the UK.

Behind each summary is a wealth of new information and technology that cannot be fully explained in a single page. Innovate UK encourages readers to reach out to either us or the CMDC organisations mentioned in this booklet to find out more about the projects and their wider work with clean maritime. There is plenty of opportunity for collaboration and investment in what is proving to be a fast-growing market.

With the recent announcement of further CMDC rounds and multi-year funding via UK SHORE (including the **£12 million** CMDC Round 2 and the **£60 million** CMDC Round 3) there has never been a better time to get involved in clean maritime.

Clean Maritime Demonstration Competition (CMDC) Round 1

CMDC Round 1 is funded by the Department for Transport (DfT) and delivered in partnership with Innovate UK, part of UK Research and Innovation (UKRI).

CMDC Round 1 was announced in March 2020 as part of the Prime Minister's Ten Point Plan to position the UK at the forefront of green shipbuilding and maritime technology. The competition was a £20m investment from government alongside a further c.£10m from industry to reduce emissions from the maritime sector, the largest such investment ever in clean maritime at the time.

CMDC Round 1, supported 55 projects and 209 organisations across the UK, including projects in Scotland, Northern Ireland and from the South West to the North East of England. As set out in the Clean Maritime Plan (2019), Government funding has been used to support early to mid stage research relating to clean maritime. The programme was used to support the research, design and development of zero emission technology and infrastructure solutions for maritime and to accelerate decarbonisation in the sector.

CMDC Round 1 projects ran from September 2021 to March 2022, a tight and ambitious timeline but projects made full use of the time available to develop comprehensive demonstrators and feasibility studies.

The Clean Maritime Demonstration Competitions are now part of the UK Shipping Office for Reducing Emissions (UK SHORE). In March 2022, the Department announced the biggest government investment ever in our UK commercial maritime sector, allocating £206m to UK SHORE, a new division within the Department for Transport focused on decarbonising the maritime sector. UK SHORE is delivering a suite of interventions throughout 2022-2025 aimed at accelerating the design, manufacture and operation of UK-made clean maritime technologies and unlocking an industry-led transition to Net Zero.

CMDC Round 2 was launched in May 2022 and CMDC Round 3 opened in September 2022. Further funding rounds are planned for 2023. Details of all CMDC funding opportunities can be found at https://www.ukri.org/councils/innovate-uk/

Structure of this booklet

This booklet is split into three sections: On Vessel technologies, Port & Infrastructure technologies and Smart Shipping & Other technologies. These are three key areas covered by 'Clean Maritime'.

Some projects may not fit entirely within their respective section and can span multiple clean maritime development areas. For example, a project may develop both a vessel and the infrastructure required to enable that vessel to operate.

Within each section, projects are further split into those that demonstrated (or are due to demonstrate) physical technologies and those that completed comprehensive feasibility studies (Strand 2 and 1 of CMDC Round 1 respectively).

There are 16 demonstrator projects (Strand 2) and 39 feasibility studies (Strand 1).

Key facts and figures

In total, projects produced around 2500 pages of reporting at the end of the CMDC Round 1. These reports contained a review of achievements, plans, predicted emissions reductions and economic impacts.

Projects have reported some provisional figures that indicate the success of the programme. It should be noted that these numbers are provisional and further assessment is needed before concrete conclusions can be drawn.

- 210 ktCO2eq / year of predicted non-scaled emissions savings (using demonstrators and small-scale solutions alone)
- 663 ktCO_2eq / year of predicted scaled emissions savings (using fully deployed and operational solutions)*
- £418,000 average funding received per project

* Equivalent to removing around 450,000 fossil fuel cars from the road[1]

Disclaimer

The information and claims in this booklet have been provided by the organisations involved with CMDC Round 1 projects and do not necessarily represent the views of Innovate UK or Department for Transport. The projects findings and conclusions have not been validated independently.

Contact

For any general enquiries related to the Clean Maritime Demonstrator Competitions, please contact James Lovett – Innovation Lead for Future Maritime Technologies at Innovate UK (james.lovett@iuk.ukri.org) or visit https://www.ukri.org/councils/innovate-uk/

For individual project enquiries, please contact the relevant project lead organisation, the website for which is listed in each project entry.

1 Calculated from 2022 BEIS GHG Conversion Factors and 2021 DfT Annual Mileage reports

On vessel technologies

Demonstration

Twin-motor, zero-emission powertrain for commercial workboats

Design and build test boats to demonstrate a zero-emission outboard motor for workboats

What was the aim?

The project aimed to design and build test vessels that would be used to demonstrate the consortium's innovative hydrogen-battery hybrid outboard motor.

How did it go?

The consortium successfully accelerated its development programme for the motor by two years and now has a proven and cost-effective motor that can challenge incumbent motor manufacturers.

What are the next steps?

A concept product was launched in Amsterdam in June 2022, and Ecomar expects a production version to be on sale from early 2023.

Project lead:

Ecomar Propulsion Ltd (www.ecomarpropulsion.com)

Partners:

SERCO, University of Plymouth, and University of Exeter's Centre for Future Clean Mobility

Robert Courts viewing the ORKA outboard with the owners of Ecomar Propulsion, Eugene Bari and Anthony Bennett

Demonstration

Feasibility and demonstration of ultra-long endurance hydrogen-powered uncrewed surface vessel

Testing the feasibility of a hydrogen-powered uncrewed surface vessel and demonstrating a prototype system in a concept platform

Project lead:
Acua Ocean Ltd (www.acua-ocean.com)

What was the aim?

The project aimed to test the regulatory, technical, operational and commercial feasibility of Acua Ocean's ultra-long endurance hydrogen-powered uncrewed surface vessel. It then wanted to move on to demonstrate a prototype.

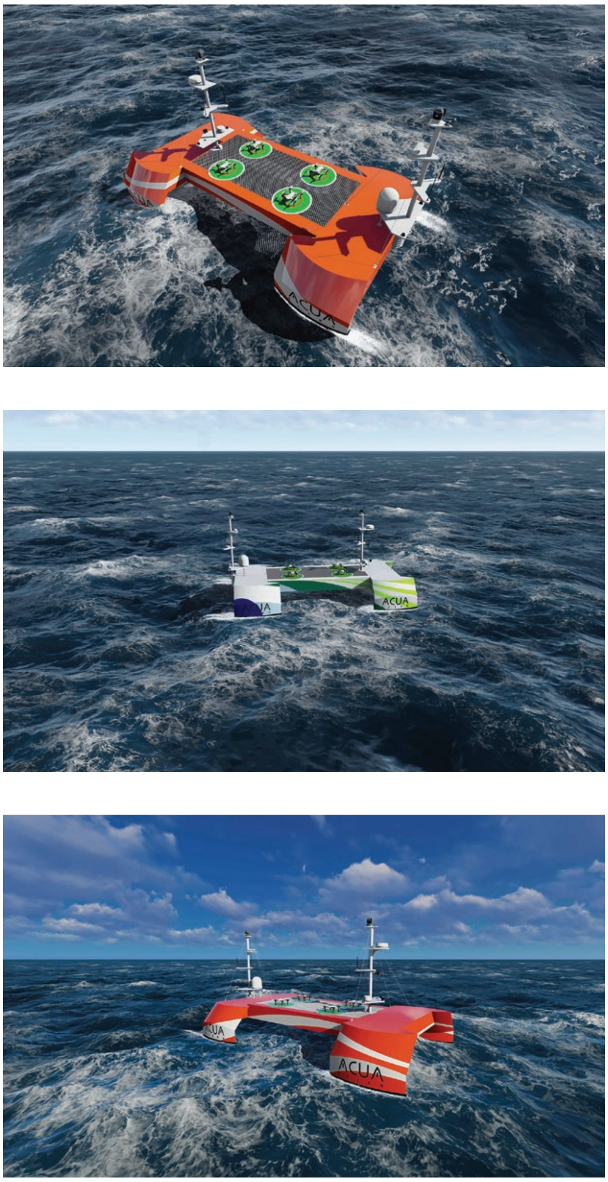
How did it go?

The team successfully integrated a prototype hydrogen system in a concept uncrewed surface vessel platform. They showed that the solution would reduce greenhouse gas emissions and would also be more cost-effective than traditional diesel-powered vessels, increase reliability and reduce downtime and maintenance.

What are the next steps?

Acua Ocean has drawn up detailed plans for a prototype commercial vessel that could be deployed in an operational environment.

ACUA
OCEAN



Renders of ACUA Ocean hydrogen-powered H-USV for ocean monitoring and protection

Demonstration

Clean hybrid alternative marine powertrain (CHAMP)

Demonstrating hybrid technology in recreational, defence and small to medium-sized commercial vessels

What was the aim?

The project aimed to validate a methanol fuelled, hybrid powertrain for the marine market to reduce emissions by 67% when compared to conventional gasoline fuelled alternatives, by pivoting proven automotive technology into the marine sector.

How did it go?

The project exceeded its targets, demonstrating that clean marine powertrains can be achieved with improved performance and reduced emissions over incumbent technologies. Furthermore, the project showcased how a motorsport derived approach to the development programme reduced lead times and costs.

What are the next steps?

The ongoing programme aims to be at the forefront of sustainable propulsion in the marine sector, working with innovative delivery partners to demonstrate the financial savings and reduction in environmental impact that can be achieved by boat operators, through proven powertrain solutions from other sectors, delivered in a cost efficient and time-reduced manner using digital tools to rapidly iterate and validate solutions.

Project lead:
Mathwall Engineering Ltd (mathwall.co.uk)

Partners:
PurpleSector, Boat Club Trafalgar Ltd, Control Ltd, Mtech-UK Associates Ltd, Bramble Energy Ltd, JBT Marine Ltd, and University of Bath

CHAMP Proof of Concept demonstrator

Proposed configuration of a hybrid rescue boat

Demonstration

Innovative electric boat and drive system development

Building an ultra efficient electric leisure boat

What was the aim?

Optima Projects aimed to build a highly efficient demonstration leisure boat powered by a new electric drive propulsion system developed by RAD Propulsion.

How did it go?

A 10m demonstration boat was built and successfully completed sea trials. The boat has a very low energy consumption, reducing the size of the battery and the cost and weight.

What are the next steps?

Plans are underway to mass produce both the drive system and the boats, which will see reductions in carbon emissions and positive economic impacts for the companies involved and the wider supply chain.

Project lead:
Optima Projects Ltd
(www.optima-projects.com)

Partners:
Solent Electrical Consultancy-Marine Ltd, and RAD Propulsion Ltd

Top and middle - 10m demonstration boat. Bottom - computer render of completed boat

optima electric boats

RAD PROPULSION

Demonstration

Marinisation and installation of printed circuit board hydrogen fuel cell into unmanned surface vessel for demonstration

Demonstrate a hydrogen fuel cell power system in an Uncrewed Surface Vessel (USV)

What was the aim?

The partners aimed to develop a Bramble Energy printed circuit board fuel cell system and demonstrate it in a Sea-Kit uncrewed surface vessel collecting oceanographic data.

How did it go?

Design of the fuel cell stack progressed quickly to initial testing of individual cell plates enabled by rapid prototyping due to the PCB construction. Simulation modelling of the system allowed some improvements prior to build. Procurement of several of the system components were impacted by global supply chain issues which pushed the schedule out so in vessel testing is planned for end of 2022.

