MarRI-UK
Research & Innovation

Navigating the Maritime Research and Innovation

Showcasing impactful DfT-funded studies on the initiation of UK maritime decarbonisation

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LET US INTRODUCE OURSELVES

Maritime Research and Innovation UK (MarRI-UK) is an industry-led membership organisation that drives the global competitiveness of the UK maritime through extensive partnerships in identifying, developing, and leveraging emerging technologies.

MarRI-UK unites industry and academia members, working closely with trade body partners and policymakers to tackle the sector's most significant innovation and technology challenges. Including the trade body partners' network, we proudly represent over 1,000 UK maritime organisations.

Over the course of the last three years, MarRI-UK has adeptly overseen the execution of 23 projects funded by the Department for Transport through three funding calls: Clean Maritime, Technology and Innovation, and Smart Maritime Land Operations.

This research booklet is dedicated to showcasing the outcomes and impact of these research initiatives. We hope that this booklet serves as a beacon of inspiration and knowledge, illuminating the path for future endeavours in maritime technologies and innovation development.

PREFACE

Welcome to this fascinating compilation of research projects within the realms of clean maritime, technology and innovation and port sea integration in the maritime industry. I am delighted to see the array of ground-breaking initiatives that have been made possible through the collective efforts of visionary project partners.

In today's world, the pressing need to achieve sustainability and reduce carbon emissions has never been more evident. The maritime sector plays a vital role in shaping our environmental future and, through MarRI-UK's expertise and support, these projects have been playing an important role in the UK Maritime sector achieving our clean maritime objectives.

Within the pages of this booklet you will find an array of ventures that push the boundaries of conventional wisdom and explore new frontiers in maritime technology. From FC-BATShip, the innovative Fuel Cell-Battery Hybrid Ship by Babcock, to WaveMaster Zero C's ambitious quest by Bibby Marine, our commitment to clean and efficient maritime operations is evident.

The research and development showcased in this booklet spans a wide spectrum of challenges and opportunities, from energy-saving technology leasing models and sustainable biofuel from salmon waste research to electrification, energy storage, and flow batteries for marine applications. The projects featured in this compilation also include ambitious strides toward maritime autonomy, such as the Intelligent Ship Centre, the Global Ocean Surveillance Network, and the Argus autonomous inspection robot developed in collaboration with leading universities and research institutions.

Each project embodies the spirit of innovation and collaboration that is driving our maritime industry toward a more sustainable future. Through the dedication of our project partners, we are confident that these pioneering endeavours will have a transformative impact on the maritime sector and inspire further progress in the years to come.

We express our sincere gratitude to all the researchers, academics, industry experts, and organisations involved in delivering these projects. Their passion, vision, and determination have brought us to a new era in maritime innovation.

Petra Wilkinson CBE
Director of Maritime

Department for Transport

PIONEERING THE FUTURE OF MARITIME: COLLABORATION, INNOVATION, AND SUSTAINABILITY

Amidst the global call for sustainable solutions, the maritime industry faces the challenging task of reconciling growth with environmental stewardship. In response, MarRI-UK was established to enhance the collaboration between the Government, industry and academia to tackle the most urgent challenges faced by the maritime industry.

Along with other research initiatives, such as the MarRI-UK Membership Programme, a remarkable alliance of researchers, institutions, and organisations has united under a group of pioneering projects funded by the Department for Transport (DfT) through MarRI-UK.

Presented in this research booklet, is a compilation of notable endeavours that exemplify the profound impact of research. Many of these projects are trailblazers, exploring alternative fuels to fortify the industry's commitment to decarbonisation. The booklet also showcases ventures delving into autonomy, digital transformation and artificial intelligence, pushing the boundaries of possibility and inspiring the maritime community with forward-looking concepts through Technology and Innovation.

John Howie MBE
Chair

Beyond individual achievements, the true value of this research lies in the collaborative relationships cultivated among a traditionally fragmented sector. These cooperative endeavours create a vibrant maritime ecosystem, where shared knowledge and innovation drive the industry towards a resilient future.

In conclusion, this research booklet stands as a testament to the power of collaboration, innovation, and sustainability in shaping the maritime sector's future. Gratitude is extended to all researchers, institutions, and stakeholders for their unwavering dedication.

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CLEAN MARITIME

Picture by courtesy of SPAERA

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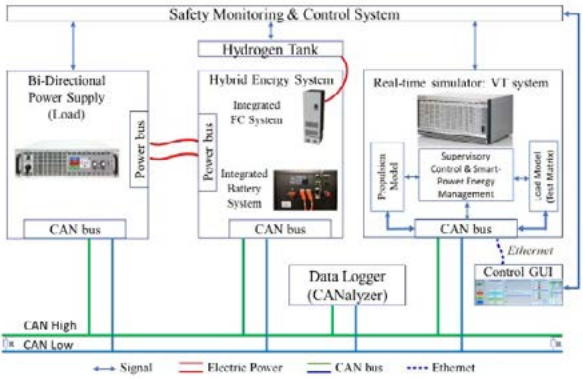
£1.4M award | £2.9M cost | 10 Projects | 31 Partners

FUEL CELL – BATTERY HYBRID SHIP

LED BY: BABCOCK Partners: WMG, Fuel Cell Systems

CHALLENGE:

Hydrogen is a good option for decarbonising shipping, providing a fuel that is zero emission with increasing focus a competitive price per kg in the coming decade. However, there are challenges that need to be overcome, namely, production and supply of green Hydrogen in large volumes as well as methods of safely integrating and storing Hydrogen on-board a ship.



WHAT WAS DONE:

- A set of design guides was produced advising the maritime industry on the key principles to consider when introducing hydrogen fuel, hydrogen FC and battery energy storage onto a vessel.
- A lab based environment was developed for assessing the physical performance of a hydrogen fuel cell and battery energy storage unit under a simulated vessel duty cycle.
- The test environment was used to develop and optimise a power and energy management solution for a hybrid hydrogen FC – battery power and propulsion, designed around a near short workboat duty cycle.

