THE NAVAL ARCHITECT

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September 2024

FEATURES

THE NAVAL ARCHITECT

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FUEL FOR THOUGHT

By **Daniel Johnson**

The container ship segment's return to LNG following a recent wave of interest in methanol- and ammonia-fuelled vessels (see p.10) highlights a significant roadblock to the shipping industry's green fuel ambitions: supplies of potential zero-emission fuels like methanol and ammonia are already short on the ground and it's likely that the industry will find it more than challenging to secure an adequate supply of the fuels in the future. Speaking at a decarbonisation seminar earlier this summer, DNV Maritime chief executive Knut Ørbeck-Nilssen candidly warned: "There are not enough green fuels available, and they will remain unavailable for most."

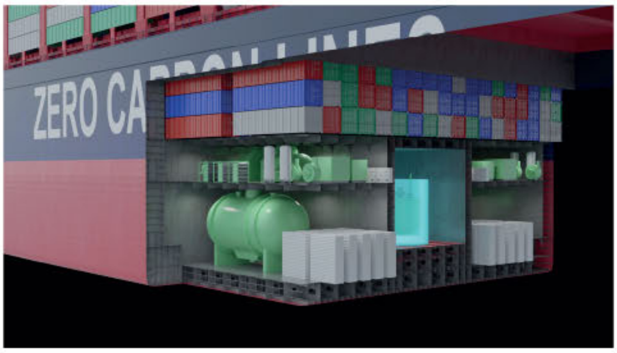
Given this reality, it shouldn't come as surprise that an increasing number of shipping stakeholders are coming together to explore the potential of another future power source – nuclear. According to some, nuclear power could transform the industry with emissions-free shipping, whilst removing the uncertainty of fuel and refuelling infrastructure development. It has also been suggested that IMO's net-zero emissions goal for 2050 will not be possible without nuclear-powered ocean-going ships.

Like LNG, the technology was in the news last month linking decarbonised shipping and container ships as Lloyd's Register (LR) and UK-based nuclear energy technology company Core Power (see *TNA*, January 2022) launched a joint regulatory assessment study around a nuclear container ship using a fourth-generation small modular reactor (SMR) to undertake cargo operations at a port in Europe. LR and Core Power have worked together for some time but in this new venture they have been joined by Danish shipping giant Maersk.

The joint study will investigate the requirements for updated safety rules along with the improved operational and regulatory understanding that is needed for the application of nuclear power in container shipping.

Ole Graa Jakobsen, Maersk's head of fleet technology, stated that if the challenges around safety, waste management and regulatory acceptance across regions can be addressed by development of the new fourth-generation SMR designs, nuclear power could potentially mature into another possible decarbonisation pathway for the logistics industry 10 to 15 years in the future.

The collaboration joins several key nuclear projects currently underway across the maritime industry that are looking to develop and demonstrate large ships powered by SMRs. It also follows a study carried out last year by classification society ABS and US-based Herbert Engineering Corp. (HEC) that concluded the adoption of advanced nuclear reactors on board a 14,000TEU container ship would increase cargo capacity and speed and eliminate the need for refuelling of the vessel during its entire 25-year lifespan. The findings of the research, according to ABS chairman and CEO Christopher J. Wiernicki, "underscore why the industry cannot afford to ignore the vast potential offered by nuclear propulsion both in terms of emissions reduction and operational efficiency".



HEC/ABS CONCEPT ARRANGEMENT OF NUCLEAR REACTOR AND SUPPORTING EQUIPMENT. SOURCE: ABS

Undoubtedly, large maritime vessels like container ships make strong candidates for nuclear propulsion. At sea for months at a time, they consume huge amounts of power and would benefit greatly from not having voyages and cargo intakes planned around bunkering opportunities. New ship designs could be developed free of some of the limitations that exist today as regards bunker capacity and location and with less need for energy saving devices and pollution abatement equipment.

