SMART GREEN SHIPPING

University of Southampton

WINDS OF CHANGE

HARNESSING WIND POWER TO ACCELERATE GLOBAL SHIPPING'S DECARBONISATION JOURNEY

Funded by UK Government

The UK is poised to take advantage of a pivotal moment in global shipping, thanks to the foresight and commitment of our long-standing collaborators and with support from both UK and Scottish governments.

The International Maritime Organization recently agreed to reduce the sector's greenhouse gas fuel intensity by 17% by 2028, rising to 21% by 2030 with penalties up to $380 per tonne of GHG for ships that fail to comply.

Wind-assist is one of the few affordable, available technologies mature enough to allow shipping to meet these targets.

The Winds of Change (WoC) project aligns with the Maritime Decarbonisation Strategy's aims of supporting UK industry to kickstart Britain's economic growth and make it a clean energy superpower.

Smart Green Shipping, the University of Southampton, the Wolfson Unit and Humphreys Yacht Design have been developing FastRigs since 2014. With critical input from Drax, investors MOLDB, and shipowners, we designed a swift install/deinstall, stowable, digitally enabled system solution.

We showcased UK capability by addressing the maritime industry's areas of concern with wind-assist: safe and robust Clydebuilt wingsails, science-backed fuel save validation and, with insurers, financiers and maritime lawyers we've created a unique wind-as-a-service customer proposition.

The complex project was executed on time, on budget.

Critically important work with the University of Southampton in this project validates that FastRigs can save up to 40% fuel per annum when deployed with our route optimisation tool, FastRoute.

This is the launchpad for FastRig's commercialisation and gives the UK a once-in-a-generation green growth opportunity to create jobs and value in engineering, digitalisation, insurance, finance and maritime law.

Di Gilpin
CEO, Smart Green Shipping

The Winds of Change project was a brilliant opportunity to combine the University of Southampton's expertise in maritime decarbonisation with that in yacht racing.

Our main role was developing numerical tools to predict the fuel savings for wind-assisted ships using our unique combination of state-of-the art facilities, including wind tunnels, a towing tank and Computational Fluid Dynamics (CFD).

For this research we focused on including the complex interactions of the forces that affect a wind-assisted ship's performance. This includes the aerodynamic interactions between the wingsail and the ship, the hydrodynamic interactions between the hull, rudder and propeller, and how these forces and moments balance to determine the power saved by wind propulsion.

One of the unique aspects of this project was the opportunity to conduct controlled and structured sea trials. This allowed direct comparisons between our predictions and the vessel performance measured at sea. By conducting these trials over multiple days, we were able to measure performance for a range of wind speeds and directions for different ship speeds.

This process provided great insight into the technical detail required for accurate performance predictions and was a great opportunity to work with a wide group of industry partners driving forward maritime decarbonisation.

Dr Joseph Banks
Associate Professor in Maritime Engineering, University of Southampton

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HARNESSING THE POWER OF WIND TO DECARBONISE THE SHIPPING INDUSTRY

UK-based Smart Green Shipping (SGS) and the University of Southampton are driving forward innovative plans to harness the power of wind in the global challenge to reduce greenhouse gas emissions and decarbonise the shipping industry.

Di, who has a wealth of innovation development experience in mobile phone technology, Formula One racing, global sailing and renewable energy, saw the potential for wingsails 16 years ago and founded SGS in 2014 to bring her vision to life.

SGS was set up in 2014 by CEO and entrepreneur Di Gilpin to develop a 21st Century wingsail system that can be swiftly retrofitted to vessels to provide wind propulsion to ships.

After exploring different sail designs with the University and the Wolfson Unit over the last 14 years, the concept for a commercially viable retrofit solution – the Future Automated Sail Technology (FastRig) wingsail - was developed and work began on constructing, testing and refining the wind propulsion system in close collaboration with shipowners and cargo operators.

The Winds of Change project, co-led by a collaboration between SGS and the University, represents a critical step towards decarbonising the shipping industry and demonstrating that wind power can play a key role in the future of maritime transportation.

It brings together a consortium of industry and research partners to work with SGS and the University of Southampton, including:

- Argo Engineering Solutions
- AW Ship Management
- Caley THREE60 Energy
- Drax
- Houlder
- Humphreys Yacht Design
- Lloyd's Register
- Malin Group
- Mitsui OSK Lines Drybulk (MOLDB)
- NTS Nuclear Transport Solutions
- Reed Smith
- Wolfson Unit

The Winds of Change project was funded by the Department for Transport and Innovate UK and involved installing and testing the wingsail on a working vessel – the MV Pacific Grebe.

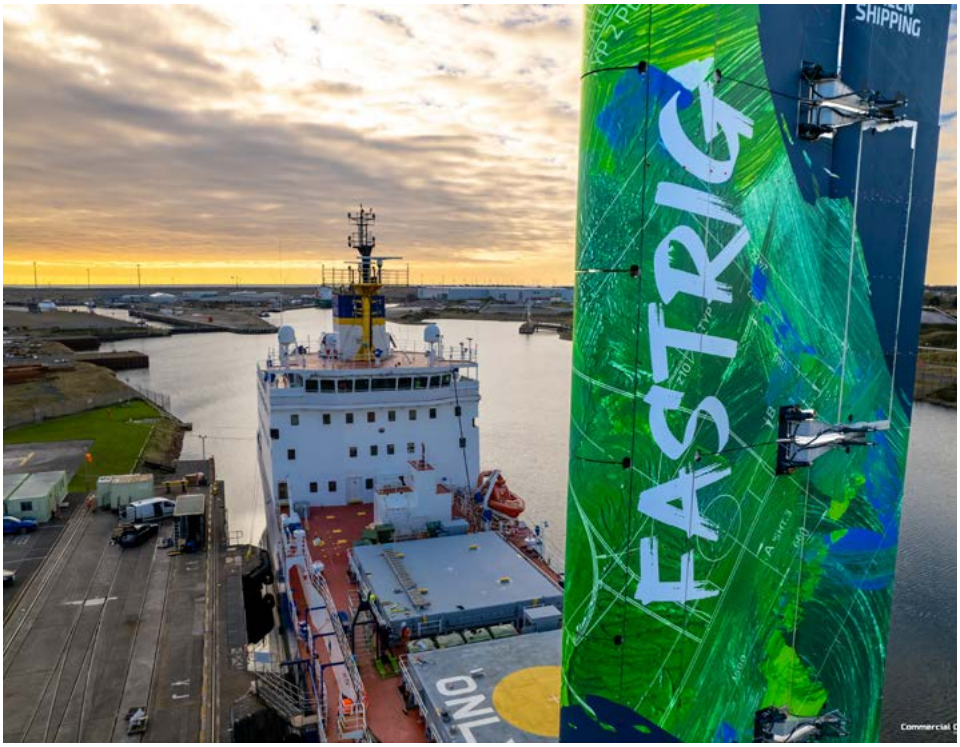
THE KEY OBJECTIVES WERE TO:

- Demonstrate the FastRig's safety and robustness – certification and compliance;
- Demonstrate the easy installation and deinstallation of the FastRig;
- Demonstrate the ease of operation by the crew;
- Corroborate the digital analyses tools co-developed by SGS and the University against real-world sea trials;
- Develop aerodynamic and systems design of SGS Fast systems.