RESULTS:

Virtual Fuel Cell Testing, identified a modified optimal energy management system (MOEMS) as the most effective power-energy management profile for a hybrid Hydrogen Fuel Cell – Battery Energy Storage solution. Optimising the load profile of the Hydrogen Fuel Cell and battery, extending the working life of the Fuel Cell.

Physical Fuel Cell Testing, evaluated the technology under three conditions; constant power demand, multi-step power demand and high/low fuel cell demand.

IMPACTS:

- The project successfully demonstrated a power management setup that reduced Hydrogen consumption by up to 16%.
- A laboratory based testing platform could be provided as a service, offering a low-cost test capability where customers can assess different power-energy management strategies, and optimise efficiency, and performance of their own solutions.

WAVEMASTER ZERO C (WMZC) LED BY: BIBBY MARINE

Partners: Damen Shipyards, Lloyd's Register, ORE Catapult, Peel Group, Square 5

WHAT WAS DONE:

- The WMZC project aimed to find the best-suited low or zero-emission fuel for the next generation of Service Operation Vessels (SOVs), inclusive of associated landside operations. The project has considered the technical, environmental, and economic challenges facing a transition to zero carbon shipping.
- Five alternative fuels (hydrogen, ammonia, methanol, electric and biodiesel in the form of hydrotreated vegetable oil (HVO)) were investigated, and design concepts were produced for each. Following this a landside analysis of the bunkering and infrastructure capabilities of each was performed to assess the feasibility of the implementation each in the short, medium, and long-term. Finally, a complete environmental analysis of each fuel simulating a typical 2-week operating cycle was performed to determine the overall emission reduction of each.

CONCLUSIONS:

A battery methanol hybrid solution was chosen as the most suitable low to zero emission option for immediate application in SOVs. The other fuels were eliminated for varying reasons such as low technological readiness levels of both design and manufacture, insufficient emissions reduction, lack of long-term production scalability and varying safety issues.

A battery-based solution was seen as the only way to be truly low or zero emission in the short-term, with lithium-ion batteries being technologically ready today.

Methanol was chosen as the secondary fuel because it can be fully carbon neutral in the future through production and use of eMethanol utilising renewable electricity and a carbon capture storage system.

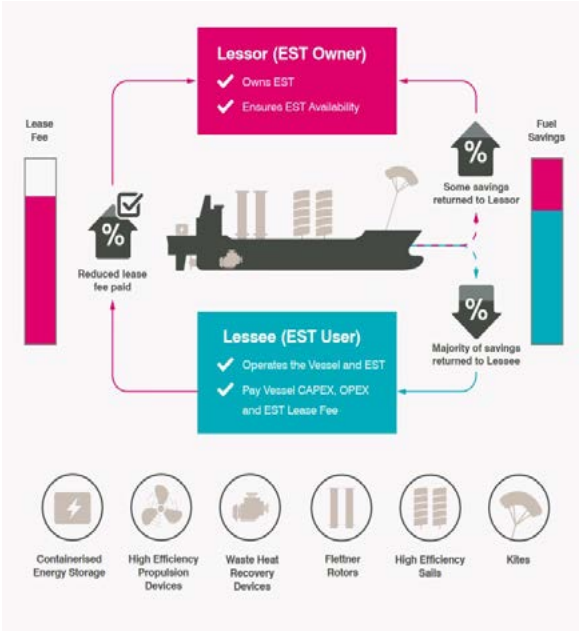
IMPACTS:

- The outcomes of the project acted as a basis for a demonstrator vessel;
- Successful CMDC2 application as a partner to MJR Power & Automation developing a novel offshore charging solution for SOVs (£926k grant);
- Successful ZEVI application leading a project to build the world's first eSOV

ENERGY SAVING TECHNOLOGY (EST) ASSET LEASING MODELS LED BY: BMT

WHAT WAS DONE:

The project investigated the potential of asset leasing for accelerating the adoption of energy saving technologies in commercial shipping. Existing asset leasing arrangements from other industries were reviewed and a concept level Asset Leasing Model (ALM) was developed with input from industry stakeholders. The research outputs will ensure that potential adopters are better informed and can more easily determine if an ALM suits their business.



PROJECT OUTPUTS:

The project has developed the first step towards an innovative financial model for ship owners to increase the uptake of energy saving technologies in shipping.

IMPACTS:

- The project has provided improved knowledge within the industry of alternative funding mechanisms to help increase the adoption of energy saving technologies.
- Internal development has continued following the project to move the concept towards a marketable prospect.
- The Asset Leasing Models remains a hot topic across industry, and has been seen by potential financial partners.

SALMO: SUSTAINABLE AQUACULTURE LEADING TO MARINE OPPORTUNITIES

LED BY: GREEN FUEL RESEARCH

Partners: London South Bank University / Lancaster University, University of Cardiff

WHAT WAS DONE:

Brought together salmon fish farmers, scientists, engineers and business experts and governmental bodies (e.g. APHA), SALMO consortium developed an innovative solution for drop-in renewable marine fuel production from salmon oil obtained from waste (biowaste category 2 and 3) for further commercialisation and subsequent decarbonisation of the UK in-shore shipping sector.

Sulphide (commercial) and novel non-sulpided based bi-metallic catalysts were designed, synthetised and tested during SALMO for upgrading the salmon oil to oxygen-free hydrocarbons and for improving the chemical composition of the final renewable marine fuel with iso-paraffins and aromatic compounds.

PROJECT OUTCOMES:

The new chemical process developed showed promising potential for future application to produce renewable (100% biogenic diesel) drop-in fuels from fish-based oils. The produced salmon-derived marine fuel is in compliance with 11 out of the 13 properties/specification of marine gas oil ISO-F-DMA of standard ISO 8217 for commercial marine fuel distillate. The other 2 out of specifications fuel properties can be brought to specification using commercial fuel additives.