What are the next steps?

The fuel cell stack has completed and passed bench testing with supporting system nearing completion. Final full system testing is due within coming weeks and installation and sea-trials in USV Maxlimer are planned for October. Full demonstration will be performed with USV Maxlimer performing a seabed surveying demonstration powered with hydrogen.
Contact SEA-KIT if you would like to attend the demonstration. Beyond the demonstration, SEA-KIT would like to continue development of the PCBFC towards a commercial product.

Project lead:
Sea-Kit International Ltd
(www.sea-kit.com)

Partners:
Bramble Energy Ltd

Demonstration

Ammonia Marine Propulsion System

Demonstrating technology to deliver ammonia-based power and propulsion to a marine fleet

What was the aim?

The project aimed to demonstrate technology for the conversion of ammonia fuel stores to fuel cell grade hydrogen suitable for Ocean Infinity's proposed ARMADA fleet of robotic boats. It aimed to build an ammonia-to-fuel-cell demonstrator, perform testing, and carry out a range of analyses.

How did it go?

Work on the ammonia-to-fuel-cell demonstrator has been delayed until September 2022 due to increased focus on system safety and integrity. Testing has been carried out on ammonia-to-hydrogen conversion, on vessel power demands and on fuel cell components. Analysis has revealed the potential to save costs and emissions by replacing land-based transport with coastal shipping. Installing the system in the proposed ARMADA fleet of more than a dozen vessels could cut CO2 emissions by 70% over 30 years.

What are the next steps?

The project is continuing its work on the ammonia-to-fuel-cell demonstrator and recommending that its system should be compared against other technologies to ensure that an optimum solution for the ARMADA fleet can be developed as a prototype by 2025.

Project lead:

Ocean Infinity Innovations Ltd (oceaninfinity.com)

Partners:

University of Southampton, Shell International Trading and Shipping Company Ltd, Oxford Green Innotech Ltd, and University of Oxford

Demonstration

Hydrogen in an integrated maritime energy transition – HIMET

Demonstrating hydrogen technologies for the marine sector

What was the aim?

The partners aimed to design, develop and demonstrate the use of four technologies to decarbonise ferries and ports in the Orkney Islands:

- hydrogen systems and micro-grids for shore-side power, including a hybrid hydrogen/solar system
- hydrogen combustion in a marine engine
- an on-board hydrogen storage container
- a hydrogen fuel cell for auxiliary supply on a vessel.

How did it go?

The project successfully designed, developed and manufactured all the elements of the project. There have been some delays due to global supply chain issues but testing and demonstration is due to take place later in 2022. Studies as part of the project have shown the potential of an optimised micro-grid with solar and fuel cell energy supply and that the technologies could decarbonise the maritime sector around Orkney.

What are the next steps?

Project partners aim to use their experience to spread ideas on future maritime working practices across the UK and further afield.

Project lead:

European Marine Energy Centre Ltd (www.emec.org.uk)

Partners:

Aquatera Ltd, Eneus Energy Ltd, Oak Technical Services, Orcades Marine Management Consultants Ltd, Orkney Islands Council, Ricardo UK Ltd, RINA Consulting Ltd, Schneider Electric Ltd, ULEMCO Ltd, and Urban Foresight Ltd

Hydrogen powered welfare unit in Orkney

Demonstration

High-efficiency controllable pitch propeller

Developing a high-efficiency controllable pitch propeller to demonstration stage

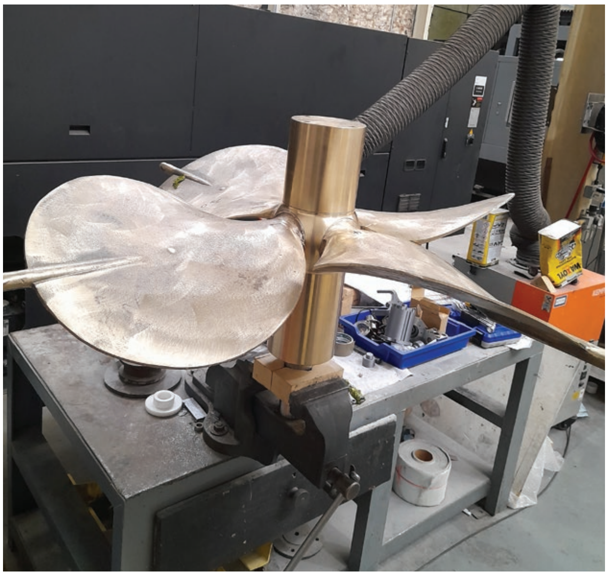
What was the aim?

Teignbridge Propellers aimed to take initial designs for a highly efficient propeller and develop it to the test or demonstration stage. More efficient propellers will support lower energy density storage for boats, such as batteries and hydrogen, and contribute to reductions in greenhouse gases.

How did it go?

The project used a wind farm vessel as a case study and found an unexpectedly small reduction in fuel use that would not justify the costs of the propeller for that particular vessel. However, further studies of other vessels are likely to identify more significant savings. Two propellers were assembled. One was tested on a bench and the other in a research vessel. The tests showed changes in the design were needed to ensure success.

Project lead:
Teignbridge Propellers International Ltd
(teignbridge.co.uk)



TEIGNBRIDGE

Demonstration

Hybrid-enabled remote operations (HeRO)

Demonstrate integration of a hybrid power train into an uncrewed surface vessel platform

What was the aim?

The partners aimed to put a hybrid powertrain into an uncrewed surface vessel that could be adapted in the future as next-generation zero emission fuels and technologies become available. It also aimed to look at ways of optimising controls to minimise emissions.

How did it go?

The project launched an uncrewed surface vessel, Decibel, in Plymouth Sound in April 2022. Partners demonstrated a ten-fold reduction in emissions compared to existing vessels, low noise levels, and good manoeuvrability, endurance and performance.

What are the next steps?

The team is looking to achieve compliance with Maritime and Coastguard Agency regulations. HydroSurv has already received design and build contracts for the vessel.

Project lead:

HydroSurv Unmanned Survey (UK) Ltd (www.hydro-surv.com)

Partners:

Fischer Panda UK Ltd, Dynautics Ltd, and Sonardyne International Ltd

Feasibility Study

eFoiler crew transfer vessel

Investigate whether an electric propulsion system could decarbonise crew transfer vessels

What was the aim?

The project aimed to see whether the Artemis eFoiler® electric propulsion system could be used to decarbonise the operations of crew transfer vessels around the world. This included creating digital twins, simulating operations of a crew transfer vessel and investigating emission reductions and potential regulatory barriers..

How did it go?

The study found a vessel equipped with the system could save 1,800 tonnes of greenhouse gases a year. It found that technical barriers to adoption could be addressed, but there were significant non-technical barriers including a lack of clarity over future fuel infrastructure and over targets for the transition to clean maritime.

What are the next steps?

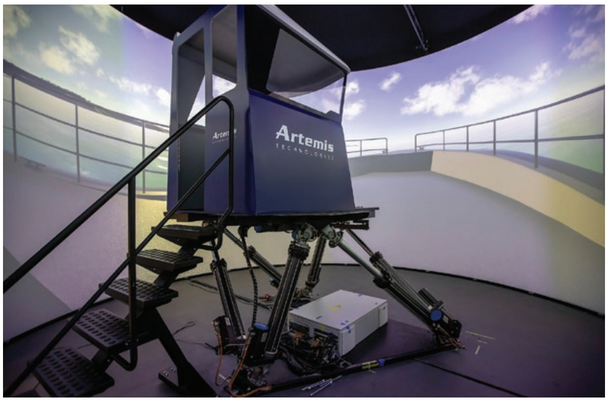
The project has drawn up plans for a demonstration.

Project lead:

Artemis Technologies Ltd
(www.artemistechnologies.co.uk)

Partners:

Lloyd's Register, Tidal Transit Ltd,
and Offshore Renewable Energy Catapult



Pioneer of Belfast - Artemis eFoiler® 100% Electric Foiling Workboat"

Artemis TECHNOLOGIES

Lloyd's Register · TIDAL TRANSIT · CATAPULT Offshore Renewable Energy

Feasibility Study

Zero-carbon flying lateen caravel container freighter

Study into the design, technology and economic competitiveness of a novel sailing container ship – the flying-lateen container ship

Project lead:
Artec Vida Ltd

What was the aim?

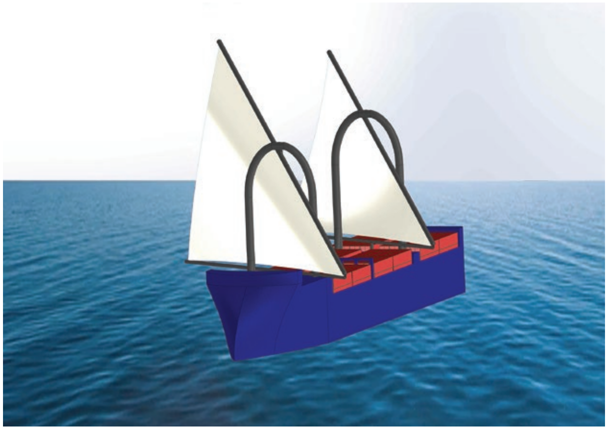
Artec Vida investigated the feasibility of a container ship based on a caravel – a highly manoeuvrable sailing ship with a lateen or triangular sail. A caravel is an attractive prospect for industry because of the high cost of zero-carbon fuels such as hydrogen, methanol, ammonia or synthetic hydrocarbons. It could cut fuel consumption by 75%.

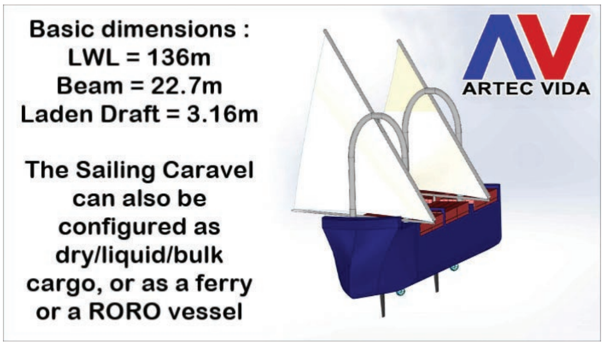
How did it go?

The project found an attractive business case for feeder and short-sea vessels operating around Europe or North America. It has identified suppliers that could construct container caravels and similar vessels and has shown that new specialist manufacturing and servicing facilities would need to be built at ports in Europe and North America to successfully introduce caravels at scale.

What are the next steps?

Artec Vida is talking to industry partners about building the first container caravel with the aim of conducting sea trials in 2025.





Feasibility Study

Automating lubricating oil analysis as a means to reduce engine greenhouse gas emissions

Understanding the real-time condition of an engine in operation and acting to improve performance

Project lead:
RAB-Microfluidics
(rab-microfluidics.co.uk)

Partners:
Caledonian Maritime Assets Ltd

What was the aim?

The aim of the project was to look at a low-cost way to help the maritime industry reduce its emissions by collecting data on the engine of a commercial vessel and correlating it with engine performance and greenhouse gas emissions to establish a cause-and-effect relationship.

How did it go?