As well as demonstrating the robustness, operability and ability to retrofit the technology, Winds of Change enabled SGS and the University to conduct detailed engineering studies, ensure compliance with authorities, and verify performance prediction calculations.

Winds of Change has accelerated the adoption of wind-assisted propulsion. There were no major technical issues with the FastRig during fitting, sea trials and decommissioning, and it received an enthusiastic response from the ship's crew.

The real-world validation of the University's performance prediction algorithm forecasting fuel savings with a high degree of accuracy, has given project partners confidence to progress to commercial installations.



Above: Fastrig installed on the Pacific Grebe whilst she was portside at Barrow-in-Furness, UK. Minimal invasive engineering means no loss of payload and significantly reduced off-hire time.

Left: highly skilled, multi-discipline team installed first-of-kind FastRig on a technically challenging ship to the satisfaction of owners, Class and Maritime and Coastguard Agency.

Opposite page: FastRig, designed with shipowners and port authorities, can be safely stowed for maximum energy efficiency in low winds, for safety in high winds, and for ease of port operations.

RISING TO THE CHALLENGE OF GLOBAL MARITIME DECARBONISATION

As the world responds to the challenge of reducing greenhouse gases and meeting the International Maritime Organization's decarbonisation goals, the shipping industry is under increasing pressure to reduce its carbon footprint.

"Wind is an intermittent power source, but, unlike other fuels, it isn't subject to the volatility of the commodity markets. By being able to predict the value of the fuel save, shipowners will benefit from certainty in an uncertain world."

Di Gilpin
CEO Smart Green Shipping

According to the International Maritime Organisation (IMO) ships over 5,000 DWT burn an aggregate of over 200 million tonnes of fuel each year, generating significant carbon dioxide emissions, and requiring the industry to find alternative propulsion methods. Emissions from global shipping continue to rise even in the face of the climate and nature emergency. The international sector accounts for 3% of total global greenhouse gas emissions.

The most common fuels today are heavy fuel oil, marine gas oil, and natural gas. Fuel consumption varies significantly between ship types.

Alternative fuels such as ammonia and hydrogen offer potential for decarbonisation, but they also present significant challenges. They are expensive and have a lower energy density that require larger tanks and reduces the ships' payload. They also require substantial infrastructure investment including retrofitting ships and developing global bunkering facilities. Therefore, they are many years away from widespread commercial adoption.

Wind-assisted propulsion, however, offers a promising solution that is viable and immediate and Smart Green Shipping's innovative easily-retrofitted FastRig technology is leading the way with the support of the University of Southampton.

SGS CEO Di Gilpin said: "Wind-assist is the best way of meeting global shipping emissions reduction targets as it reduces operating costs. Wind energy can play a crucial role in addressing the global decarbonisation challenge.

"The world's shipping fleet consists of around 60,000 vessels and it is estimated approximately two thirds* of these are well-suited to be retrofitted with wind-assist technologies. If all ships capable of adopting wind power, were to do so, the International Windship Association calculates it could reduce shipping emissions worldwide by a third."

However, despite the potential of wind-assisted propulsion, the shipping industry has been hesitant to adopt new technologies as many shipowners are wary of being first movers. This Winds of Change project has addressed these market concerns by incorporating input from shipowners.

Di said: "Many shipowners are keen to be 'fast-followers', they recognise the potential but don't want to be the first to support the technology and systems demonstrations. This UK Government-supported Winds of Change project has helped to build market confidence.

"FastRig wingsails are lightweight, stowable and easily able to be retrofitted, and by using historical and forecast weather data, we can predict when and how wind will blow, and the financial impact that this will have on operational costs.

"Wind is an intermittent power source, but, unlike other fuels, it isn't subject to the volatility of the commodity markets. By being able to predict the value of the fuel save, shipowners will benefit from certainty in an uncertain world.

"Wind has been called global shipping's decarbonisation superpower. It is free, abundant and exclusively available to ships enabled to harness it."

SGS's retrofittable FastRig wingsail, augments existing ships' fuel-powered engines, cuts fuel costs and reduces emissions. They offer faster return on investment and are compatible with current fleets, offering shipowners and charterers easily available affordable compliance solutions.

Di added: "Winds of Change has been about giving the industry the confidence to change and to demonstrate that modern ships can benefit from using the power of the wind in a 21st Century digitally enabled way."

*Reducing the maritime sector's contribution to climate change and air pollution: economic opportunities from low and zero emission shipping – A report for the Department for Transport

Demonstrating FastRig safety and robustness during sea trails

FASTRIG:
THE HARDWARE SOLUTION

FastRig is an innovative technology designed and created by Smart Green Shipping that harnesses the power of the wind to produce thrust and propulsion for existing and new build commercial vessels.

Driven by science, it builds on more than a decade of SGS collaboration with the University of Southampton to create a pioneering wind-assist fuel saving device for the shipping industry.

FastRig is a lightweight, aluminium, stowable, rigid wingsail, that is made from 100% recyclable materials and can be easily retrofitted to vessels with available deck space such as bulkers and tankers. It avoids the loss of sea days as it is easy to install and decommission dockside and can also be fitted to new vessels.

It can realise up to 40% fuel and greenhouse gas emissions savings per annum and this can be further improved with route optimisation.

Research carried out by SGS found that the concerns from the shipping industry fell into three categories:

- robustness and safety;
- viability and validation;
- economics and accessibility.

SGS addressed these issues as they developed the FastRig design and technology.

THE FASTRIG IS:

LIGHTWEIGHT

- Easy and quick to install/deinstall
- Can be fitted to coincide with long term cargo contracts
- Doesn't take up cargo space
- Maximises ship utilisation – doesn't lose sea days through lengthy installations