IMPACTS:

- For the first time, hydrotreating of fish waste oil to drop-in hydrocarbon fuel was demonstrated and validated in marine use.
- Salmo's technology is ready for the next stage of the scaling-up process, i.e. demonstration plant.

ELECTRIFICATION AND STORAGE OF ENERGY ON COASTAL GENERAL CARGO VESSEL

LED BY: INTRADA SHIPS MANAGEMENT

PROJECT AIM:

The project is concerned with installing a stored energy supply in order to theoretically replace the main generator on a general cargo vessel.

WHAT'S BEING DONE:

The project will demonstrate that generators can be replaced by stored energy. The scale of energy required in port and during manoeuvring is much lower than for main propulsion, so is the target of this project. There have been many logistical and practical challenges with using stored energy, with safety being the main one. The generator on a modern vessel is also part of an ecosystem, with all waste energy utilised on the vessel. The outcome of the project will be a technical appraisal that others can follow to replace generators on their vessel.

CHALLENGES:

The two biggest challenges to this project have been identified as:

Supply chain: There are limited availability of high capacity energy storage.

Regulations: Regulations are still being defined for the use of batteries after several high-profile incidents.

IMPACTS:

- It is demonstrated that the generator can be replaced by stored energy in batteries.
- Expected up to 19% fuel saving if there is enough stored energy capacity.

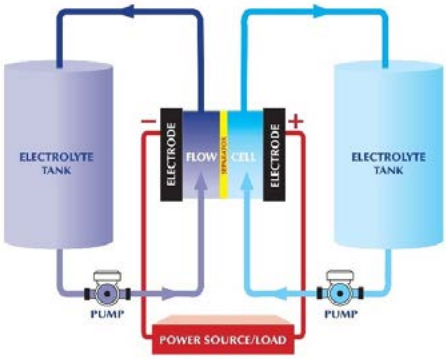
FLOW BATTERIES FOR MARINE APPLICATION (FLO-MAR) LED BY: MARINE SOUTH EAST

Partner: Houlder, Lloyds Register, Swanbarton

WHAT WAS DONE:

Aimed to confirm the feasibility of using flow batteries for onboard energy storage, and to de-risk the further development and demonstration of a pilot flow battery, vessel characteristics and performance for the different flow battery types against lithium-ion were compared, and which vessel types and duty cycles are particularly attractive for the various battery types were identified. A concept design of the most suitable vessel type was developed, which shows how a flow battery could be incorporated into an existing vessel design.

Harbour ferry that could be an early adopter for flow battery technology



CONCLUSIONS:

- Weight and stability changes are acceptable for short range vessels.
- Electrical propulsion system can be of a conventional arrangement.
- Operating speeds can be similar to conventional craft.
- Weight increases can be reduced by the use of super-capacitors.
- The operation of a flow-battery vessel requires effective, efficient, and regular replenishment to maintain service schedules.
- Emerging organic electrolytes may replace vanadium based systems, offering improved energy density, reduced environmental impacts and reduced costs.

IMPACTS SINCE COMPLETION:

- Lessons learnt incorporated into follow-on zero emission vessel development projects
- Flow battery technology has matured and the market for all-electric short distance ferries has strengthened
- Requirement to secure support for a FLO-MAR demonstration vessel

ENVIRONMENT BENEFITS:

- Viable for deep sea electric ships in the long term
- No 'high risks' associated with the placement of a flow battery on the study vessel.
- A flow battery vessel produces no local emissions of CO_2, particulates, SOx or NOx.
- Electrification of the reference vessel saves 223T CO_2 and 731Kg NOx per annum.

THE UK'S FIRST FULLY ELECTRIC DOMESTIC PASSENGER FERRY LED BY: PLYMOUTH BOAT TRIPS

Partners: EVParts, Plymouth University, Teignbridge Propellers, University of Exeter, Voyager Marine.

WHAT WAS DONE:

Aiming to collect, refine and advance knowledge on operating an electric ferry within Plymouth Sound, the UK's first, sea going, electric passenger vessel, e-Voyager, was created.

The project brought together a range of expertise including boat builders, electrical engineers, ferry operators and academic institutes, aimed at advancing skills and de-carbonising the maritime sector.

The new green boat was set to launch in Oct 2020, mirroring Plymouth Boat Trips' existing ferry routes, including Cremyll Ferry, a busy commuter connection between Cornwall and Plymouth.

The vessel has operated throughout Plymouth Sound and has demonstrated the ability of the system to be an effective and viable solution for zero carbon operation for the under 24m commercial vessel sector.

IMPACTS:

- The project kickstarted the development of new rules and regulations for novel propulsion systems in smaller vessels, with Maritime and Coastguard Agency (MCA) and Bureau Veritas, to enable under 24m fully electric commercial vessels to be converted or built.
- The output of the project is being used to help the design of a much larger 250 passenger vessel and is being utilised in a new retro conversion of a 63 passenger PBT ferry.

TorQ
LED BY: RS SAILING

PROJECT AIM:

The project aimed to design, test, and commission a fully electric Rigid Inflatable Power Boat (RIB) with optimised hull, propulsion and electric batteries, suitable for the marine environment.

PROJECT OUTPUT:

Despite various technical challenges and physical size constraints, RS Sailing designed and developed a 40-kW rim drive motor, which was evolved from the original belt driven.

IMPACT:

- The motor was integrated to RS Sailing Pulse 63.