The partners used the RAB-Microfluidics portable oil condition monitoring prototype device to collect data. The team was able to establish a strong statistical relationship between condition, operation, performance and greenhouse gas emissions of a commercial vessel engine and to develop ways of saving energy.

What are the next steps?

The team is well placed to pursue a demonstration project that would show how a 40-times reduction in greenhouse gas emissions could be achieved by predicting fuel consumption based on historical data and on real-time data on engine condition, operation and performance. A demonstration project would also support the marketing of the portable device and help to generate revenue for the business.

RAB-MicroFluidics portable oil condition monitoring device

Feasibility Study

Direct ammonia fuel cells for maritime propulsion

Developing a fuel cell that can convert ammonia into water and nitrogen and deliver electricity

What was the aim?

The project aimed to develop a fuel cell system that has been demonstrated for hydrogen into one that could be used for ammonia and to show how it could be a robust and highly competitive product for the maritime sector.

How did it go?

The team worked to optimise electrodes for the ammonia conversion and on the technology for building cells. They achieved good performance and stability in the cells and successfully assembled bundles of cells. The work also included studies on minimising emissions, optimising management of the system, and on implementing the system in long-distance and heavy modes of transport where hydrogen or batteries were not effective.

What are the next steps?

The partners have established a route to market and drawn up plans that would support a demonstrator project of the technology.

Project lead:

Zem Fuel Systems Ltd

Partners:

University of St Andrews, Low Emissions Resources Global Ltd, and Cromarty Firth Port Authority

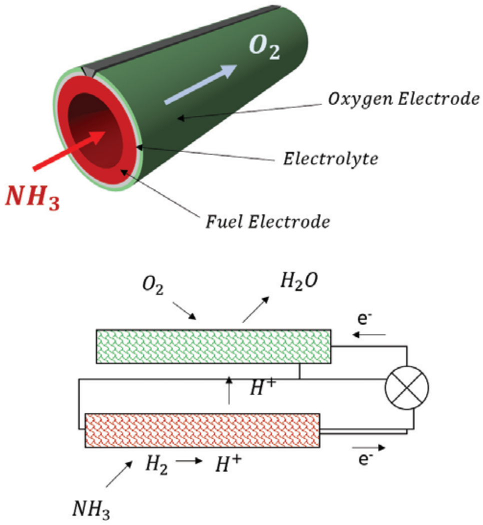


Figure 1: Single fuel cell showing (a) components and (b) how the cell operates.

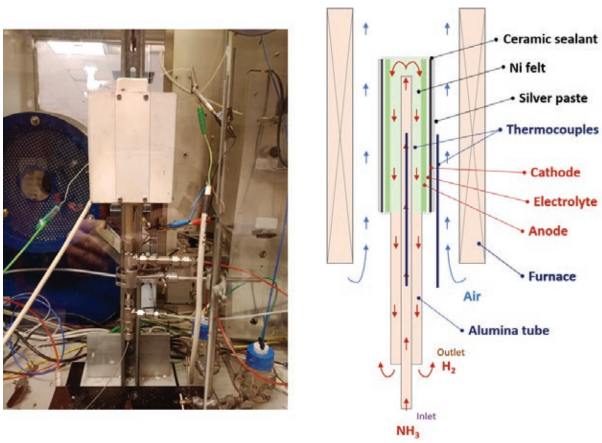


Figure 2: Fuel Cell test system assembly

zero | emissions | marine

University of St Andrews

PORT OF CROMARTY FIRTH

Feasibility Study

Electrifying the Broads

Decarbonising hire cruisers on the Norfolk Broads

Project lead:
RenEnergy Ltd (renenergy.co.uk)

Partners:
Broads Authority, Norfolk Broads Direct, and Hydrogen East

What was the aim?

The project aimed to collect geospatial, technological and socio-economic data that could be the basis of a demonstration of how to electrify an existing fleet of hire cruisers. It also aimed to look at energy needs on board the vessel, the required charging infrastructure and how easily a solution could be scaled up.

How did it go?

The project concluded that it was possible to operate a fully electric hire cruiser on the Broads if there was sufficient charging infrastructure. Hire cruisers make up 9% of the Broads mechanised fleet but have significant carbon emissions. The partners found that converting them to clean energy would save around 18% of carbon emissions from the total Broads fleet. The project also concluded that converting the fleet to electric power could create 24 new highly skilled jobs.

What are the next steps?

A demonstration project in 2023 will see a diesel-powered cruiser converted to fully electric power using commercially available batteries. It will be supported by 11 shoreside charging points. A future demonstration project could involve five cruisers.

RenEnergy Design Supply Install

Broads Authority NBD Hydrogen East

Feasibility Study

Avoiding the hard cell – fuel cell integration into a large ship's power architecture

Improving the maritime industry's readiness to adopt cleaner technology by integrating fuel cells into large ships.

What was the aim?

The partners aimed to model the integration of solid oxide fuel cells into a large cruise ship. The technology is flexible enough to operate with different fuels. The challenge was to see how the technology could supply the large power demands posed by such a ship.

How did it go?

The team identified that a 10 megawatt fuel cell power installation was feasible. This would be enough to replace the power supplied by large diesel generators and, for example, allow a ship to leave its engines off in a port. This could offer a 47% reduction in CO_2 emissions and completely remove emissions of nitrogen oxides.

Project lead:

GE Energy Power Conversion UK Ltd (www.gepowerconversion.com)

Partners:

Ceres Power Ltd, MSC Cruise Management, and Lloyds Register

Ceres example fuel cell

ceres

Lloyd's Register

Feasibility Study

High-performance reefable wingsail feasibility study

Using efficient high-performance sailing rigs and developing a sail control system for vessels of different sizes

Project lead:
Oceanic Wingsails Ltd
(oceanicwingsails.co.uk)

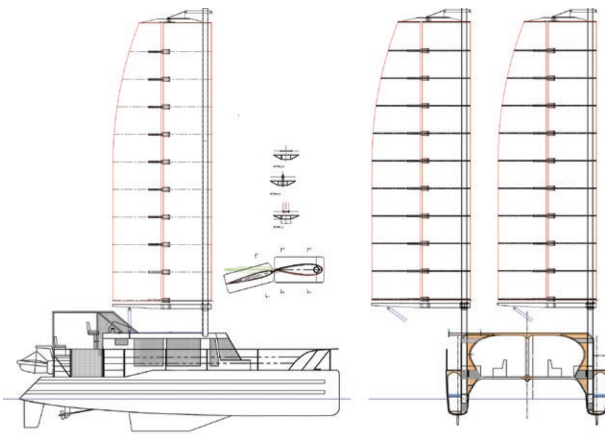
Partners:
Saillink Ltd

What was the aim?

The partners aimed to look at the feasibility of using modern high-performance film-based sail cloths for a variety of vessels. They also wanted to look at the feasibility of a simple sail control system similar to the forward-neutral-reverse engine control in a powered boat.

How did it go?

The project drew up a detailed plan for demonstrating the technology on a 6.5 metre trimaran. It found that designs would generally be compliant with existing regulations for small sailing ships and could also meet regulations in larger vessels. If widely adopted, the system could lead to significant reductions in emissions and support UK jobs.



Oceanic Wingsails Ltd
Wingsails for the real world

SailLink

Feasibility Study

Clipper 2.0: economical and technical feasibility of decarbonising high-speed public water transport on the River Thames

Evaluating use of three forms of hydrogen fuel in new vessels and as a potential retrofit

What was the aim?

The project aimed to assess the potential use of gaseous hydrogen, liquid hydrogen and methanol in a variety of new and existing Thames Clipper vessels. This included assessing energy and fuel quantities required on routes, how fuel cells and batteries could be accommodated in the hull, regulatory constraints and economic viability.

How did it go?

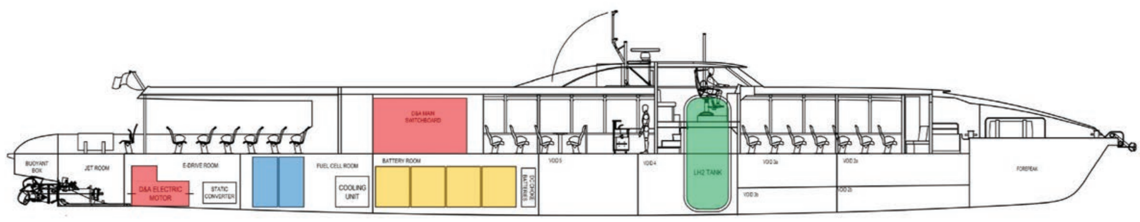
The team found that all three fuels were technically feasible. However, methanol was discounted as it would lead to significant CO_2 emissions at a local level. Gaseous and liquid hydrogen presented regulatory challenges that would need to be overcome. The team settled on liquid hydrogen as the most practical option. It concluded that retrofitting an existing vessel was unlikely to be economically viable and the cost of new vessels would be higher than the current marine gas oil and hybrid options. None of the options would be cheaper to operate than use of marine gas oil.

Project lead:

Thames Clippers (www.thamesclippers.com)

Partners:

Mayfair Marine, One2Thgree Naval Architects, and DNV



Feasibility Study

Project HOST (hydrogen and oxygen south Thames)

Investigating decarbonisation of a vessel fleet using hydrogen created at a riverside facility

What was the aim?

The project aimed to see whether land at the former Littlebrook Power Station was able to house a hydrogen plant able to meet the energy needs of Clipper Fleet, which operates a high-speed catamaran river bus service on the Thames in London, and also to supply HGV operators.

How did it go?

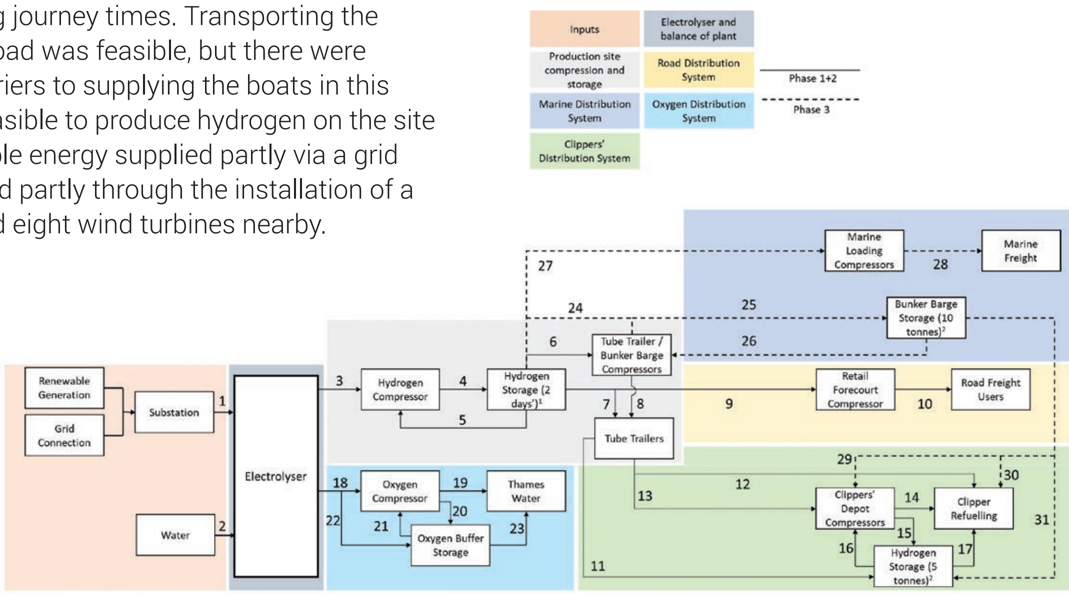
The partners found that docking the catamarans at the piers at Littlebrook would not be viable due to the long journey times. Transporting the hydrogen by road was feasible, but there were regulatory barriers to supplying the boats in this way. It was feasible to produce hydrogen on the site using renewable energy supplied partly via a grid connection and partly through the installation of a solar array and eight wind turbines nearby.