STOWABLE

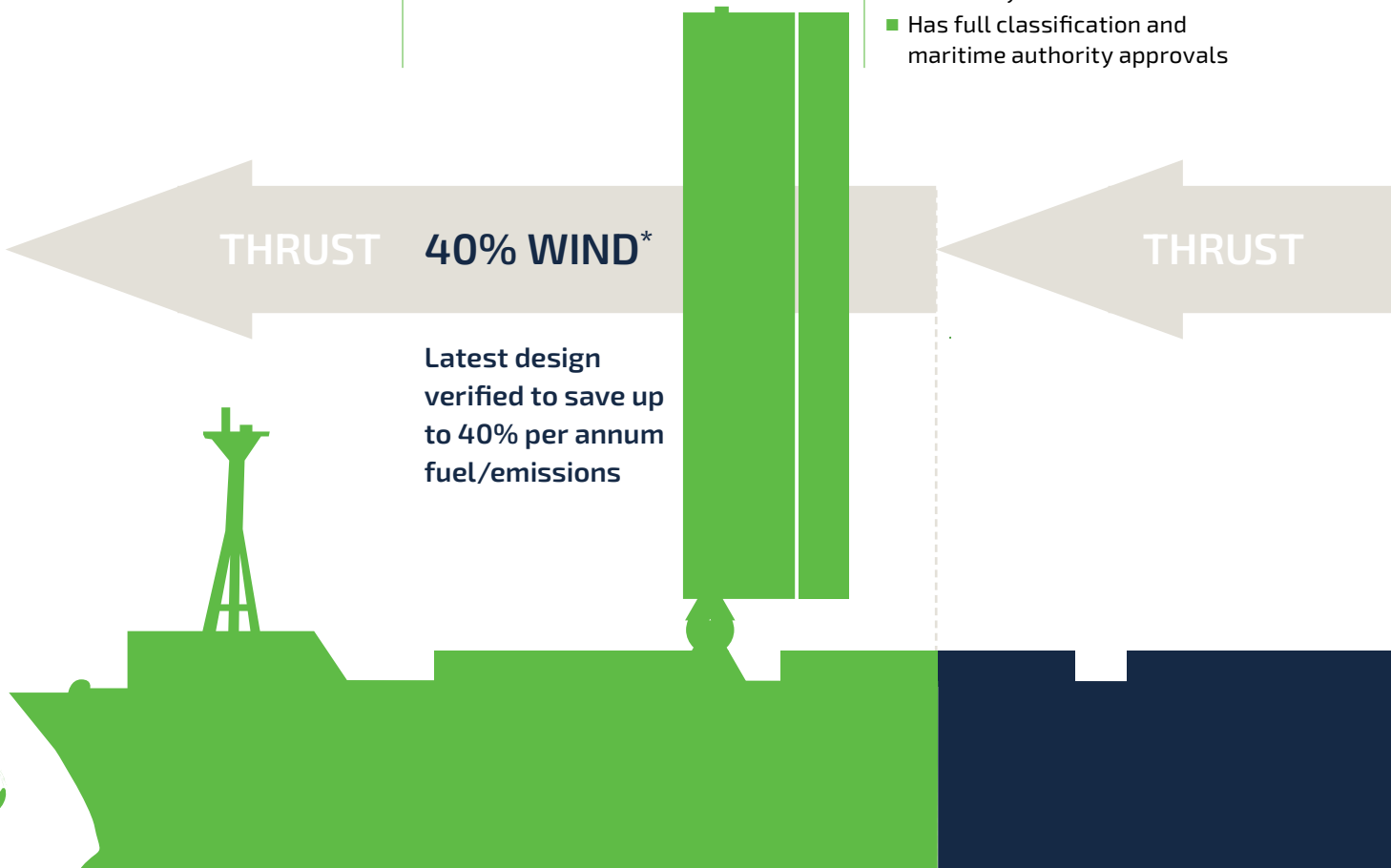
- Improves overall performance – reduces wind resistance in low wind; improves safety in high winds
- Enables visibility for navigation
- Enables loading/discharge

RECYCLABLE

- Reduces the use of scarce materials
- Underpins a circular business model leading to a better overall value proposition

ROBUST

- Built using steel and aluminium – balancing lightweight, affordable and recyclable
- Modular for easy transport and repair
- Uses off-the-shelf, proven components combined in novel ways
- Has full classification and maritime authority approvals



AUTONOMOUS/INTELLIGENT

- Reduces need for lengthy crew training
- Knows which way the wind is blowing and adopts best orientation
- Knows when the wind is too high and presents a safety risk or too low and creates wind resistance that needs more fuel/engine power
- Senses bridges, other air draft and port obstacles.

SOFTWARE SYSTEMS OFFER FURTHER OPTIMISATION

To maximise the performance and uptake of the FastRig SGS has also developed software systems – FastRoute and FastReach.

FASTROUTE

Combines artificial intelligence with high-performance computing to calculate fuel savings from the FastRig wingsails on any global route. The software uses a scientifically verified method to deliver accurate predictions helping operators quantify the value of wind assistance.

There are two ways to use FastRoute:

- **FastRoute Predict** – a digital assessment tool that uses historical data to quantify the value of fuel savings from different FastRig configurations for a range of ship types, vessel speeds and routes.
- **FastRoute Optimise** – uses weather forecast data to optimise the route for FastRig-fitted ships to save even more fuel and greenhouse gas emissions. It ensures the maximum saving on any route whilst still meeting arrival times.

FASTREACH

A comprehensive Wind-as-a-Service solution that eliminates adoption barriers through leasing options rather than capital purchases. It simultaneously reduces shipping costs and emissions while extending the operational life of existing vessels. This frictionless, de-risking proposition includes:

- Operation and maintenance;
- Regulatory compliance;
- Standardised legal agreements.

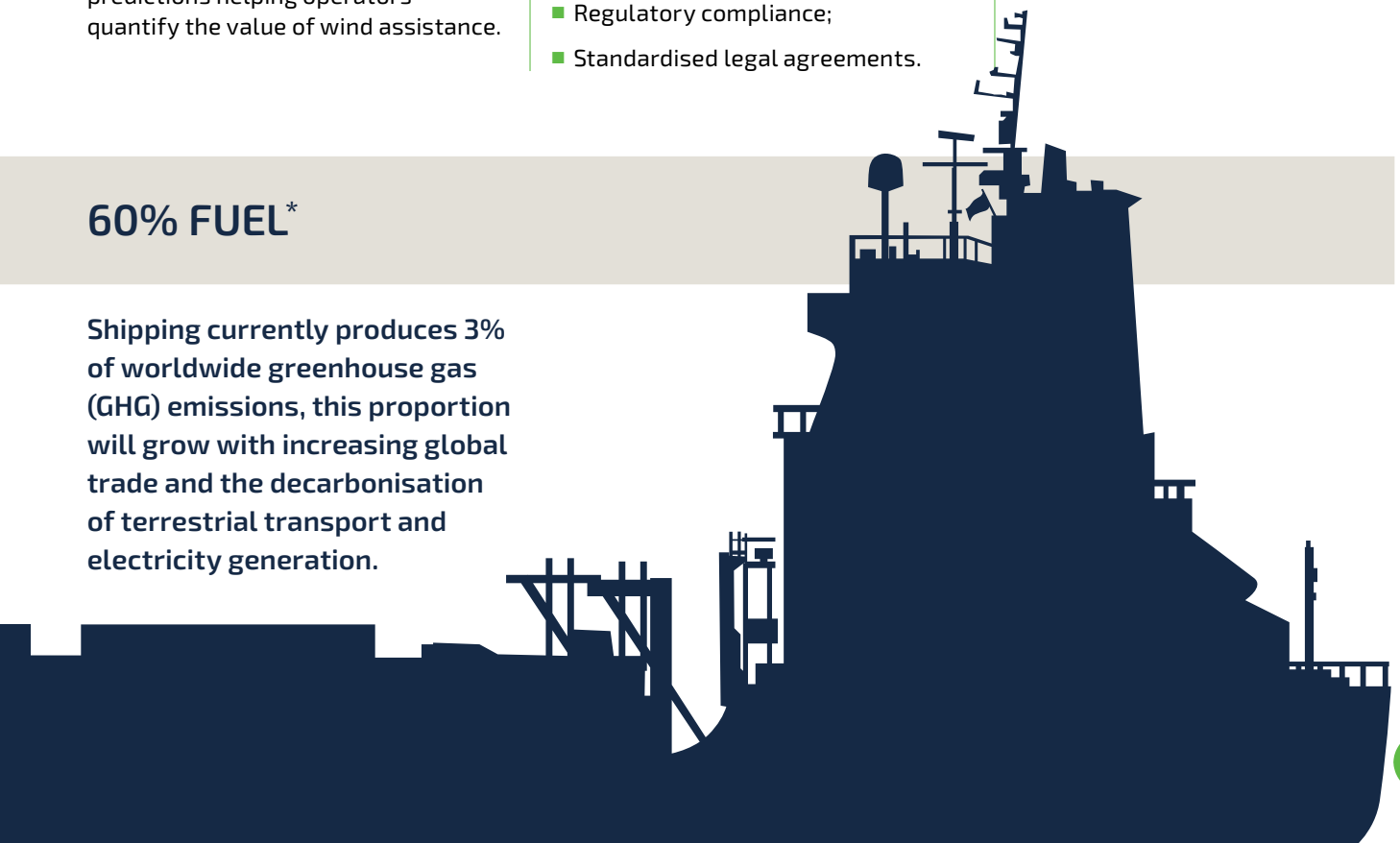
FastReach offers seamless integration for immediate impact:

- Zero CapEx deployment through lease financing models;
- Complete operational support including installation, maintenance, and crew training;
- Compliance management for IMO, regional and future regulations;
- Standardised contracts to streamline process;
- Off-the-shelf insurance agreements and guaranteed fuel savings.