Sustainability Through Efficient Actions in Maritime (STEAM) Led by: Signol

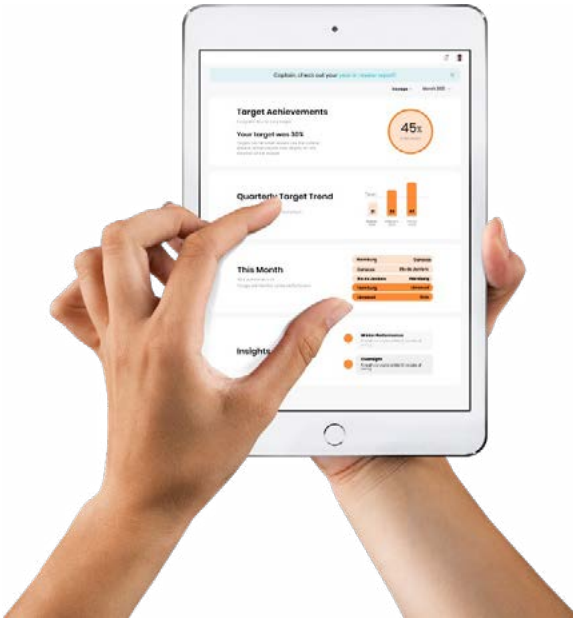
Partner: University College London (UCL) - Energy Institute.

PROJECT AIM:

The project aims to directly target the behaviour of crews in order to improve fuel efficiency. In doing so, Signol studied specific maritime crew operational behaviours.

WHAT WAS DONE:

Qualitative research, including interviews and surveys, were used to assess the best way to adapt the Signol software system to the maritime industry. From the interviews, speed optimisation and reduction stood out as the most significant operational measure for improving efficiency, followed by auxiliary engine optimisation. Quantitative research was conducted to assess the effect of each individual Captain on a vessel's efficiency. Individual captain fuel efficiency varied significantly even when external factors were controlled for.



IMPACTS:

The findings from the project helped to inform the wider development of Signol's Maritime MVP. From the data analysed under the STEAM project, adapting Signol's aviation product for implementation on oil tankers was projected to achieve a significant reduction in fuel use.

Signol has since launched its commercial Maritime product and, after undertaking a number of successful trials across a range of fleet types, the fuel and emissions savings results have exceeded expectations ranging from 5.5% to 14%.

Signol has signed a number of commercial agreements across the maritime industry.

ADVANCED ZERO EMISSIONS AMMONIA ENGINES FOR FUTURE MARINE APPLICATIONS LED BY: UNIVERSITY OF NOTTINGHAM

Partners: MAHLE, Shell

WHAT WAS DONE:

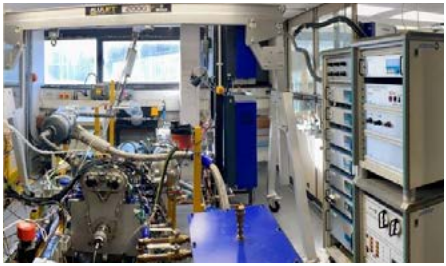
This project compared two promising combustion concepts for future ammonia fuelled marine engines: dual fuel spark ignition and novel fast burning jet ignition combustion.

The work was undertaken using a state-of-the-art single cylinder research engine supplied by MAHLE Powertrain Limited (used to assess both advanced spark ignition and jet ignition) and an existing Volvo "D8" diesel marine engine, upgraded to dual fuel ammonia for this project.

CONCLUSIONS:

Overall, the experimental work successfully demonstrated the basic feasibility of using ammonia as a main fuel for both spark and jet ignition concepts, with operation at up to 100% ammonia fuelling viable at medium engine loads and above in a fully warm engine.

Results obtained in the Volvo D8 diesel during dual fuel operation also demonstrated that ammonia can also be utilised as a main fuel (diesel energy substitution ratios above 50%) albeit operating with significantly higher ammonia "slip" than the spark and jet ignition concepts due to deteriorated combustion efficiency.



IMPACTS:

Considerable learning on health and safety aspects of upgrading an engine test cell for ammonia compliance that may have direct implications on future vessel design and operation, with recommendations made that ammonia can only be used in industrial settings where strict health and safety protocols can be maintained.

Improved fundamental understanding of the optimum combustion and emissions of future retrofit ammonia engines, highlighting the need for advanced exhaust emission's after treatment to avoid excessive N_2O and NH_3 funnel emissions.

Successful award of £5.5m EPSRC project MariNH_3 to develop ammonia propulsion technologies.

TECHNOLOGY and INNOVATION

Assuring safe port navigation by applying machine learning for automated monitoring of changes in nearshore bathymetry – University of Liverpool

Maritime Cyber Risk Assessment Tooling – University of Plymouth

Offshore Charging for Hybrid and Electric Vessels – Jebb Smith

Global Ocean Surveillance Network – PicSea

Live Maps: Sea – Create Technologies

Portonomy - integrating autonomous vessel with port operations – Marico Marine

Argus – Autonomous Devices Limited

Lookout Awareness of Distractions – Liverpool John Moores University

Re-Charge LOHC @ Sea – Newcastle Marine Services Ltd

Innovative Power and Propulsion for MAV – City College Plymouth

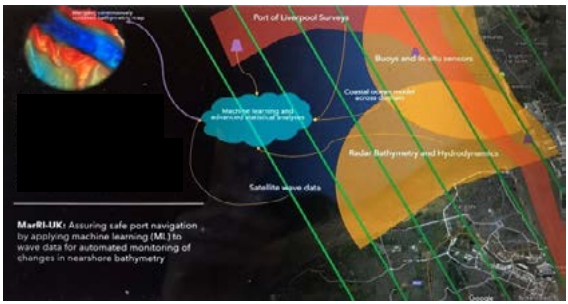
Intelligent Ship Centre (IGNITE) – Solent University

£1.5M award | £2.2M cost | 11 Projects | 22 Partners

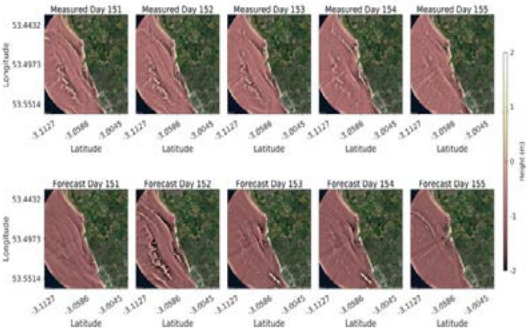
APPLYING MACHINE LEARNING (ML) FOR AUTOMATED MONITORING NEARSHORE BATHYMETRY LED BY: UNIVERSITY OF LIVERPOOL

WHAT WAS DONE:

The project applied machine learning and AI to a combination of data technologies (satellite and land-based radar), computer models, and sensor timeseries in a unique and integrated way to monitor changes in sub- and intertidal bathymetry.