However, amidst the promising developments in small modular reactors for marine use, it is essential to acknowledge the complicated regulatory hurdles that need to be overcome and that public acceptance regarding safety and the likely refusal of some ports to welcome nuclear ships remain a critical concern. One industry insider recently quipped to me that the challenge of changing the public's perception on nuclear power was akin to "climbing Mount Everest in flip-flops". LR's *Fuel for Thought: Nuclear* report, released in July, also notes that investment readiness levels in nuclear propulsion remain very low due to uncertainties around the wider uptake of nuclear technology in commercial shipping.

Expectations of seeing nuclear-powered merchant vessels ploughing the ocean in the next decade or so remain open to debate, but the conversation around the potential of modern reactor technology and how this will affect the design and operation of future vessels is well underway.

In the rush to find cleaner fuels, the shipping industry shouldn't overlook other ways it can reduce its carbon footprint. Energy-efficiency measures such as wind-assisted propulsion have been shown to yield significant fuel and emissions savings. RINA's Wind Propulsion 2024 Conference, to be held 22-23 October (see p.30), will provide an essential insight into how recent technological, design and policy developments are shaping the future landscape for this burgeoning maritime innovation. ■

NEWS

SHIPBUILDING

BAE NAMES NEW SHIPBUILDING HALL AFTER PIONEERING FEMALE WW2 ELECTRICIAN

HARVEY RECEIVED AN HONORARY DEGREE OF DOCTOR OF ENGINEERING FROM GLASGOW CALEDONIAN UNIVERSITY IN 2018. SOURCE: BAE SYSTEMS

BAE Systems has paid tribute to the wartime efforts of a female shipyard worker by naming its new Glasgow shipbuilding facility the Janet Harvey Hall.

The expansive hall, currently under construction, is a key element of the £300m transformation of BAE Systems' shipbuilding facilities on the River Clyde. Once complete, the hall will consist of more than 6,000tonnes of steel and 20,000m^3 of concrete. With two 100tonne cranes and two 20tonne cranes, the facility is designed to accommodate up to 500 workers per shift.

As an electrician in the River Clyde's shipyards during World War 2, Janet Harvey played a crucial role in Britain's war effort and helped break down gender barriers. She was one of just a handful of women working as an electrician alongside the 100,000-strong male workforce.

Harvey was awarded an Honorary Degree of Doctor of Engineering from Glasgow Caledonian University at the age of 96 in recognition of her outstanding contribution to Glasgow's shipyards during the war.

Poignantly, she died on Armistice Day (11 November) in 2023 at the age of 101.

According to BAE Systems, naming the hall after Harvey not only honours her contribution, but also the efforts of all the women who stepped up and became electricians, welders, engineers and platers when the call came.

Jen Blee, business operations director of BAE Systems' naval ships business, says: "It's fitting that a pioneer such as Janet will remain synonymous with our efforts to re-imagine complex shipbuilding on the upper Clyde. Today, women like Janet are much more commonplace in our yards than they once were and their numbers and impact continues to grow."

OFFSHORE

VARD SECURES CONTRACT FOR ADVANCED ENERGY CONSTRUCTION VESSEL

Fincantieri Group subsidiary VARD has been awarded a contract by Norway-based Wind Energy Construction for the design and construction of an energy construction vessel (ECV). The contract includes an option for one further vessel.

The new ECV will be based on the VARD 3 11 design, tailor-made for the offshore wind and subsea market, including inspection, maintenance and repair of pipes, and construction and installation of infrastructure above and below sea level.

Scheduled for delivery in Q2 2027, the unit will be built, outfitted, commissioned and delivered from the Vard Vung Tau shipyard in Vietnam. It will feature a length of 111.5m and a beam of 22.4m and be able to accommodate 120 people on board.

The vessel will be VARD's first to include a permanently installed electric-controlled motion-compensated (ECMC) gangway with integrated 3D-compensated crane capabilities. It will also be fitted with a 150tonne motion-compensated offshore crane to support the expanding renewables market.