Project lead:

Ove Arup and Partners Ltd (www.arup.com)

Partners:

Wight Shipyard Company Ltd, Collins River Enterprises Ltd, National Grid Carbon Limited, and Shell New Energies UK Ltd



[1] Part of the storage will be kept at < 200 bar to ensure it can be recycled to the compressor. Part will be kept up to 500 bar for direct refuelling and supply to forecourt compressor.

[2] Part of the storage will be kept at < 200 bar to ensure it can be recycled to the compressor. Part will be kept up to 750 bar for direct refuelling.

Feasibility Study

Carnot marine vessel auxiliary power units – feasibility study

Operation of an ultra-efficient Carnot ceramic auxiliary engine on a Carisbrooke cargo vessel

What was the aim?

The aim was to test the suitability of a Carnot ceramic engine for use for auxiliary power on a large vessel. The ceramic engine can withstand higher temperatures than a conventional engine, eliminating the need for cooling and thereby saving fuel.

How did it go?

The study demonstrated that adoption of an ammonia/hydrogen Carnot engine would be profitable, comply with regulations and meet the needs of the cargo vessel. The team has identified a large target market for the technology and developed a costed plan for a demonstration. An assessment by the University of Strathclyde found that a Carnot engine could save 17,400 tonnes of CO_2 over its lifetime compared to the existing auxiliary engine in use on the cargo vessel.

What are the next steps?

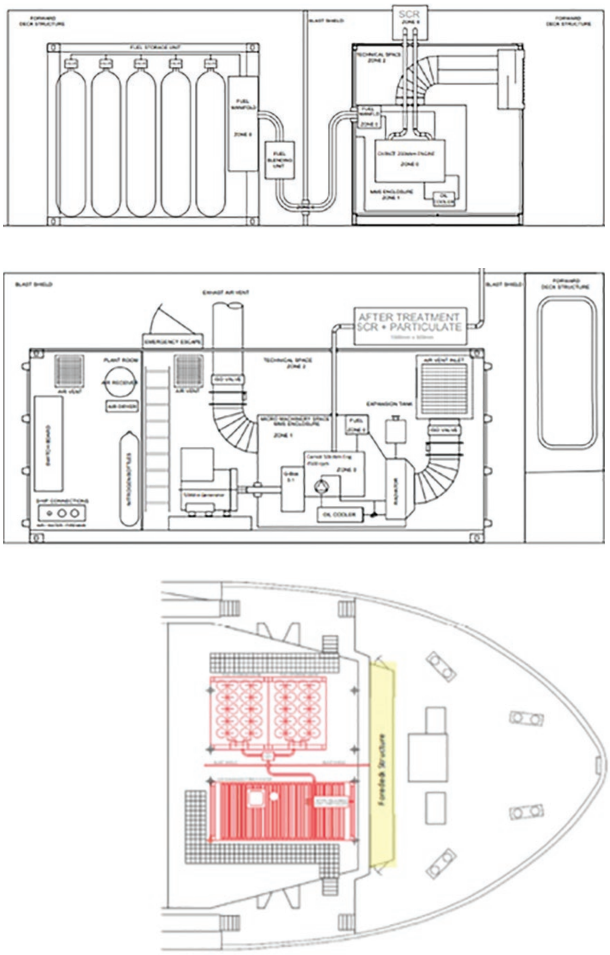
Carnot has a 36-month project plan to prototype a 50kw engine and then demonstrate it for 40 days on a Carisbrooke vessel. If successful, Carnot aims to be producing 10,000 engines a year by 2036 with a total value of more than £676 million.

Project lead:

Carnot (carnotengines.com)

Partners:

Carisbrooke Shipping Ltd, Cleanship Solutions Ltd, Optimat Ltd, and University of Strathclyde



Containerised alternative fuel storage systems and deck layouts

CARNOT

CARISBROOKE SHIPPING

optimat

University of Strathclyde Glasgow

Feasibility Study

Project Cygnus – zero-emissions potential in the re-power of small inboard and sterndrive craft

Zero-emission propulsion in small boats

Project lead:
EMB Power Ltd (www.embtechgroup.com)

Partners:
3 & Lime Design Ltd, and Electrical Architectures Ltd

What was the aim?

The partners wanted to examine the various options for zero emissions propulsion in boats of 7-to- 14 metres in length, assess the cost and practicality and look at regulations and public perception.

How did it go?

The project found that the best solution for converting small boats without excessive modification to the hull and to maintain performance would be to use a battery electric unit and to have
a hybrid option.

What are the next steps?

EMB will construct a prototype that would be a plug and play replacement for some of the most popular internal combustion engine power units. The aim is to have a modular format that would allow components to be switched out and replaced as the technology and battery capacity improves and as the supporting infrastructure and regulation develops.

Feasibility Study

CLEANFERRY: Pathways to decarbonising ferry operations across the River Tyne

Developing a technology route map for a carbon free Shields Ferry service

What was the aim?

CLEANFERRY aimed to understand energy use for the two ferries crossing the Tyne, assess viable and clean alternative propulsion systems and draw up a detailed plan for a demonstrator.

How did it go?

The project found that full electrification would be the most suitable way to decarbonise the Shields Ferry, and the Spirit of the Tyne was the best vessel to be retrofitted because it was expected to have the longest remaining life. It also found that 67% of all emissions took place while the ferries were stationary. A new mooring strategy could mean a saving of 25% in greenhouse gas emissions, and further reductions could be found by training staff in efficient performance strategies.

What are the next steps?

Next steps are to look at quick gains through a new mooring strategy and staff training, continued monitoring of emissions, and development of a virtual crossing to assess power demand both on the vessel and on shore-based facilities. The project anticipates it could achieve a progressive reduction in greenhouse gas emissions culminating in a 100% reduction by 2030.

Project lead:

Newcastle University (www.ncl.ac.uk/)

Partners:

Royston Ltd, and Tyneside Transport Services Ltd

Spirit of the Tyne - target vessel for this project

Feasibility Study

Zero-emission super efficient hybrid research vessel design for Plymouth Marine Laboratory

Designs for a zero-emission workboat for the Plymouth Marine Laboratory

What was the aim?

The aim of the project was to design a suitable hull for the laboratory's workboat and develop a hydrogen/oxygen steam propulsion system. The team also aimed to integrate an electric propeller drive and wingsail technology, model emissions, and develop a fully costed plan for a demonstrator.

How did it go?

The team has developed a detail costed plan for the QuestZero workboat demonstration project. It estimates that a green-hydrogen-fuelled craft would save 280,000 tonnes of CO2 over a three-year period.

What are the next steps?

The aim is to retrofit a 14-17m surveying catamaran with the technologies investigated in the study, including an innovative hydrogen steam turbine, a high efficiency propeller, and a wingsail with hydroelastic foils.

Project lead:

ID Portal Engineering (www.idportal.net)

Partners:

Steamology, and Duo Drive

QuestZero

Research Vessel PML | Plymouth Marine Laboratory

QuestZero

PML | Plymouth Marine Laboratory

IDPortal Engineering

STEAMOLOGY zero emission power solutions

duodrivetrain end-to-end performance engineering

Feasibility Study

Offshore charging vessel

Investigating the design of a permanently stationed offshore charging vessel

What was the aim?

The aim was to look at the feasibility of having a charging vessel permanently stationed at sea that could charge electrified boats servicing offshore wind farms.

How did it go?

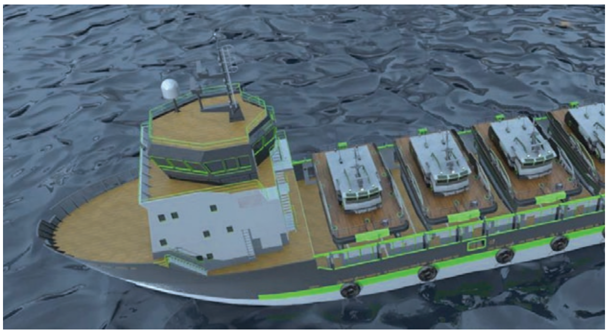
The partners identified a site in the Humber area that could host a 'mother ship'. The ship would be capable of charging crew transfer vessels alongside it during the day and capable of lifting five vessels on board at night and charging them. It would be connected to the same substation that serves an offshore wind farm. The partners have also identified a ship that could be refitted with the necessary infrastructure. They estimate that an offshore charging vessel would allow each crew transfer vessel to save 309,000 tonnes of CO_2 over its 30-year life. If all crew transfer vessels were electric, it could lead to industry-wide savings of 316,725,000 of CO_2 by 2030.

What are the next steps?

The partners aim to invest in the retrofit of the ship identified in the project and demonstrate its feasibility. They are proposing to create 10 offshore charging vessels over the next 10 years, each serving five electric crew transfer vessels. This could provide new shipbuilding activity in the UK and create more than 200 highly skilled technical and engineering jobs.

Project lead:
Aluminium Marine Consultants Ltd (https://www.aluminium-boats.com)

Partners:
Offshore Renewable Energy Catapult, MJR Power and Automation, Turbulent Simulations and Jeremy Benn Associates



Feasibility Study

Oceanways – zero emission autonomous cargo submarine

Building and testing a prototype submarine powered by green hydrogen

What was the aim?

The partners aimed to test the feasibility of building a prototype submarine. They also wanted to understand the technical and economic challenges.

How did it go?

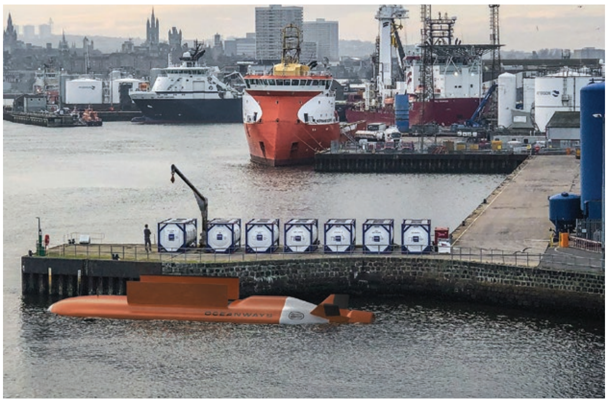
The team has identified a commercial use case in Scotland. It says its solution would lead to significant reductions in carbon emissions over conventional lorry and ferry freight.

What are the next steps?

The project is planning to do a demonstration on a route in Scotland. It estimates that it could create 30,000 jobs by 2028 if it meets its growth plan.