A nexus of data with different resolutions in space and time can be combined to provide a range of maritime and coastal stakeholders with information on nearshore water depth and sediment build-up that is routinely and rapidly updated. It therefore supports safe and fuel efficient port operations and coastal management interventions.



CONCLUSIONS:

A high level of confidence (RMSE error ~10-15%) is demonstrated in forecasting regional hydrodynamics and bathymetry over a 4-5 day window from a 'training' timeseries of approximately 150 days.

IMPACTS:

It is demonstrated that Eigenshores data products can alert port operators and coastal resource managers to significant reductions in the depth of access channels, the migration of dynamic sedimentary features, and intertidal beach volume than can then inform operational and strategic interventions in the shape of targeting maintenance dredging or beach recharge.

MARITIME CYBER RISK ASSESSMENT TOOLING LED BY: UNIVERSITY OF PLYMOUTH

Key words: Cyber security, consultancy

BACKGROUND:

Cybercrime is increasing in size and complexity and maritime is one of the sectors seeing a significant increase of cyber activity. While increased connectivity between ships, personal devices, and on-shore infrastructure has improved operational efficiency and physical safety, it also increases vulnerabilities across IT and OT systems. This ship diversity mandates that a risk assessment solution needs to be flexible without losing detail.

PROJECT OUTCOME:

The MaCRA software and the services provide can now:

1. Offer accurate characterization of maritime-cyber risks and their severity;
2. provide scalable measurements from single systems or ships to fleets;
3. Identify systems that would most benefit, or need, additional security;
4. Identify top risk outcomes, attackers, attack-vectors;
5. Provide risk data in useful views to support human decisions.

IMPACTS:

- Spin out consultancy company Riskocity was established in Jan 2022;
- Currently in the process of raising £250k seed funding under SEIS;
- Commercial project with the first customer under development

OFFSHORE CHARGING FOR HYBRID AND ELECTRIC VESSELS LED BY: OASIS MARINE

CHALLENGE:

The UK and Europe are global leaders in offshore wind farms with a current fleet of 150 Crew Transfer Vessels (CTVs), expected to rise to over 1000 by 2030.

Hybrid or electric CTVs can recharge in harbour overnight, but don't have sufficient range for a round trip to the wind farm on battery power.

Offshore charging in the wind farm is critical to enable hybrid and electric vessels and minimise carbon emissions.

SOLUTION:

The Oasis Power Buoy (OPB) is a mooring and charging buoy for offshore wind farms. It charges electric and hybrid vessels with renewable, low-cost energy generated by the wind farm.

WHAT WAS DONE:

The Oasis Power Buoy full scale prototype was designed and built, offshore trials conducted, and patent application carried out. Key supply chain partnerships were developed, market research conducted and customer engagement enhanced by evidence from the trial results.

LESSONS LEARNED:

Importance of industry standard connectors. Marine licence application advanced planning. Engaging with vessel partners who support offshore trials and prioritise innovation and re-testing.

IMPACTS:

- The follow-on funding were unlocked as the result of the outcome of this project:
- Innovate UK - Clean Maritime Demonstration Competition, Round 3 (£2.14m total) for further trials in Aberdeen Bay, development and fabrication of pre-production Oasis Power Buoy
- Hydrogen Offshore Transfer System project under CMDC1 (£121K) for Hydrogen buoy development
- Emerging Energy Technology Fund from Scottish Government (£149K) to analyse and tank-test offshore deepwater buoy and mooring designs

GLOBAL OCEAN SURVEILLANCE NETWORK LED BY: PICSEA

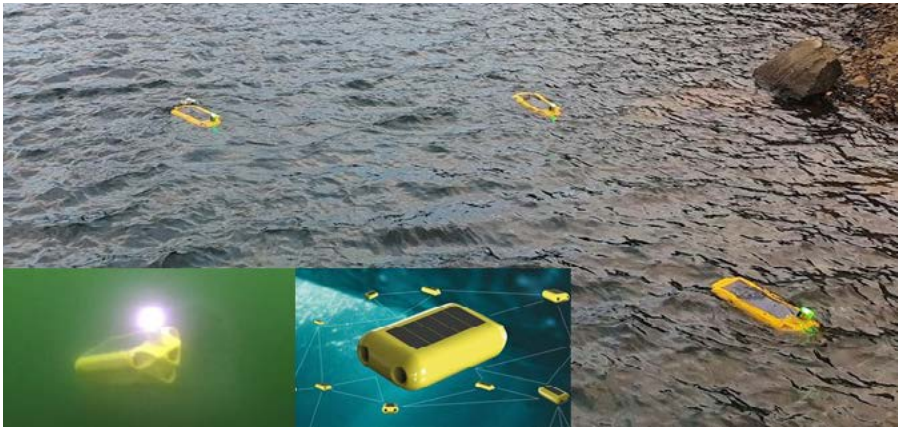
Partners: Fort William Underwater Trials Centre, Offshore Renewable Energy Catapult (OREC), Scottish Association of Marine Science (SAMS), University of Edinburgh, University of York

WHAT WAS DONE:

PicSea has used their experience and engineering expertise to build Autonomous Underwater Vehicles (AUV's). This is a easily deployed platform that can quickly and easily be mobilised, deployed, operated and retrieved by one operator. The benefits include low capital and human risk, low deployment and logistical expenses, and less timeline for collecting underwater data.