Combined with FastRig's rapid install/deinstall engineering, FastReach allows temporary or permanent deployment making SGS the most flexible and low-risk offering on the market.

60% FUEL*

Shipping currently produces 3% of worldwide greenhouse gas (GHG) emissions, this proportion will grow with increasing global trade and the decarbonisation of terrestrial transport and electricity generation.



A COMMUNITY
OF COLLABORATORS

The Winds of Change project brings together a consortium of industry and research partners to work with Smart Green Shipping and the University of Southampton.

TECHNICAL

Humphreys Yacht Design
Principal naval architects

Responsible for the concept design, detailed design and ongoing optimisation.

Wolfson Unit
University of Southampton's engineering consultants to the maritime sector and fluid dynamics experts.

Responsible for simulating the aerodynamic performance and conducting experimental model tests.

Argo Engineering Solutions
Structural engineers

Translated naval architects drawings into construction and production detail.

Houlder
Engineering design

Carried out ship/FastRig integration feasibility analysis and measured systems for the sea trials.

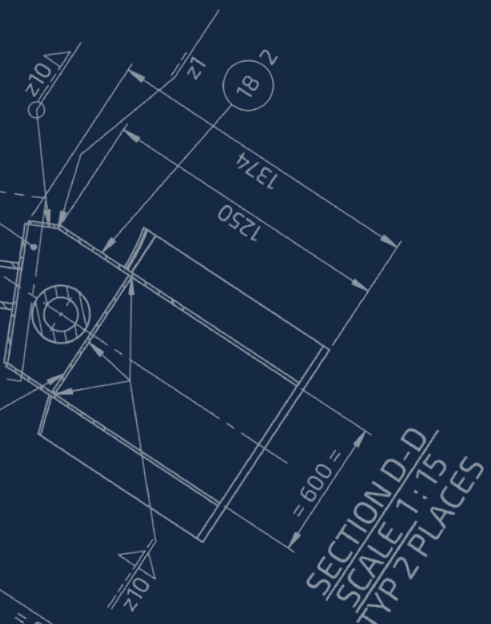
Caley THREE60 Energy
Lifting systems design and base manufacture

Installed the FastRig on the MV Pacific Grebe

Malin Group
Wing element manufacturer

Carried out the installation logistics

AW Ship Management
Operators of the MV Pacific Grebe



COMMERCIAL

Drax
UK provider of dispatchable renewable energy and global sustainable biomass supply chain

Long-term SGS partners who created demand pull for FastRigs through engagement with the ship owner community.

Mitsui OSK Lines Drybulk (MOLDB)
Shipowner and SGS investor

Advised on technology and maritime market dynamics.

NTS Nuclear Transport Solutions
Shipowner

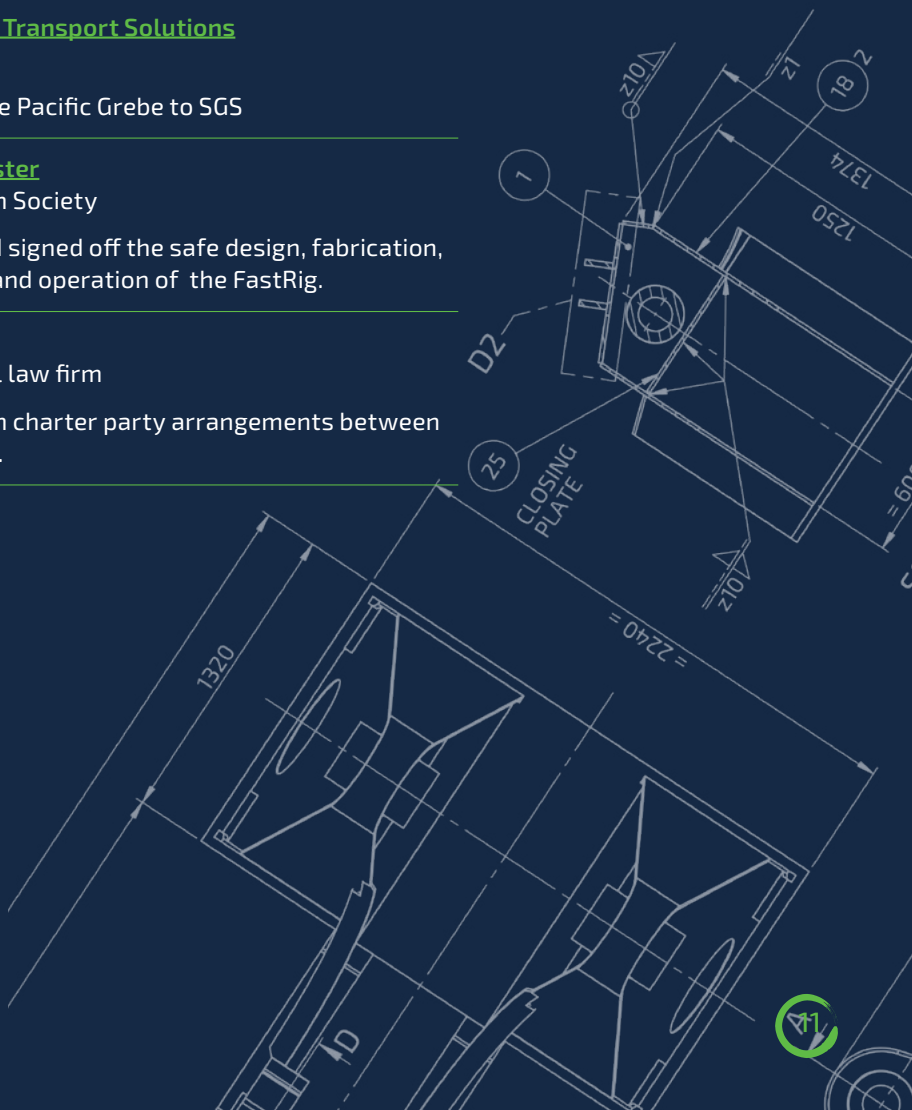
Chartered the Pacific Grebe to SGS

Lloyd's Register
Classification Society

Oversaw and signed off the safe design, fabrication, installation and operation of the FastRig.

Reed Smith
International law firm

Supported on charter party arrangements between SGS and NTS.



SIMULATING
HARSH SEA CONDITIONS
ON LAND

A former wind turbine test site in an exposed corner of Scotland was the perfect location for the first rigorous testing of Smart Green Shipping's FastRig prototype.