Project lead:
Oceanways technologies Ltd
(www.oceanways.co)

Partners:
Buckley Yacht Design Ltd, M Subs Ltd, and University of Strathclyde



Rendered images of the Oceanways submarine

OCEANWAYS®

BYD NAVAL ARCHITECTS | MSubs Ltd underwater vehicles & equipment | University of Strathclyde Glasgow

Feasibility Study

Feasibility study into decarbonisation of Service Operation Vessel newbuild and retrofit

Ways to achieve a net zero maritime service operation by 2040

What was the aim?

The project aimed to investigate how Bibby Marine could achieve its target of achieving net zero for its fleet of service operation vessels by 2040. Bibby provides a platform for the operation and maintenance of offshore wind farms, including hotel services for up to 90 people on board. Each boat produces 7,000 tonnes of greenhouse gases a year.

How did it go?

The team looked at two ways of achieving the target – through use of liquid hydrogen as a fuel and through Expleo's methanol-fuelled solid oxide fuel cell system with carbon capture storage and batteries. Liquid hydrogen was feasible and could deliver an 83% reduction in greenhouse gas emissions. However, the technology was unlikely to be ready until later in the decade. The fuel cell system could lead to a 93% reduction in greenhouse gases and an annual saving of £1.3 million.

What are the next steps?

The project consortium is proposing to deliver a service operating vessel using Expleo's technology. Efforts to secure regulatory approval are under way, and the aim is to achieve commercial readiness by the end of 2025.

Project lead:
Bibby Marine Services Ltd

Partners:
Expleo Engineering UK Ltd, and Houlder Ltd

Computer render of zero emission Service Operation Vessel

Feasibility Study

Cross-river zero-emission ferry

A design for a zero-emission river ferry with autonomous features to minimise energy usage

What was the aim?

The project aimed to carry out a feasibility study into a zero-emission ferry on a Thames Clipper crossing between the Hilton Double Tree Hotel and Canary Wharf in London. This included work on the vessel and its power source, the shore infrastructure and an automated mooring system.

How did it go?

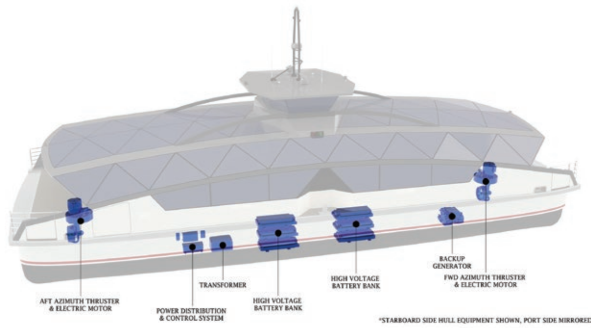
Designs for a new boat with a catamaran hull were examined from the perspective of propulsion, efficiency, mooring and berthing. The study found that the new hull could carry sufficient batteries to propel the boat for a working day and to allow charging overnight. Planning approval in principle was achieved for moorings in deeper water and for floating J-shaped berths for loading passengers and cyclists on and off. The study also selected options for an automated mooring system, and a power management and battery system with automated energy management features.

What are the next steps?

The study has provided a costed plan for a demonstrator project covering the construction of the vessel and berths and establishment of a ferry service once the necessary consents have been obtained.

Project lead:
Thames Clippers (www.thamesclippers.com)

Partners:
BAE, Beckett Rankine, Wight Shipyard, and AusYachts Naval Architects



Computer renders of Thames Clipper zero-emission ferry

thames clippers

BAE SYSTEMS

BECKETT RANKINE Marine Consulting Engineers

WIGHT SHIPYARD CO.

AUS YACHTS

Feasibility Study

SKYTUG – wind propulsion for deep sea shipping

Investigating the feasibility of a kite-propelled ocean tug to tow cargo ships

Project lead:
Bluewater Engineering Ltd
(www.skytug.co.uk)

What was the aim?

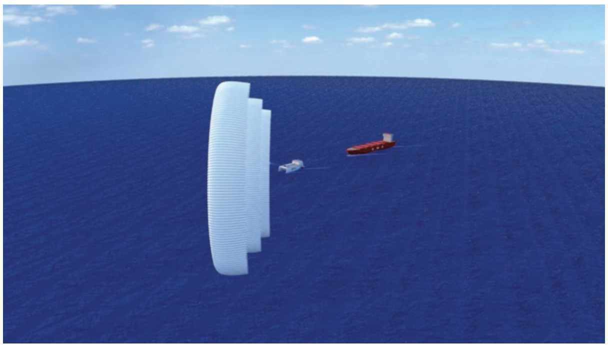
The aim of the project was to assess the technical and economic feasibility of the SKYTUG concept. It involves using a variety of large kites for propelling and towing cargo ships on ocean voyages.

How did it go?

The study showed that the concept was technically and economically viable.

What are the next steps?

The next stage will involve the design and construction of a demonstration vessel and sea trials.



Feasibility Study

Transition to hydrogen-powered ocean-going and short-sea shipping with enabling retrofit technologies

Investigating hydrogen power for a support vessel

What was the aim?

The partners aimed to explore the possibility of retrofitting hydrogen power to an offshore windfarm support vessel operated by O S Energy, the Prince Madog. This included developing hydrogen storage solutions, ways of saving energy to minimise on-board storage, investigating power trains, and exploring the technical and economic feasibility.

How did it go?

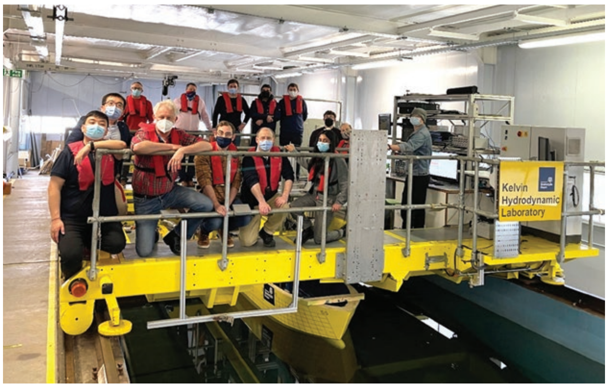
The team looked at four innovations – onboard hydrogen storage, energy-saving solutions for a hydrogen-powered ship, a power train, and a multi-chemistry battery system. The project concluded that the innovations could be retrofitted to the Prince Madog.

What are the next steps?

The partners aim to deliver a hydrogen-powered offshore support vessel in the UK in four-to-five years.

Project lead:
University of Strathclyde

Partners:
Logan Energy Ltd, Solis Marine Engineering Ltd, O S Energy (UK) Ltd, Chimera Energy Ltd, and University of Exeter



Feasibility Study

Composites application to propulsion systems for upscaling and low emissions

Investigating the use of composite materials for propellers and propulsion systems to reduce emissions

What was the aim?

The partners aimed to improve the design and modelling of a propulsion system with a 6m diameter propeller and to look at new composite materials, designs and manufacturing processes.

How did it go?

The partners produced a preliminary design for a composite propulsion system that would reduce greenhouse gas emissions and could be used with low-density and zero-carbon fuels. They also produced a business case and investment plan to demonstrate the propulsion system on a vessel.

Project lead:

Teignbridge Propellers International Limited

Partners:

High Value Manufacturing Catapult
(National Composites Centre)

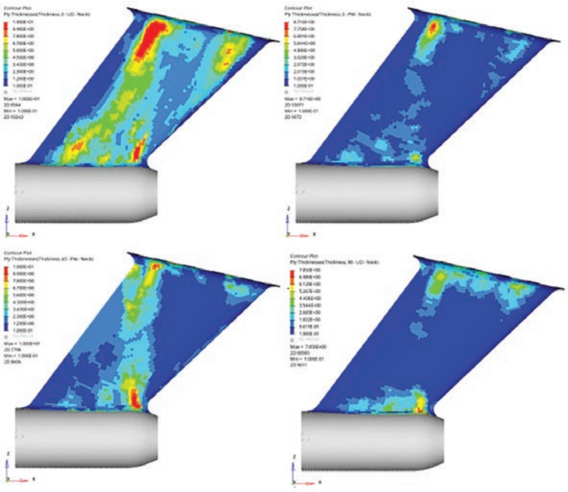


Figure 10 –Required Ply Thicknesses, Top Left: 0° UD, Top Right: 0° Woven, Bottom Left: ±45° Woven, Bottom Right: 90° UD

Feasibility Study

Project LiNa-Wave: Development of a working model solid-state battery system for maritime applications

Viability of a sodium-metal-chloride (solid-state) battery for the maritime industry.

What was the aim?

The partners aimed to confirm the technical and commercial viability of a solid-state battery for the maritime industry.

How did it go?

The team achieved a proof of concept of the battery, which was validated by an independent expert. Safety and performance requirements were confirmed, and modelling allowed thermal management of the battery pack to be optimised and the design of the pack to be tailored to the needs of the maritime industry. Partners also gained an understanding of the regulatory challenges and industry expectations, which confirmed their belief that sodium-metal-chloride batteries will achieve compliance much easier than lithium-ion batteries.

What are the next steps?

The team has drawn up a follow-on project that outlines the steps needed to get to the launch of a product.

Project lead:

LiNa Energy Ltd (www.lina.energy)

Partners:

Lancaster University, and Bibby Marine Services Ltd

Feasibility Study

Zero-carbon base load power for large ships

Fuel cell and battery technology to power a cruise ship's auxiliary systems

What was the aim?

The project aimed to investigate the feasibility of replacing the use of internal combustion engines to run a cruise ship's heating, ventilation, air conditioning and waste processing systems with solid oxide fuel cell technology and batteries. A typical cruise ship needs 10 megawatts of power, the same as needed to power 10,000 UK homes.

How did it go?

The project showed that a cruise ship could use a fuel cell technology and batteries powered by liquefied natural gas, with the possibility of a future change to green hydrogen. A system based on liquefied natural gas would eliminate particulate matter, significantly reduce nitrous oxides, and cut CO_2 emissions by 20 to 27%. Switching to green hydrogen would eliminate particulates and CO_2 and reduce nitrous oxides even further. The team also assessed that the system would meet regulations and could be integrated into the design of a cruise ship.

What are the next steps?

The project suggests the solid oxide fuel cell technology and battery should be developed further, with the system components initially working together in a land-based demonstration and then at a larger scale on board a vessel.

Project lead:

Carnival PLC (www.carnivalcorp.com)

Partners:

University of Southampton, Shell International Trading and Shipping Company Ltd, Ceres Power Ltd, and Lloyd's Register Group Services Ltd

Feasibility Study

BRAMBUS

Investigate the economic and operational viability of hydrogen fuel cells in the maritime sector

What was the aim?

The partners aimed to investigate the economic viability of Bramble's innovative fuel cell technology based on printed circuit boards. They also aimed to look at the regulatory gaps that needed to be addressed and at issues of hydrogen storage and supply.

How did it go?

The project developed a detailed design and business case for use of Bramble Energy's fuel cell technology in a hybrid fuel cell and battery combined heat and power system. It says the system is ready to operate in a recreational inland water vessel.

Project lead:
Bramble Energy Ltd
(www.brambleenergy.com)

Partners:
E P Barrus Ltd

Port and infrastructure technologies

Demonstration

Maritime e-charging living lab

Shore-side charging facilities for electric marine vessels

What was the aim?