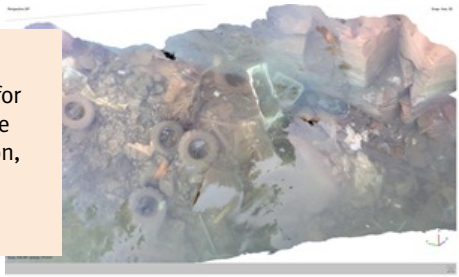
WHAT COULD WE OFFER:

The deployed vehicles could execute defined missions after being deployed into water. They can collect data according to defined routes. Following retrieval, data can be downloaded; post-processed and a georeferenced 3D reconstruction of the target area will be produced for end users.



IMPACT:

The system offers a cost effective solution for many different industries including offshore renewables, oil and gas, telecommunication, environmental research and motoring, fishing, ports, shipping and archaeology.



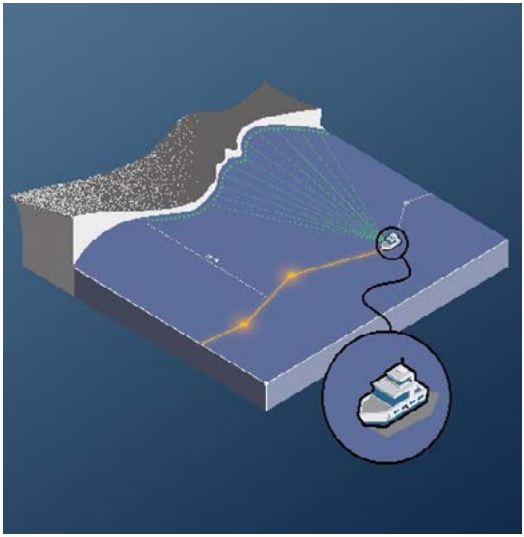
LIVEMAPS: SEA
LED BY: CREATEC

PROJECT OUTPUT:

This project adapted Createc's Live Maps algorithms, developed for the MoD to fly aerial systems when satellite navigation systems are degraded or blocked, to the maritime industry.

An infrastructure free Global Navigation Satellite System(GNSS) alternative by using radar and maps was developed.

During the project, an off the shelf radar was used to record two data sets sailing off of the West coast of Scotland. Raw data was captured and used to develop a frame to frame matching algorithm. Live sailing was able to be simulated for development purposes, as was as if "real" when conducting desktop testing.



WHAT WAS ACHIEVED:

The capability forms a complimentary system alongside traditional navigation as a standalone navigation tool in more niche MoD applications. In addition, it can serve as a reliable backup in areas of GNSS denial or spoofing, or as part of a larger navigation ecosystem, providing GPS verification and error checking.

Accurate GPS equivalent odometry and map building was achieved using radar only, with minimal drift, whilst sailing 48km plus. The initial hypotheses were successfully demonstrated.

IMPACT:

The technology developed under this project has benefitted development of LiveMaps: Air (an offline localisation system for aircraft/drones), by furthering the company's understanding of handling multi-modal data fusion, for GPS verification and error checking.

PORTONOMY - INTEGRATING AUTONOMOUS VESSEL ACTIVITY WITH PORT OPERATIONS

LED BY: MARICO MARINE

Key words: Autonomous vessel, Port authorities, testing

WHAT WAS DONE:

Born out of the Port Marine Safety Code, the Portonomy project developed a practicable risk-based consenting process to allow UK Port Authorities to safely permit the testing and operation of uncrewed vessels within their waters. In addition, a proof-of-concept system (the Portonomy System) was developed, that would enable Port Authorities and uncrewed vessel operators to implement the required risk control measures in a cost-effective manner.

WHAT WAS ACHIEVED:

In this project, with the new risk control measures in place, Newhaven Port Authority was happy for the uncrewed vessel use-case to operate without a guard vessel. This represents a significant achievement in removing a key economic hurdle to the day-to-day use of autonomy in UK waters, since a guard vessel can cost between £1000 - £5,000+ / day. In addition, the key risk control measures that need to be implemented are establishing VHF communications between the autonomous vessel pilot and Port Control, and sharing the operational picture available to Port Control with the autonomous vessel pilot, giving them a much greater degree of maritime situational awareness.

IMPACTS:

- Further development: the Portonomy process has been employed commercially in Portsmouth, and on the River Thames to support the Clean Maritime programme.
- Further funding: the Portonomy process has been used to underpin uncrewed vessel testing for the MarRI-UK & DfT funded ‘Shipping and Port Interfaces in the New Era’ (SPINE) Project.

ARGUS
LED BY: AUTONOMOUS DEVICES

Partner: Lloyds' Register

BACKGROUND:

Future Maritime Autonomous Surface Ships (MASS) will require a completely new approach to vessel design and certification. Savings inherent in removing an onboard human presence will be offset by the need to automate, monitor, control and maintain systems which currently rely exclusively on onboard monitoring and intervention by a human crew.

APPLICATIONS: Ship inspection, Wind farm inspection, MASS presence

PROJECT OUTPUTS:

Autonomous Devices has been able to demonstrate a core capability envisaged for Argus, namely the ability to obtain sensor measurements from geometrically challenging and hard-to-access parts of a ship's structure, with a very high degree of automation ultimately suitable for long range teleoperation.

WHAT WE OFFER:

Low risk, low cost, flexible robotic Non Destructive Inspection for vessel where human access will be challenging

IMPACTS:

Argus technology can reduce the need for costly, time consuming and relatively higher risk practices such as using cherry pickers, scaffolding, rope access and rafting for contact-based Non Destructive Inspection. It has potential to reduce the number of personnel required for surveys, whilst improving repeatability.