KEY OUTCOMES OF THE LAND TRIALS AND NEXT STEPS

The land-based testing demonstrated:

- the hardware's durability in extreme weather conditions;
- the effectiveness of emergency stowage procedures and rapid deployment capabilities;
- the viability and simplicity of remotely operating the wingsail.

Based at Hunterston, on the Firth of Clyde, the area was a remote and extreme environment. "This was as close as we could get to being at sea, without being at sea," said SGS CEO Di Gilpin.

The land trials were the first time the team had had the chance to develop the design, test the manufacturing process, install the FastRig, and ensure the system's safety and reliability in real-life conditions.

The team strongly believed in the potential of their technology so they also used the exercise to officially launch the FastRig and showcase their innovation to key stakeholders including classification societies, shipbuilders, ship owners, manufacturers and the media.

INSTALLING THE RIG

SGS CEO Di Gilpin said: "FastRig was the result of many years of work and transitioning the concept from the drawing board to reality on land came with its own set of challenges."

The test setup simulated real-world conditions. The FastRig was placed on a concrete plinth and the control system housed in a portacabin - mimicking how it would function aboard a ship's bridge.

"It was exceptionally windy and we got the chance to test it up to the limits of the Lloyd's Register classification. The data we gathered gave us strong confidence in the FastRig's ability to withstand harsh weather," said Di.

As well as testing the FastRig's safety, the trial also assessed its materials engineering, durability and performance in varying wind speeds and at various angles.

Di said: "The land-based trial allowed us to collect crucial performance data, refine operational procedures, and demonstrate the technology in action. The data that we were able to gather from this land trial was vital in ensuring we got approval for the system's safety from classification societies and the Maritime and Coastguard Agency before we deployed it onto a vessel."

REASSURING THE INDUSTRY

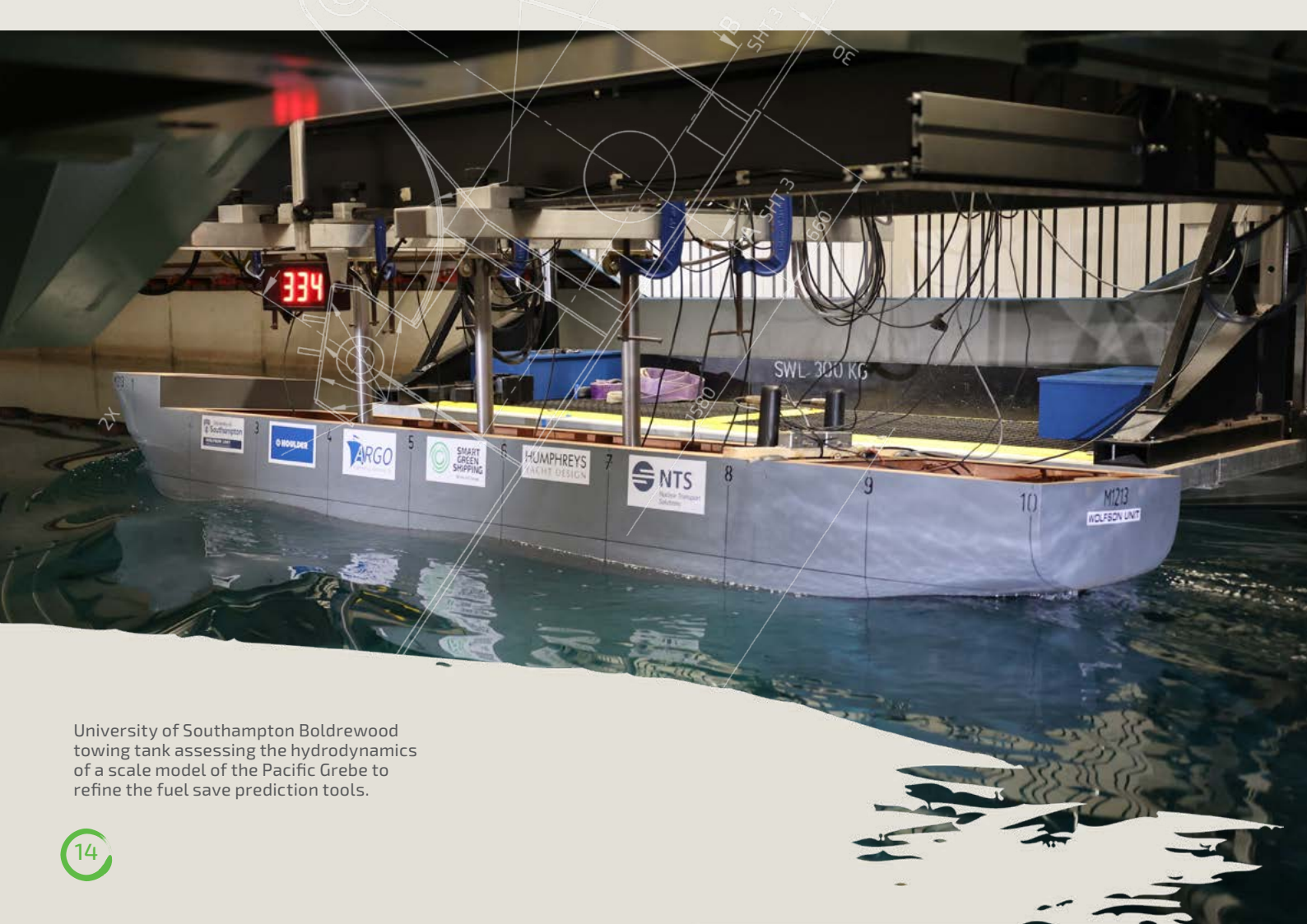
The land trials were also an opportunity for the media and industry experts to get close to and see the technology in action.

They had the chance to interact with the system, control it remotely from a desktop station and experience first-hand how intuitive it was to operate.

Di said: "In our early research, ship owners, operators and manufacturers have been cautious about allowing unfamiliar technology to be installed on their ships, so this was a chance to reassure them.

"By demonstrating that we could successfully build, test and deploy technology in these harsh conditions on land, we proved the feasibility of moving forward with sea trials."

FastRig installed at Hunterston, North Ayrshire for initial materials and systems testing. Close to her Glasgow based manufacturers, Malin and Caley who oversaw quality and refined the design for ship installation.



University of Southampton Boldrewood towing tank assessing the hydrodynamics of a scale model of the Pacific Grebe to refine the fuel save prediction tools.

OPTIMISING
SHIP PERFORMANCE
WITH WIND-ASSISTED TECHNOLOGY

The University of Southampton is Smart Green Shipping's key research partner and the Winds of Change project is at the forefront of wind-assist research that will accelerate global shipping towards Net Zero.

Southampton researchers in maritime engineering and consultants from the University's Wolfson Unit have played a critical role in testing SGS's innovative FastRig technology both in simulated experiments and in the real-life trials at sea.

WHY SOUTHAMPTON?

The University of Southampton offers a unique combination of state-of-the-art facilities, including wind tunnels, a towing tank and one of the largest computational resources at a UK university.

This enabled them to provide SGS with a comprehensive approach to studying both the aerodynamics and hydrodynamics of their technology, and to combine experimental and computational techniques to predict and optimise wingsail-assisted shipping performance.

Dr Joseph Banks is an Associate Professor in Maritime Engineering and leads the research at Southampton.