The partners planned to set up the UK's first hub of on-shore electric charging facilities for electric boats in Plymouth.

How did it go?

The project has installed a series of rapid charging stations in prominent locations along the perimeter of Plymouth Sound National Marine Park. They include the UK's first 150kw chargepoint for boats at Mount Batten, the UK's first 75kw chargepoints for boats at Queen Anne's Battery, and a 25kw installation at the Barbican landing stage. Charging times in Plymouth are almost 40 times faster than many marina power supplies could achieve for electric vessels. Research by the university suggests the network could reduce the port's emissions by 96.6% in the next 30 years.

Project lead:
University of Plymouth (www.plymouth.ac.uk)

Partners:
Plymouth City Council, Princess Yachts Ltd, and Aqua SuperPower Ltd

Demonstration

Hydrogen bunkering for Crew Transfer Vessels

Develop and deploy hydrogen bunkering to support hydrogen-powered vessels

What was the aim?

The aim was to build a bunkering trailer to store and deliver hydrogen for a hydrogen-powered crew transfer vessel developed by Windcat Workboats and CMB Revolve Technologies Ltd. This included storage on board the ship, a mobile bunkering station, a fixed bunkering station and a container system.

Project lead:
CMB Revolve Technologies Ltd (cmb.tech)

Demonstration

Offshore wind on-turbine electrical vessel charging system

Installing electric vessel chargepoints on an offshore wind turbine

What was the aim?

The project aimed to design, test, build and factory test a vessel chargepoint for crew transfer vessels that could be fitted to an offshore wind turbine. Crew transfer vessels using conventional fuels contribute 10-20% of the lifecycle carbon emissions of a wind farm project, and lack of charging at sea is a barrier to vessel electrification.

How did it go?

The partners designed, built and tested a system that uses the infrastructure already in place on a turbine platform. A cable reel lowers the cable from the turbine to the vessel where it is plugged into the vessel's battery charger. Partners have also developed standards, working practices and procedures to carry out this activity at sea.

What are the next steps?

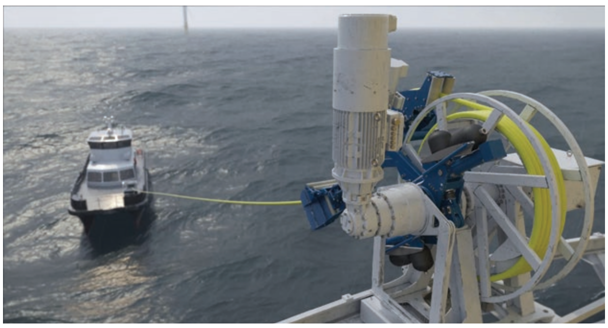
MJR Power now has a product that can be installed at offshore wind farms in the UK and globally.

Project lead:

MJR Power and Automation (www.mjrpower.com)

Partners:

Tidal Transit Ltd, Artemis Technologies Ltd, Xceco Ltd, and Offshore Renewable Energy Catapult



Top - charging system in factory. Middle and bottom - computer renders of charging system in situ on wind turbine

Demonstration

Clean Tyne – UK blueprint for decarbonisation demonstrator

Energy digitalisation and decarbonisation in a port and a decarbonisation demonstrator

What was the aim?

The aim of the project was to assess the scope for energy digitalisation and identify the way forward for a decarbonisation demonstrator at the Port of Tyne. The Port of Tyne aims to be carbon neutral by 2030 and fully electric by 2050.

How did it go?

The project was a great success, the DEOP platform developed by Siemens was hugely beneficial to the Port of Tyne, allowing it to visualise its current energy utilisation in real time.

The system also gave useful insights into feasibility around future projects on the ports clean energy roadmap. This gave the port the ability to undertaken informed cost benefit analysis of future energy project enabling the prioritisation of the most cost effective solutions.

What are the next steps?

The port will continue to work with Siemens and the other partners to further develop the system to integrate addition energy sources as more smart metering comes online. We will also integrate fuel usage statistics to aid the optimisation of quayside equipment.

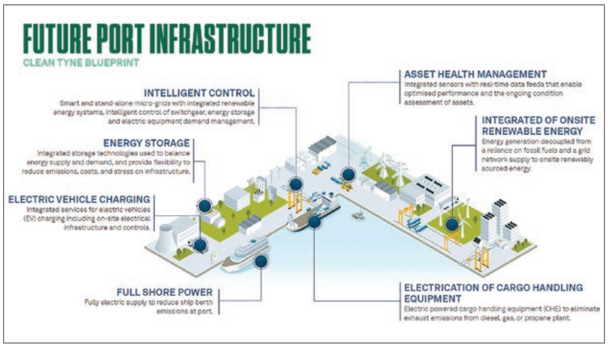
We shall also explore opportunities to introduce new metrics to the system including water and waste.

Project lead:

Port Of Tyne Authority

Partners:

Connected Places Catapult, North of Tyne Combined Authority, Siemens PLC, and Newcastle University



Port and infrastructure technologies

Demonstration

Supercapacitors for zero-emission port-side vehicles

Developing energy storage systems for cargo-handling vehicles

What was the aim?

The partners aimed to further develop and scale up new high-performance energy storage systems based on use of high-power, high-energy-density supercapacitors. This included demonstrating small batch production of the specialised electrodes and their integration into pouch cells, battery management, charging infrastructure and testing and validating in a cargo handling vehicle at the ports of Milford Haven and Belfast.

Project lead:

Westfield Sports Cars Ltd (westfield-sportscars.co.uk)

Partners:

Centre for Process Innovation Ltd, Milford Haven Port Authority PFP Ltd Partnership, and 2-Dtech Ltd

2-DTECH

Demonstration

Shipping, hydrogen and port ecosystems UK – SHAPE

Generating hydrogen and using it in a large and successful port

What was the aim?

The partners aimed to demonstrate a modular green hydrogen generation system for Portsmouth International Port. They also wanted to deliver a digital decision support tool for port managers across the UK to use in determining the economic case for hydrogen generation and use.

How did it go?

The partners successfully delivered three main elements of demonstration – a plug-and-play and scaleable hydrogen electrolyser and refueler, a hybrid hydrogen engine retrofitted to an existing vessel, and a digital twin ecosystem. The last element led to the creation of a dashboard that is already being used by the port as a monitoring and implementation tool for clean maritime. The project also investigated regulations and standards to both support the development of the demonstrator and to aid development of a clean maritime plan for Portsmouth International Port.

What are the next steps?

The project has developed a five-year vision to significantly improve air quality at the port and ensure net carbon neutral operations by 2030. It envisages a mix of electrification, digitisation and use of alternative fuels and recommends a range of investments supported by business cases developed during the project. Discussions are also under way on developing the vision on a larger scale to benefit the city and the region.

Project lead:

University of Portsmouth (www.port.ac.uk)

Partners:

Iotic Labs Ltd, Lloyds Register, Connected Places Catapult, KnowNow Information Ltd, University of Brighton, Barter for Things Ltd, Cox Powertrain Ltd, Engas Global Ltd, and Portsmouth International Port

Demonstration

A pilot plant demonstration of direct air capture of atmospheric CO_2, as the crucial first step to synthesising carbon-neutral methanol as a green marine fuel

Capturing CO_2 to synthesise carbon neutral methanol

Project lead:
Carbon Neutral Petrol Ltd

What was the aim?

The project seeks to determine the energy cost of the capture and release of the CO_2 and the cost of the hydrogen that is required. Direct Air Capture (DAC) methods of CO_2 are in their early stages of development. We have plans to further modify the electrolyser so that all the hydrogen need can be co-produced which will lower the energy cost significantly.

While in the first instance, the target market for the DAC CO_2 will be the synthesis of carbon neutral methanol as a carbon neutral replacement fuel for fossil diesel in commercial shipping, a successful DAC project will open the way to being able to also synthesise petrol and aviation fuel in a carbon neutral manner.

Feasibility Study

National clean maritime demonstration hub

A zero-emission fuel demonstration zone in a port

What was the aim?

The team aimed to investigate demand for zero-emission fuels at the port of Grimsby and the technical potential of providing it. Partners also aimed to draw up a blueprint for clean maritime technology in the UK.

How did it go?

The project looked at the provision of test and demonstration facilities including zero-emission fuel infrastructure, test rigs for mechanical and electrical systems, test site and dry docks, robotics and autonomous systems, and an area of 1,000 square kilometres of water at Plymouth suitable for building and supporting next-generation marine technologies. It also identified a range of measures to support a UK supply chain, including a technology accelerator, support for technology transfer from other industries, improved training and skills, a venture capital fund, and work on regulations.

What are the next steps?

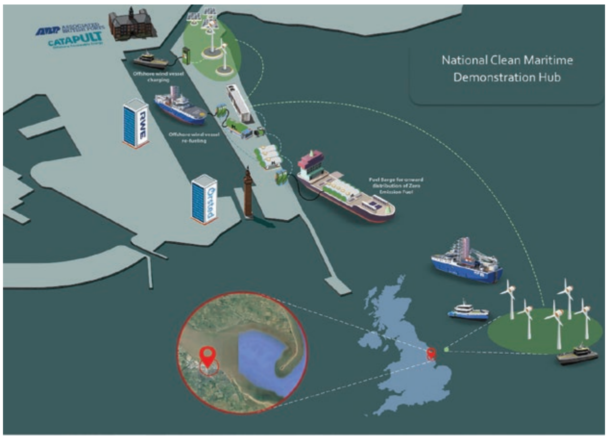
The project estimates that it could cost around £7 million to set up a zero-emission hub in Grimsby and a further £1 million a year to run it.

Project lead:

Offshore Renewable Energy Catapult (ore.catapult.org.uk)

Partners:

MJR Controls Ltd, Rix Shipping Company Ltd, Lloyd's Register, Zero Emissions Maritime Technology Ltd, Wood Group UK Ltd, TPG Maritime Ltd, Infrastrata PLC, and Associated British Ports



CATAPULT Offshore Renewable Energy

mjr Power & Automation · Z-M Tech · wood. · wa · tpgroup · Lloyd's Register · ABP Associated British Ports · Harland & Wolff

Feasibility Study

Vertically integrated cloud-based ports

An energy digital twin to help plan the decarbonisation of a port

What was the aim?

The team aimed to create an energy digital twin for Teesport, which is targeting carbon neutrality by 2027 mainly through electrification and local clean energy production. It aimed to show how a microgrid managed system could avoid the need for large infrastructure upgrades.

How did it go?

The partners looked at developing a set of 'digital twin' features and functions that would improve energy efficiency and local energy consumption. These included an energy management system combined with an energy storage system and smart charging for electric vehicles. The team looked at the vertical integration of the features and a scalable infrastructure was specified and tested using a digital twin platform.

What are the next steps?

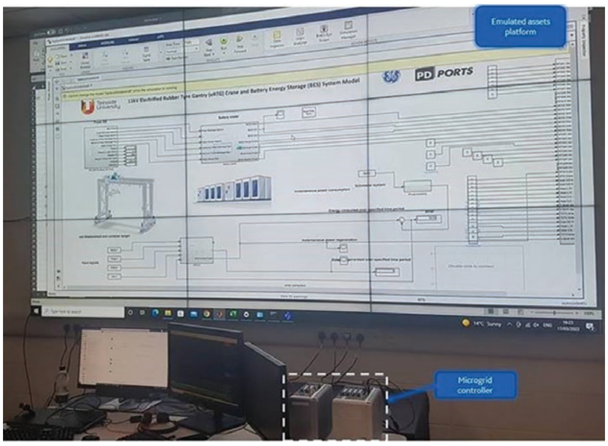
The project is proposing a follow-on demonstration project based on the specification drawn up in the study.