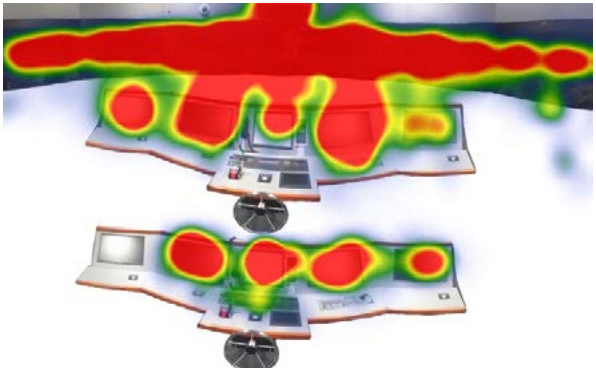
In the longer term, the technical elements could be further matured towards a long range robotic telepresence on future MASS.

LOOKOUT AWARENESS OF DISTRACTIONS THE CREATION OF A DISTRACTION EVALUATION RATIO (LADDER)

LED BY: LIVERPOOL JOHN MOORES UNIVERSITY

CHALLENGE:

65% of ship collisions result from improper lookout and the root cause of underlying issues appears to be a lack of definition of the term 'proper lookout' leading to a lack of appreciation for the shortfalls that need to be addressed to improve watchkeeper behaviour.



WHAT WAS DONE:

A definition for the term 'proper lookout' is provided, and it was proposed to amend the International Code on Standards of Training, Certification and Watchkeeping for Seafarers (STCW Code) by inclusion of this definition.

A 'base' distraction evaluation ratio (DER) was established.

The concept of Centre Console Display (CCD) was introduced to facilitate provision of reduced but most relevant collision avoidance and navigational information to the Officers of the Watch (OOW).

A scan pattern that can be applied by the OOWs was introduced together with the CCD concept and then evaluates the data captured on simulator bridges.

IMPACTS:

- Update to International Code on Standards of Training, Certification and Watchkeeping for Seafarers (STCW Code) was proposed;
- Regulation update by including CCD, and scan pattern;
- The outputs from this work are directly shared with the industry and the regulators through published articles and journal papers.

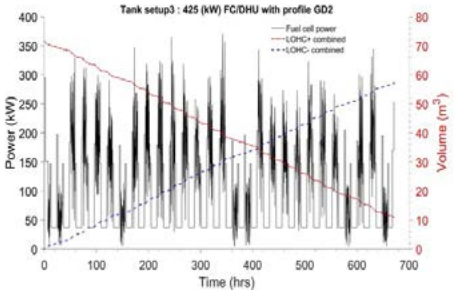
RE-CHARGE LOHC@Sea: EMISSION-FREE PROPULSION OF OFFSHORE SERVICE VESSELS

LED BY: NEWCASTLE MARINE SERVICES

Partners: O.S. Energy, University of Strathclyde, Altran

WHAT WAS DONE:

The project investigated the feasibility of installing a hydrogen-based propulsion and power system on the vessel Søløven and developed a numerical tool that allows modelling of the vessels operation. This system utilises liquid organic hydrogen compounds (LOHC) as an energy carrier in combination with a fuel cell to power the vessels system and propulsion needs.



CONCLUSIONS:

- LOHC can be used as a zero-emission fuel on board an existing vessel.
- The feasibility of using available spaces of a short sea offshore service vessel to increase tank capacities is provided and all relevant regulatory stability considerations are complied with.
- The vessel can deliver its usual operation in a commercial context post conversion of the fuel system.
- The energy balance between LOHC dehydrogenation and fuel cell cooling shows that process integration can improve the efficiency of the on-board hydrogen extraction process.
- The costs of running a vessel with LOHC are lower than maintaining the current diesel engine-based system.
- CAPEX costs are large, however return of initial investment may be attractive through increased prices charged as premium for zero emission operations.

IMPACTS:

- Foundation for versatile numerical system evaluating future fuels applications
- Further development of H2, Battery and Methanol systems within CMDC2
- Hydrogen and Electric Propulsion Demonstrators in CMDC3
- System in use for several newbuild projects and retrofit case studies

INTELLIGENT SHIP CENTRE (IGNITE)
LED BY: SOLENT UNIVERSITY

Partner: Wartsila

BACKGROUND AND PROJECT AIM:

Maritime Autonomous Surface Ships (MASS) was identified as a key sector trend in Maritime 2050 and by the International Maritime Organisation (IMO).The IGNITE project aimed to develop and deploy an innovative system for scaled operation of MASS technologies, creating a safe testing and training environment for MASS-human interaction.

WHAT WAS DONE:

1. Reviewed the effective use of scaled and digital modelling to provide training and RC MASS interaction research.
2. Deployed technological solutions for remote and autonomous control and operation of a scaled RC MASS testing facility.
3. Validated the capability of scaled RC MASS testing for vessel interaction research and seafarer training.
4. Provided informed recommendations for the development of RC MASS operations training and curriculum materials.

IMPACTS:

- Increased awareness of MASS technology in the sector
- Identification of MASS training gaps and opportunities
- Policy recommendations for MASS training and regulation
- Facility for the safe development and testing of MASS systems

SERVICES WE PROVIDE:

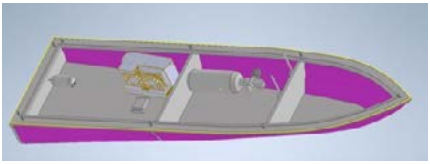
- Testing
- Simulation
- Training
- Consultation

INNOVATIVE POWER AND PROPULSION FOR MAV LED BY: CITY COLLEGE PLYMOUTH

Partner: University of Exeter

WHAT WAS DONE:

"The project is to investigate the application of hydrogen fuels cells within the marine autonomy sector, students studying on a range of FdSc engineering courses have been set the task to design and research autonomous marine vessel using hydrogen fuel cells. Where possible off the shelf products were used either in their preferred environment or engineered to work in the marine environment. Students where split into teams working on the designs, building and testing the vessels".