He said: "At the heart of optimising wind-assisted ships is the need to balance aerodynamic and hydrodynamic forces. We used a combination of numerical models, such as computational fluid dynamics (CFD) and experimental data from tests in our towing tank and wind tunnel facilities to understand how these forces interact under different conditions.

"Our research enabled us to predict the ship's performance for different wind speeds and directions, comparing the vessel's speed and power consumption with and without the wingsails. This allowed us to determine potential fuel savings and improvements in operational efficiency."

TOWING TANK TESTING

It has long been common practice for scale models of ships' hulls to be built and towed through a basin of water to test their hydrodynamics. Even with the introduction of computer-aided design, programming, data analysis and artificial intelligence, towing tanks are still an important factor in ship design and testing.

Joe said: "In wind-assisted shipping, the ship is acting in a hybrid way. It is being propelled from its engines and propeller, but there is also thrust from the forces generated by the wingsail. Most existing ships are not optimised for wind propulsion, so the data from the towing tank is vital in assessing how they will perform with combined sail and propeller propulsion.

"We took the data from the model tests and then numerical simulations to build the best picture of what to expect when the Pacific Grebe and the wingsail finally come together and the two propulsion forces work on the one ship simultaneously."

Southampton has the largest University towing tank in the UK at 138m long, 6m wide and 3.5m deep and it is here that a scale model of the nuclear waste vessel the MV Pacific Grebe was put through its paces. The Grebe is the vessel on which the FastRig was installed to carry out sea trials.

KEY FINDING

The presence of cranes do not significantly impact the Fastrig's ability to create driving force to propel the vessel at the wind angles tested.

UNDERSTANDING THE IMPACT OF WINGSAILS ON SHIP DYNAMICS

Traditionally, ships have relied on propellers to generate thrust to move the vessel forward, but SGS's FastRig wingsail changes the propulsion. The thrust produced by the wingsail reduces the amount of force the propellers need to generate to travel at the same speed.

While this enhances the forward thrust of the vessel, it also generates sideways force causing the ship to drift sideways slightly, creating a leeway angle between the hull and the direction of travel, that can affect the performance of both the propeller and the rudder.

Understanding how the hull, rudder and propeller interact in this situation has been a key research focus of the University.

Joe said: "Our aim was to predict and optimise these interactions for wind-assisted ships and to see how they could improve performance and fuel efficiency, and further reduce carbon emissions.

"Most of the research published on wind-propelled ships focuses on the aerodynamic performance of the device. Whilst this is a crucial part of the performance prediction, one of this project's key research focuses was to understand the hydrodynamic interactions between the hull, propeller and rudder in greater detail than has been done before. We have systematically assessed the impact of leeway angle, rudder angle and different propeller loadings on the hydrodynamic performance of the vessel.

"We developed a performance prediction tool that integrates both aerodynamic and hydrodynamic data. This tool allows us to predict the ship's fuel savings based on specific conditions such as wind speed and direction, and is designed to balance all forces and moments acting on the ship. By including the complex hydrodynamic interaction between the hull, rudder and propeller, we can provide a comprehensive prediction of energy savings."

These performance predictions feed into the FastRoute software to assess the performance of the vessel on a given route.

ACADEMIC AND INDUSTRY COLLABORATION

The work for the Winds of Change project has involved both academics in maritime engineering, as well as consultants from the University's Wolfson Unit that provides engineering consultancy to the maritime sector.

Joe said: "The introduction of wingsails and the leeway angle requires specific considerations in ship handling. One of the most crucial factors is the rudder angle needed to maintain a constant course. Our research focused on determining the necessary rudder adjustments for ships using large amounts of wind energy, enabling precise control and optimisation of the vessel's path.

"We combined our academic expertise with practical insights from Wolfson Unit engineers to bridge the gap between the theory and practical application.

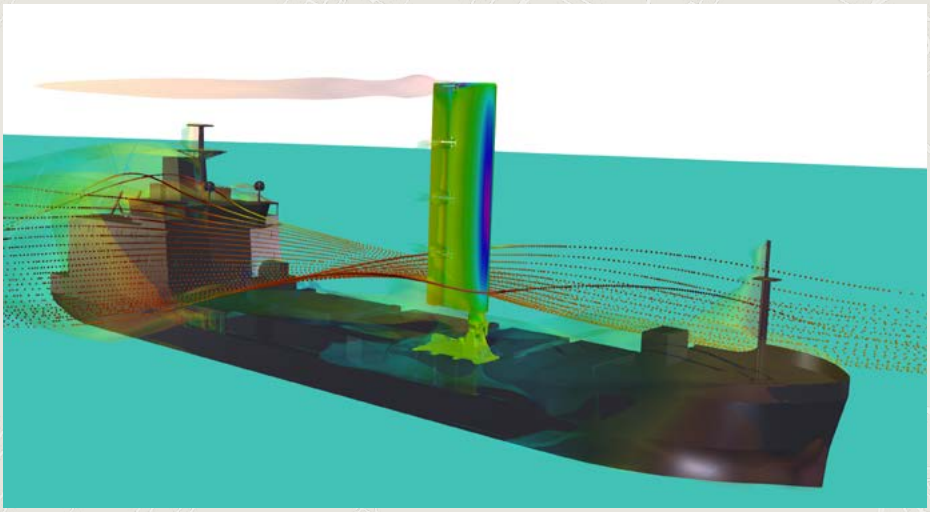
"With our predictive models, advanced testing methods, and collaboration with industry experts, we helped develop the case for adopting SGS's wind-assisted propulsion technology that can reduce fuel consumption, cut emissions, and improve overall performance."

The next step was to validate these predictions against real-life data from the sea trials and that's where the installation on the MV Pacific Grebe played a vital role.

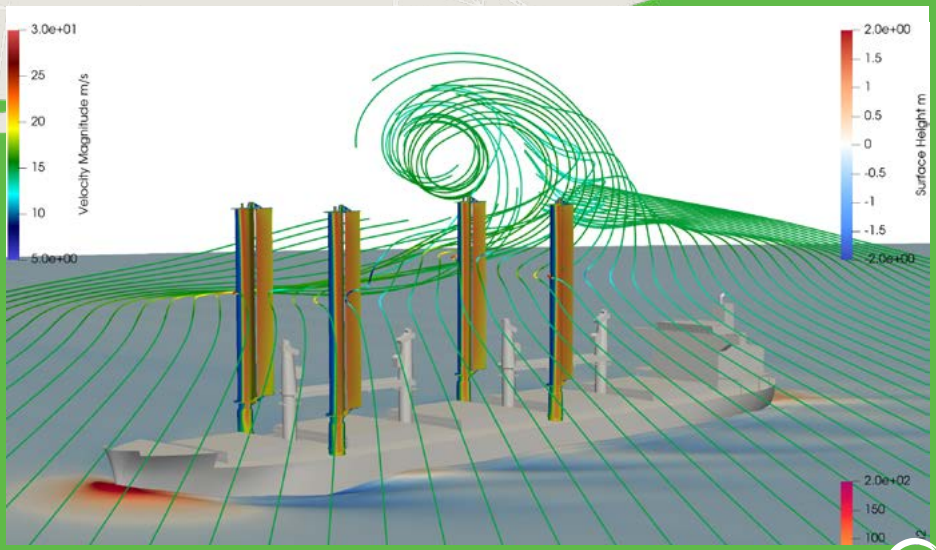
WIND TUNNEL TESTING

A program of wind tunnel testing was conducted in the University of Southampton's largest wind tunnel to:

- Gain a better understanding of the interaction of superstructure and deck cranes on the performance of aerodynamic performance due to the wind assist of the Fastrig;
- Provide force data with which to validate the CFD numerical tools used throughout the project.