Project lead:

Ge Energy Power Conversion UK Ltd (www.gepowerconversion.com)

Partners:

Connected Places Catapult, Teesside University, and PD Teesport Ltd



Feasibility Study

Data-led emissions management

Investigating ways to improve emissions monitoring and reporting in ports

What was the aim?

The aim was to establish a way to generate detailed emissions estimates from vessel transmissions.

How did it go?

The team established a way to calculate emissions based on data from the port of Plymouth. It was able to set up a live connection to view emissions in real time and to demonstrate the value of the data through the processing of data sets. The team was also able to create emissions estimates from historic data going back to 2016. They found that most emissions came from operational vessels, oil tankers and service vessels. More than 55% of emissions were produced by stationary vessels. The partners also considered how the data could be used by fleet operators to make their operations more efficient.

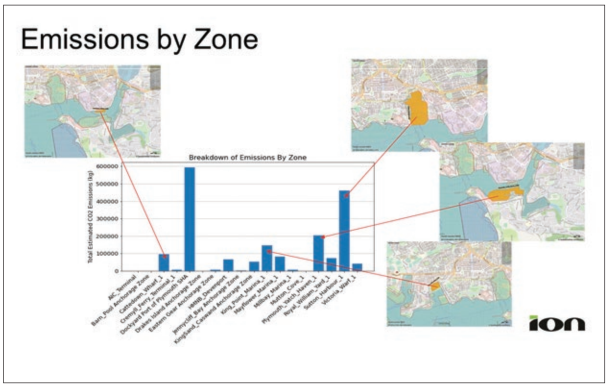
What are the next steps?

The team is proposing three future projects to:

- review the data to see what actions can be taken arising out of it
- run an assessment of emissions from offshore windfarm crew transfer vessels running out of Grimsby
- assess emissions from the Port of Tyne with the aim of finding ways to reduce them.

Project lead:
Concept Systems Ltd

Partners:
Offshore Renewable Energy Catapult, and Plymouth Marine Laboratories



Feasibility Study

Northern Ireland green seas

Looking at ways to decarbonise a large transport and freight port, a small leisure port and a remote island harbour

What was the aim?

The study aimed to look at practical ways to reach net zero operations by 2050 at three locations – Belfast Harbour, Bangor Marina and Rathlin Island.

How did it go?

The results of the feasibility study provided a roadmap for delivering on zero-emission maritime operations in Northern Ireland. It considered battery energy storage, green hydrogen production and bunkering, shore-side electrical grid infrastructure and renewable energy supply. It found that some areas could upgrade infrastructure relatively easily while others would find it a significant challenge.

What are the next steps?

The team has drawn up a demonstration project that would look at the infrastructure needed to decarbonise Belfast Harbour's port and vessel operations.

Project lead:

Energia NI Storage Ltd (energiagroup.com)

Partners:

Artemis Technologies Ltd, Belfast Harbour, Mott Macdonald Ltd, N Ireland Electricity Networks Ltd, Queen's University Belfast, and Ulster University

Port and infrastructure technologies

Feasibility Study

Freeport East energy hub feasibility study

Investigating a low-carbon hydrogen hub at the Port of Felixstowe

What was the aim?

The partners aimed to examine the potential for the Port of Felixstowe to decarbonise both its on- port activities and those in the interconnected local area. This included looking at the various ways of doing this, the economic, regulatory, social, and technical challenges, and the opportunities.

How did it go?

The study found an opportunity to rapidly reduce CO_2 emissions by 60% through use of hydrogen. A hydrogen fuelling station could also be scaled up to serve vehicles such as visiting HGVs. It found that the greatest impact could be achieved through the wider activities. The proposed Sizewell C nuclear power station in Suffolk could provide low-carbon electricity and heat that would support hydrogen production at or near the port through steam-assisted electrolysis.

What are the next steps?

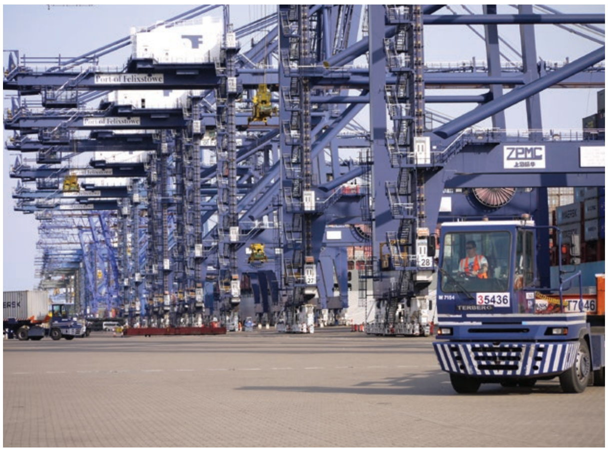
The project is part of a wider vision for the region as a hydrogen hub using low-carbon electricity and heat from nuclear power stations and offshore wind farms.

Project lead:

Felixstowe Dock and Railway Company (www.portoffelixstowe.co.uk)

Partners:

EDF Energy R&D UK Centre Ltd, Cranfield University, and NNB Generation Company (Szc) Ltd



Feasibility Study

Feasibility study for shore power in Aberdeen Harbour

Investigating use of on-shore power to supply vessels at berth

Project lead:
Connected Places Catapult

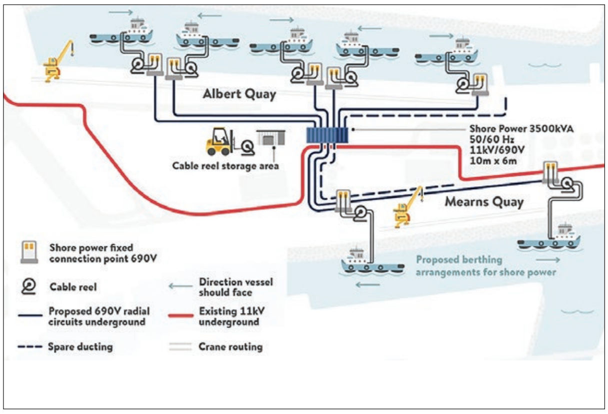
Partners:
Aberdeen Harbour Board

What was the aim?

The project aimed to build on the results of a study that found more than 75% of emissions at the Port of Aberdeen came from use of ship engines to power auxiliary systems while they were at berth. The team aimed to develop a detailed design and outline business case for a demonstration project to supply green electricity from the shore.

How did it go?

The project produced a design for demonstration of shore power facilities for seven berths. It found that implementing shore power in Albert and Mearns Quay would save 60,000 tonnes of greenhouse gases over 20 years, an 82% reduction in emissions. Rolling it out to the whole port would save 34,000 tonnes of greenhouse gases a year or 78% of the harbour's total emissions.



What are the next steps?

Findings of the study will be shared with other ports across the UK. The team hopes a demonstration project will create an environment for rapid take-up of shore power.

Feasibility Study

Dover clean ferry power: techno-economic feasibility analysis of electric power solutions for Port of Dover ferries

Investigating the feasibility of electric power for short Channel crossings

What was the aim?

The partners sought to investigate the technical and economic feasibility of using electric power for English Channel crossings on the Dover-to-Calais and Dunkirk ferries. This included identifying energy demand and supply now and in the future for hybrid or fully electric propulsion.

How did it go?

The team developed several innovative tools to help the port and ferry operators to understand the scale of the issue and the developments needed to address it. It drew up a roadmap towards net zero emissions for the port and outlined a demonstration project. The team found that there would be a 90% saving in greenhouse gas emissions if all ferries on the routes changed to full electric power for propulsion and services. It would require significant improvements to energy infrastructure at the port.

What are the next steps?

The partners have identified further work to address the unique aspects of operations at Dover where ferries have a fast turnover and carry more than £144 billion in international trade. They have particularly identified the need to do further work on ultra-fast charging, energy storage and use of renewables.

Project lead:
University of Kent (www.kent.ac.uk)

Partners:
Port of Dover, P&O Ferries, Schneider Electric, and Warwick Manufacturing Group

Feasibility Study

Mayflower – the feasibility study

A green hydrogen supply and reduction in greenhouse gas emissions at a port

What was the aim?

The project aimed to look at the technical and economic feasibility of providing a green hydrogen supply to the Port of Immingham and how that would reduce greenhouse gas emissions.

How did it go?

The team looked at how equipment could switch from handling fossil fuels to hydrogen and how that would unlock hydrogen and ammonia as a fuel for port-related transport. The project estimated that switching port operations to hydrogen could save 5,100 tonnes of greenhouse gases a year and a further 5,000 tonnes if extended to other existing terminal operators. However, they identified high commercial risks for early investments, a lack of development in port fuel cell equipment, higher operating costs of hydrogen and lack of clarity in targets for decarbonisation of maritime operations.

What are the next steps?

The project suggests a three-phased approach. Phase one would include an economic study, research on transport in the surrounding area and a development plan for fuel cell conversion. Phase two would include equipment prototypes, a demonstration in a real operating environment and building of a hydrogen fuel station. A third phase would see the start of small-scale operations from 2026. Ultimately, this could see greenhouse gas reductions of 10,100 tonnes a year.

Project lead:

Uniper Technologies (www.uniper.energy/)

Partners:

Associated British Ports, Siemens Energy UK, and Toyota Tsusho UK

Feasibility Study

Hydrogen offshore transfer system

Taking hydrogen refuelling station technology from the land to sea

What was the aim?

The team aimed to look at the technical and economic feasibility of a hydrogen offshore transfer system for the maritime industry.

How did it go?

The partners carried out an initial scoping study of a hydrogen offshore transfer system and looked at the business case and a future demonstration plan. The work included creating a conceptual design in enough detail to highlight and address the main safety and technological risks. It proved that a hydrogen offshore transfer system could be built and operated safely.

What are the next steps?

The project has shown that a hydrogen offshore transfer system could be used to refuel small to medium-sized vessels with gaseous hydrogen, most likely in combination with other fuels. Future work should look at liquid hydrogen potential for larger ships.

Project lead:

Jebb Smith Ltd (jebbsmith.com)

Partners:

Logan Energy Limited, Cenex (Centre of Excellence For Low Carbon and Fuel Cell Technologies)

Feasibility Study

Green hydrogen production barge

Replacing Poole Harbour's use of diesel with hydrogen

What was the aim?

The partners aimed to assess how much hydrogen would be needed to replace the diesel used by Poole Harbour and whether it was feasible to produce the hydrogen on a barge. They aimed to look at the cost of producing the hydrogen, any potential efficiency gains from using it as a fuel, and potential reductions in greenhouse gases.

How did it go?

The project found Poole Harbour would need five tonnes a month of hydrogen to operate its assets such as mobile cranes, forklifts, pilot boats and harbour tugs. Enough hydrogen could be produced on a 40m barge moored at the quayside and hosting an electrolyser, compressor, storage and dispenser units. The cost of switching could be competitive with use of red diesel.