PROJECT OUTPUT AND CHALLENGES:

With the Covid disruption, the students in the first year of the project only involved in the design and simulation of the autonomous vessel. Students in the following year designed and built vessel prototype. However, with supply chain issue related to small scale hydrogen fuel cell and cascading system, students only tested their prototypes with electric propulsion. Nevertheless, knowledge about autonomous vessels, hydrogen fuel cell and dual propulsion were gained through the course.

IMPACTS:

- Skills development in autonomous vessel design, build and testing;
- Knowledge gained in alternative fuel propulsion;
- Future Hydrogen FC testing capability.

Smart Maritime Land Operations

UK Hydrogen Highway – Port of London Authority

Shipping and Port Interfaces In New Era (SPINE) – Marine South East

£2.4M award | £3.8M cost | 2 Projects | 17 Partners

MARITIME HYDROGEN HIGHWAY

LED BY: PORT OF LONDON AUTHORITY (PLA)

Partners: Health and Safety Executive, Newcastle Marine Services, ORE Catapult, O.S. Energy (UK) Ltd, University of Birmingham, University of Kent, University of Strathclyde

PROJECT AIM:

The hydrogen highway project has been designed as an end to end UK wide scenario, to find where enabling is required to help us all collectively achieve our aims, which include development and demonstrating the safe and effective use of Hydrogen. It is a consortium of academics, regulators and commercial entities which requires a high degree of collaboration and peer review

EXPECTED OUTPUTS:

- UK offshore hydrogen generation capability assessment and UK hydrogen demand map;
- Roadmap highlight requirements to enable a development of an autonomous hydrogen highway energy infrastructure;
- Demonstrator of Hydrogen Fuel Cell System at a port along Thames;
- Modular autonomous hydrogen generation, storage, transport, and offloading system design;
- Recommendations to hydrogen carriers, storage and transport with scalable UK wide solutions.
- Design and simulation of an Autonomous Mooring and Bunkering System.

CHALLENGES AND OPPORTUNITIES:

- Regulatory challenges for the use of hydrogen in the marine environment and to get to a position of a common methodology for assessment, together with the other shareholders.
- Collaborating with stakeholders, specifically due to lack of industry acceptance towards hydrogen usage.
- Aligning business model with practical and safe highway solutions.

SHIPPING AND PORT INTERFACES IN NEW ERA LED BY: MSE INTERNATIONAL

Partners: Frequentis, Houder, HydroSurv, Marico Marine, NOC, Ricardo, Swanbarton, University of Plymouth

PROJECT AIM:

SPINE is developing technologies to interface between ships, remote control centres, port operating systems and national energy infrastructure to help to accelerate the transition to zero emission and autonomous shipping.

PLANNED OUTPUTS:

Advancing the automation of operations in ship/shore integration from an energy and autonomy perspective in the port environment through

- Development of a port energy management tool for servicing ships
- Demonstration of short sea shipping technologies using MASS
- Design of novel integrated berthing/ recharging fuelling facilities for ports
- Definition of use-case scenarios to justify future deployment

CHALLENGES:

The prolonged launch of the anticipated new edition of the Work Boat Code, (WBC3), which is essential for the USV being used for the SPINE technology demonstrations, has created a challenge for the advancement of the project.

EXPECTED IMPACTS:

- Accelerated de-crewing to reduce costs and energy demand
- Optimised energy use & linkage with wider infrastructure
- De-risked investment options for ports and shipping

CHALLENGES FACED BY INDUSTRY

Throughout the course of the projects, our passionate team of partners uncovered a number of captivating challenges that the sector must confront head-on. These hurdles, though formidable, serve as beacons guiding us towards a brighter future.

SUPPLY CHAIN: Establishing a resilient and sustainable supply chain for the procurement, manufacture and distribution of low-carbon technologies and fuels is a critical challenge in achieving UK maritime decarbonisation goals.

FUEL UNCERTAINTY: Despite extensive research, ship owners are still unsure of the range and application of alternative fuel for their vessel for the long term. This could slow refit and new build decisions.

HEALTH AND SAFETY: Ensuring the implementation of new technologies and practices without compromising the health and safety of maritime workforce (ashore an afloat) presents a key challenge in the industry's green transformation.

REGULATION: A main challenge in UK maritime decarbonisation lies in fast developing comprehensive and effective regulations (both aboard vessels and in shore infrastructure) that incentivise and support the adoption of newly developed technologies and practices across the industry. Of particular concern has been the timescales to get approval for demonstrations etc, this has caused delays to a number of projects.

SKILLS DEVELOPMENT: The shortage of skilled personnel with expertise in emerging low-carbon technologies and sustainable practices necessitates the development of comprehensive training programs and initiatives to equip the UK maritime workforce with the necessary skills to drive decarbonisation efforts.

MarRI-UK MEMBERS RESEARCH

Our Members Research programme is led by the Industry Members and is conducted collaboratively with our academic members.

Our 2023/24 Members Research Programme focuses on three themes: Autonomy, Clean Maritime and Digital.

For any further information, please contact: **info@marri-uk.org**

Aims to minimise environmental impact and promote sustainability in the maritime industry through research on alternative fuels, vessel hybrid propulsion technologies, energy-efficient ship designs, carbon capture systems, advanced hull coatings, new shipbuilding materials, and shore-to-ship power solutions.

Autonomy research spans across safety enhancement through automation, overcoming autonomous shipping barriers, developing maintenance-free and remotely monitored autonomous vessel operations, ensuring safe navigation through robust mapping, regulations for autonomous vessels, and economic implications of autonomous systems.

Digital research within our programme encompasses cybersecurity, future shipyard innovations, vessel data appraisal and utilisation for compliance and decision-making, and optimised modular digital thread architectures.

OUR MEMBERS AND PARTNERS


Index


Join MarRI-UK to be part of a leading partnership that is transforming the UK maritime industry through research and innovation