Simulations conducted by the University of Southampton assessed the aerodynamic performance of the FastRig design on both the Pacific Grebe and a future Handymax commercial installation.



INSTALLING
THE FASTRIG
ON A NUCLEAR WASTE VESSEL

UK Government funding rules meant that Smart Green Shipping had to install the FastRig on a UK-flagged vessel to carry out the sea trials.

They chartered Nuclear Transport Solution's MV Pacific Grebe - a nuclear waste carrier that is technically challenging and has exceptionally high safety requirements.

With its highly skilled and motivated community of partners and contractors, the Winds of Change team successfully installed and operated the FastRig wingsail at sea, demonstrating its feasibility for broad commercial use.

The Port of Barrow was the location for the FastRig installation and, last September, SGS and its research and industry partners and collaborators set up at the docks. Owing to the sensitive nature of the MV Pacific Grebe, it is subject to extremely high security and the Winds of Change team operated against a day-by-day detailed, trackable project plan.

One of the key benefits of the FastRig is that it can be installed dockside, negating the need for the ship to be in a dry dock and reducing the loss of sea and revenue-generating days. The installation was completed within a four-week turnaround, from the contract signing to the ship's departure on sea trials, notably efficient for a first-of-its-kind project on a particularly challenging ship.

AS IT HAPPENED – A STEP BY STEP ACCOUNT

The first stage of the installation was to create a working site at the dockside to support the multidisciplined team needed to prepare the ship, install the hardware and commission the FastRig.

Before the FastRig arrived on site, steel fabricated foundations had to be welded to the existing structural elements of the ship.

The weather that was initially favourable, then became much more challenging, but, despite the conditions, the work was successfully expedited, certified by Lloyd's Register, and signed off by the ship's managers AW Ship Management.

Once this phase was complete, the base unit that houses the hydraulics, wing command and control systems was craned and secured onto the foundation.

Whilst the foundation was being installed, the cabling of the data and control systems between the base and the ship's bridge were installed. Additional RADAR - to meet Maritime and Coastguard Agency (MCA) requirements - and wind instruments, an integral component of automated FastRig operation, were fitted on the bow of the ship.

The main element of the wing was lifted and bolted to the slew ring, the four flaps and eight nose cone elements were craned aboard, and the assembly of the entire wing was achieved through carefully adjusting the wing rotation to meticulously align them as these components were bolted into place.

Ian said: "The installation and decommissioning processes were completed in a matter of weeks. A massive achievement for the first installation of a prototype FastRig."

The final commissioning program was then undertaken including end-to-end testing of the emergency stowage processes, which allow the fully deployed FastRig to be safely folded in a dead ship situation in preparation for the MCA inspection visit that was scheduled for the day before embarkation.

All of the designs, processes and systems were approved by Lloyd's Register, the MCA and the ship's owners in advance of installation and all were in attendance prior to sailing to sign off on the physical works, materials and safety procedures.

SGS Director Ian Haugh said: "On October 15, 2024, having successfully completed the installation programme to timetable, the MV Pacific Grebe sailed out of port, marking a significant milestone in the Winds of Change project."

After four weeks of sea trials and technology showcase events in Southampton and Greenock, the MV Pacific Grebe arrived back in Barrow ready for decommissioning. By the end of November, this was completed and remedial works to return the Grebe to its original state had been carried out and signed off by Lloyd's Register and the ship's owner.

"The project's success demonstrated the potential for fast and efficient installation of the FastRig dockside, saving the ship owner considerable time and expense."

Where there's a will there's a way

Smart Green Shipping and the University of Southampton acknowledge that if it wasn't for their superb team of partners and contractors who went above and beyond the call of duty, they wouldn't be where they are today.

SGS Director Ian Haugh said: "This project involved a high level of teamwork; with everyone - from engineers to contractors - showing exceptional commitment, working late into the night to ensure the installation went to plan. This dedication, combined with detailed planning and clear reporting, enabled us to stay on track, meet all our deadlines and deliver within budget.

"This highlights the importance of collaboration, innovation, and dedication. The positive relationships we fostered with contractors and partners over a number of years were key to delivering this achievement and the installation and subsequent sea trials were a testament to the team's effort and the technical capability of the FastRig system.

"Watching the ship sail away into the sunrise to carry out the sea trials was an emotional moment and I was lucky enough to be there. It marked a major step in a journey started by our CEO, Di Gilpin, more than a decade ago."

TRIALLING
THE TECHNOLOGY AT SEA

Smart Green Shipping and the University of Southampton got the chance to demonstrate the FastRig and put it through its paces, during four weeks of sea trials on board the MV Pacific Grebe.

The sea trials also provided the opportunity to validate their software prediction systems against real-world data, and show that the infrastructure could be easily installed and decommissioned while the ship was dockside.

Houlder led the sea trial feasibility study that:

- evaluated the technical risks and challenges;
- analysed the structural impact of the wingsail on the vessel;
- assessed the stability and weight distribution;
- examined system integration;
- monitored vessel performance before and after installation.

SGS CEO Di Gilpin said: "Our ability to charter the MV Pacific Grebe vessel provided a unique opportunity to conduct structured sea trials.

"Typically, ships fitted with wind-assist devices operate as usual, with only opportunistic performance data being collected, and often not with the high fidelity-measuring equipment installed, which we were able to do for our sea trials.

"In contrast, our structured International Towing Tank Conference protocol-guided trials allowed for precise data collection and analysis, which means that our commercial partners can confidently contract around reliable performance data."

The extensive sea trials followed a paired run approach for direct comparison. The ship's performance was first measured with the FastRig feathered to minimise aerodynamic force - representing the no wind propulsion condition. The ship was then maintained at a constant speed and wind angle, and all relevant performance metrics were measured over a 15-minute period.

Then the wingsail was adjusted to generate maximum thrust and the same set of measurements were recorded over another 15-minute period.

Dr Joseph Banks, Associate Professor in Maritime Engineering at the University of Southampton, who oversaw the trials onboard, said: "This approach ensured that all conditions, except for the activation of the wind propulsion system, remained consistent. By comparing these two states, we obtained a clear and accurate assessment of the wingsail's impact on the vessel's performance.

"Over four weeks of intensive sea trial testing, we gathered valuable data that provided direct insights into the operational benefits of wind-assisted propulsion. The structured nature of these trials allowed us to minimise uncertainties and produce a robust, evidence-based evaluation of the system's effectiveness, in order to validate our numerical prediction methods."

Views from the crew

Paul Goodchild, Master of the MV Pacific Grebe (now retired)

"I was initially sceptical when I joined the project, I've worked at sea for 45 years and had never seen a suitable solution for using wind power in addition to engines to reduce emissions and fuel use.

"When we were joined by the Smart Green Shipping team and their contractors, I was impressed with their enthusiasm. They worked seamlessly with our crew and we were able to contribute valuable knowledge and suggestions for future improvements."