Project lead:

Longitude Consulting Engineers Limited (www.longitude- engineering.com)

Partners:

Poole Harbour Commissioners, Green Hydrogen Solutions Ltd, London Offshore Consultants Ltd

Smart shipping and other technologies

Feasibility Study

NEPTUNE

A desk-based digital tool to analyse, scope and develop plans to support zero emission maritime operations in the Shetlands

What was the aim?

The partners aimed to develop a toolkit that would reduce the cost of planning and implementing zero-carbon energy systems for ships and buildings on the Shetlands and that could also be used on other islands or in other ports. It supports Project ORION, a partnership developing a green hydrogen export business by harnessing offshore wind power.

How did it go?

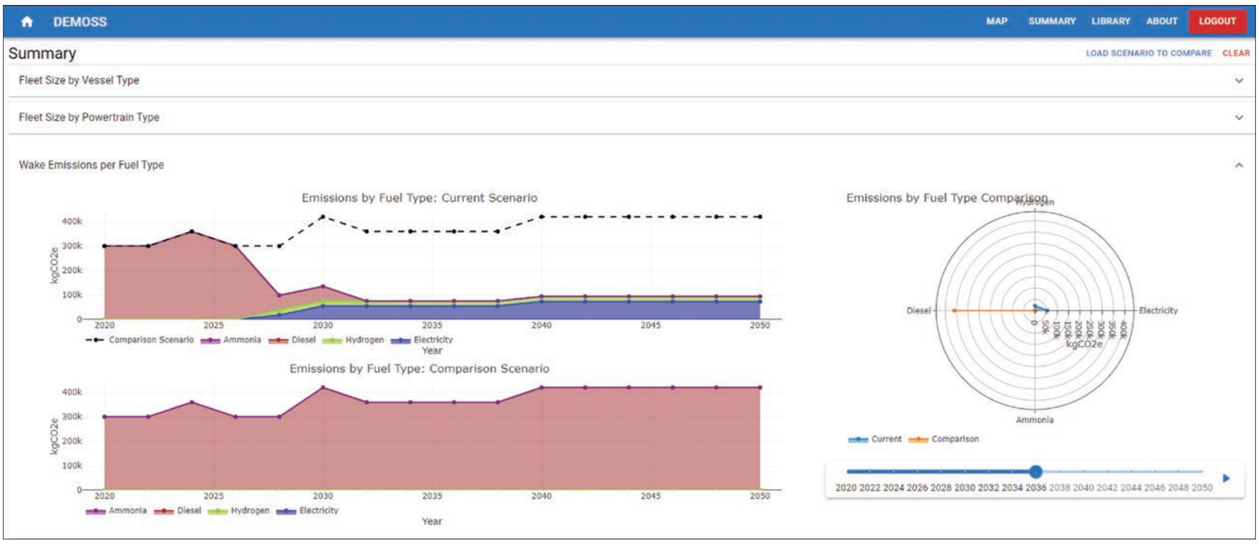
The project created a database of the maritime system, and gathered data for ports, vessels and the green energy capacity of the island. Partners collected and exchanged information on technologies and fuels. This allowed the successful creation of a decision-modelling and support system digital tool.

Project lead:

University of Strathclyde (www.strath.ac.uk)

Partners:

Rosyth Royal Dockyard Ltd, Ricardo UK Ltd, and Shetland Islands Council



Feasibility Study

Ship and fleet emission calculator

Evaluating an emissions calculator driven by artificial intelligence for individual ships and fleets

What was the aim?

The project aimed to see if it was possible to create an emissions calculator that would also integrate into an existing shipbroker product. The tool could be used to minimise the carbon footprint of ships and fleets and support future developments in propulsion technology.

Project lead:
Spot Ship Exchange Holdings Ltd
(www.spot-ship.com)

Feasibility Study

Lifecycle energy solutions for clean Scotland/UK maritime economy

Developing a UK roadmap for clean energy in the West Scotland and UK shipping sector

What was the aim?

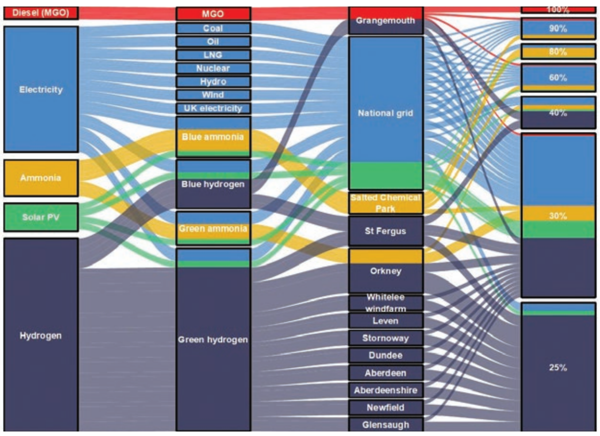
The partners aimed to look at the economic, operational and environmental viability of three fuels for the shipping sector – ammonia, hydrogen and electricity.

How did it go?

The study looked at 31 ferries working on 27 short coastal routes in West Scotland and examined various scenarios for infrastructure and energy grids for the three different fuels. This included looking at technical, safety and regulatory requirements and likely barriers and supply chain constraints. It also looked at conceptual designs for ships running on the various fuels. The project has provided potential solutions for future maritime operations.

Project lead:
University of Strathclyde

Partners:
Caledonian Maritime Assets Ltd



CMAL
Caledonian Maritime Assets Ltd
Stòras Mara Cailleannach Eta

University of Strathclyde Glasgow

Smart shipping and other technologies

Feasibility Study

Feasibility study to explore net carbon zero vessel solutions on the Thames

Investigating the feasibility of autonomous and zero-carbon freight transport on Thames barges

What was the aim?

The project aimed to look at the feasibility of switching Thames operator Cory's operations to a fleet of 24 autonomous and zero carbon barges. Cory transfers a million tonnes of waste a year and it represents about 29% of all Thames freight traffic. It uses 1,315,384 litres of fuel and generates 3,651 tonnes of greenhouse gases a year.

How did it go?

The study suggested electric propulsion and an autonomy system could be dropped into a future barge. Two barges could be rafted together to reduce costs. Operations would be more expensive than existing ones, but this did not account for rising fuel costs or potential future carbon levies. Capital costs of the new system would be significant.

What are the next steps?

The project drew up plans for a demonstrator with a semi-autonomous system and a hybrid electric system rather than full electric due to technical uncertainty around the full solution, significant capital costs and lack of clarity around Thames freight standards. However, although the concept was promising, the cost and challenging timescale of the plan mean it is unlikely to proceed to the next phase.

Project lead:

Bae Systems Surface Ships Ltd (www.baesystems.com)

Partners:

Wight Shipyard Company Ltd, Cory Environmental Holdings Ltd, and Bae Systems (Operations) Ltd

Feasibility Study

REMASTER (Recyclable marine structure towards emission reduction)

Use of recyclable thermoplastic composite in vessel structures to support adoption of zero-emission propulsion

What was the aim?

The partners aimed to investigate the adoption of automated manufacturing processes to reduce production emissions and waste.

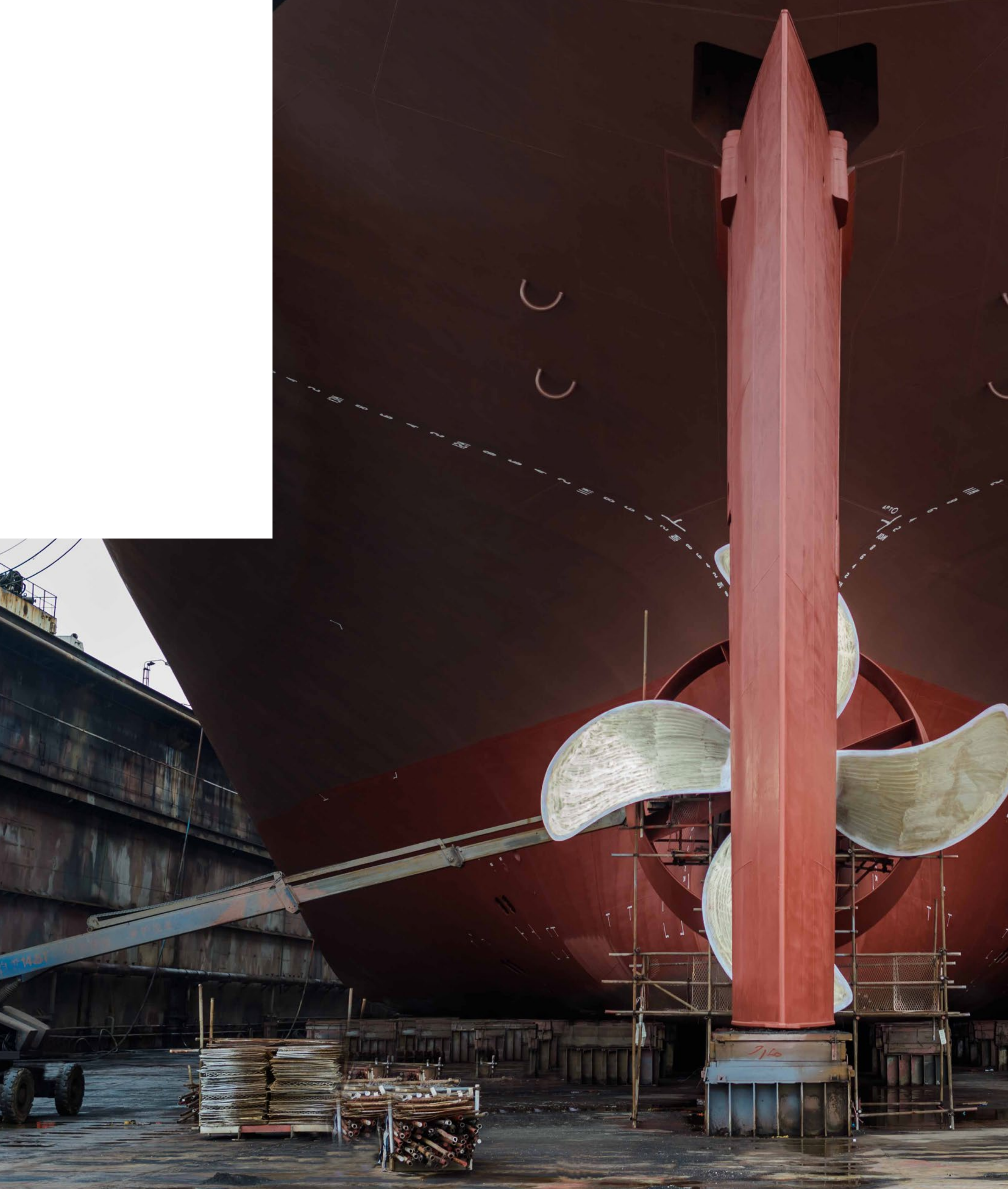
How did it go?

The study looked at innovative materials and at composite bonding techniques including composite welding. It also looked at new yacht design and naval architecture software and processes that could help to improve vessel performance and reduce emissions.

Project lead:
BR Yachting Developments Ltd

Partners:
Airborne Composites Ltd, and Expert Tooling Ltd

Index



Innovate UK

Department for Transport