Tom Calderbank, Chief Officer of the MV Pacific Grebe

"We're committed to improving the environmental credentials of shipping and reducing its impact on the environment. We've conducted the trials to help provide real-world data, and if it reduces fuel consumption and emissions I'd gladly sail with these fitted.

"It's been an interesting project to work on, overcoming some complex challenges but the team have been fantastic. I hope to see these fitted to ships around the globe and I'll know I played a part in their success."

Undertaking formal sea trials to ITTC protocols, the structured nature of the process minimises uncertainties.

SEA TRIAL SUCCESS

The Winds of Change project provided an exceptional opportunity to test the 20m reduced scale prototype of Smart Green Shipping's FastRig wingsail. The FastRig was put through its paces for a month in various sea and wind conditions and the results were a huge success.

WINDS OF CHANGE

- demonstrated the FastRig's safety and robustness through regulatory approval with no significant incidents during any part of the process;
- demonstrated the easy installation and deinstallation of the FastRig from a commercial vessel;
- demonstrated the ease of operation and gained valuable insights from the captain and crew who enthusiastically embraced the operation at sea;
- corroborated the digital analyses tools co-developed by SGS and the University of Southampton against real-world sea trials and developed trust and confidence for commercial installations;
- developed the aerodynamic and systems design of SGS Fast systems.

Comparing the sea trial results with the predictions from the University of Southampton's modelling tool, revealed only marginal differences, falling within typical measurement uncertainty margins for such trials. This consistency suggests that the predictive performance models can be used for the accurate fuel saving quantification required to underpin contractual agreements.

Dr Joseph Banks, Associate Professor in Maritime Engineering at the University of Southampton, said: "During the sea trials, we compared the performance of the ship, with and without the FastRig, operating across a range of different ship speeds and wind conditions. This enabled 21 trial conditions to be compared with our performance predictions, 15 at a ship speed of 9kts and 6 at 11kts."

The scientifically rigorous sea trials were based on the newly published International Towing Tank Conference (ITTC) Recommended Procedure – Sea trials for assessing the power saving from wind-assisted propulsion. Houlder independently measured and analysed the vessel's performance data based on this procedure. The onboard sea trials team, along with SGS personnel, included members from the University and Houlder to verify the protocols and measurements conducted.

For each trial condition the ship conducted two paired runs. The first with the wingsail feathered (wind propulsion off), and the second with the wingsail trimmed (wind propulsion on). The additional aerodynamic thrust causes the ship to increase its speed and unload the propeller.

For both paired runs, Houlder measured the average ship speed through the water, delivered power on the prop shafts and the wind direction and speed. This allowed them to determine the change in speed and delivered power between the feathered and trimmed conditions.

The total power savings were also calculated by Houlder from the measured sea-trial data, to remove the effect of the change in ship speed. When compared with the results from the University's performance prediction tool, the findings revealed good prediction accuracy of the total power saving demonstrated across a range of wind angles and speed.

Joe said: "There is good agreement for most trial conditions between the predicted and measured savings. This gives us a high degree of confidence in predicting the power savings of the FastRig for commercial installations."

The next steps

The Winds of Change project has been a huge success in:

- validating the FastRig technology;
- proving its robustness, safety and ease of operation;
- reassuring the maritime industry that science-backed fuel saving analyses can be trusted by validating the predicted and actual performance measurements.

"We are delighted with the way the Winds of Change project has gone, the support we have had, and the results we have seen," said Di Gilpin, SGS CEO.

"We delivered everything we said we would, on time and in budget. By delivering the FastRig demonstration six months ahead of project close, we've been able to use the remaining time available to analyse all the performance data and incorporate the lessons learned from the Winds of Change collaboration into our commercial installations.

"We have refined and improved the aerodynamic design, streamlined the installation process and produced a fully costed Business Case for our four 35m FastRig commercial installation that is scheduled for 2026."

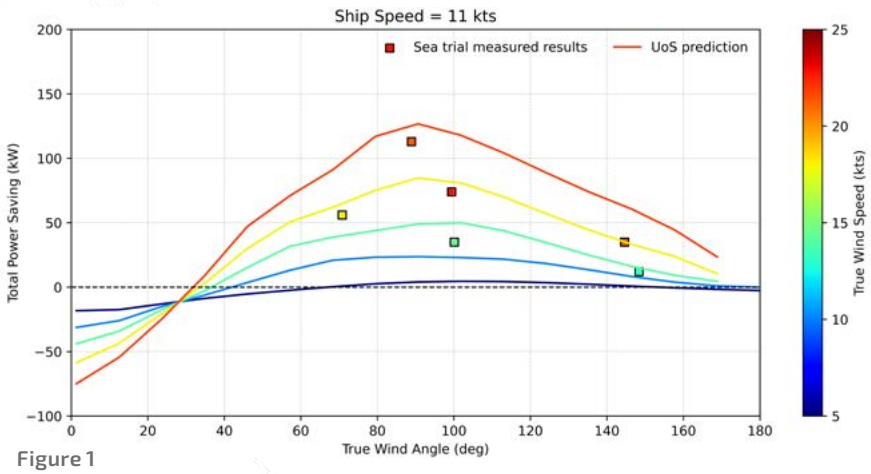


Figure 1

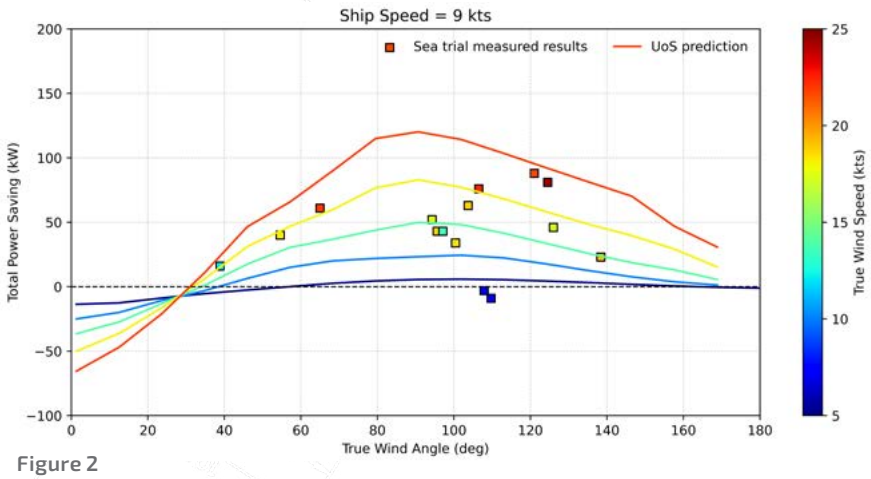


Figure 2

Total power saved due to a single reduced-scale FastRig prototype, at a constant ship speed of 11kts (Figure 1) and 9kts (Figure 2). Predicted savings plotted as curves for different True Wind Speeds (TWS). Calculated savings from sea-trials plotted as data points coloured by TWS. Good agreement between predicted and measured performance can be observed when data points are close to a line of the same colour. A minority of data points show larger discrepancies, these were due to non optimal wing settings in those particular sea trialled conditions compared to the relevant optimised simulation data.

SMART GREEN SHIPPING

The world's shipping fleet consists of around 60,000 vessels and it is estimated approximately two thirds* of these are well-suited to be retrofitted with wind-assist technologies.

* Reducing the maritime sector's contribution to climate change and air pollution: economic opportunities from low and zero emission shipping – A report for the Department for Transport

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