Pierroberto Folgiero, CEO and managing director of Fincantieri, comments: "This new order further confirms our technological and industrial leadership in the offshore wind sector, which is growing strongly and offers solid prospects. Fincantieri is playing a leading role, also thanks to the success of our innovative solutions. We will keep focusing on innovation and energy transition as key pillars of our commitment, as per our Industrial Plan."

RENDER OF THE VARD 3 11 DESIGN. SOURCE: VARD

INLAND & COASTAL VESSELS

CONCORDIA DAMEN AWARDED CONTRACT TO DELIVER LUXURY RIVER CRUISE VESSEL

Netherlands-based shipyard Concordia Damen has received an order for its in-house designed hybrid propulsion CDS River Cruise 135 vessel from an undisclosed Swiss luxury river cruise operator.

CDS RIVER CRUISE 135. SOURCE: CONCORDIA DAMEN

The 135m length by 11.45m width ship will have a diesel-electric propulsion system to reduce fuel consumption, optimise efficiency and lower emissions.

According to the yard, the vessel's low draft will enable it to easily navigate shallow waters and allow the operator to maintain operations during low-water seasons. The vessel will also feature high insulation and laser-controlled ventilation, and environmentally friendly materials will be used for the outfitting.

The CDS River Cruise 135 can accommodate 176 passengers in 76 cabins. Its customisable interiors include "spacious cabins, energy-friendly HVAC systems, and dedicated crew areas to ensure a comfortable and enjoyable experience for both guests and crew".

"We are excited to partner with this leading Swiss operator to deliver our innovative River Cruise 135. This contract underscores our commitment to eco-friendly practices and excellence in shipbuilding," says Johan Muilenburg, project manager at Concordia Damen.

He adds: "One of the features I personally like best is the fact that we've integrated solar panels in the railing, which are instrumental in charging the battery system. Another one is that we've proven that this design needs significantly less power to sail under normal circumstances; a real fuel and cost saver."

The yard says it is building a stock of vessel hulls in order to meet anticipated demand.

CRUISE SHIPS

DISNEY CRUISE LINE ORDERS FOUR MORE VESSELS FROM MEYER WERFT

DISNEY WILL MORE THAN DOUBLE ITS FIVE-SHIP FLEET OVER THE NEXT SEVEN YEARS. SOURCE: CREATIVE COMMONS

Disney Cruise Line has announced that it will build four new cruise ships. The newbuilds will be constructed by German shipyard Meyer Werft and are scheduled to join the Walt Disney Company subsidiary's fleet between 2027 and 2031.

The ship names, designs and itineraries are still in development.

The announcement comes during a period of expansion for the cruise line. It currently operates five ships and is in the process of building four others, which are also being constructed at Meyer Werft. These newbuilds, combined with the additional four vessels just announced, will take its fleet to 13 ships by 2031.

"Our Disney cruise ships are the true ambassadors for our brands and beloved by families the world over," says Thomas Mazloum, president, New Experiences Portfolio and Disney Signature Experiences. "As we embark on this ambitious and unprecedented expansion for Disney Cruise Line, we are delighted to work with Meyer Werft once again."

Meyer Werft and Disney Cruise Line have a longstanding relationship that started with *Disney Dream* and *Disney Fantasy*, which were delivered in 2010 and 2012.

"We are very happy to continue our partnership with Disney Cruise Line and build four additional outstanding ships over the next seven years. We now have eight ships for Disney Cruise Line in our order book which reflects the trust in our capabilities and hard work of our team," says Bernard Meyer, CEO of Meyer Werft.

ALTERNATIVE FUELS

SOUTH KOREA'S PLAN FOR GREEN MARINE FUEL SUPPLY CHAIN PROGRESSES

Ulsan Port Authority (UPA) has signed an equity investment agreement worth US$17.6 million with compatriot organisation Hyundai Oil Terminal Corporation to establish an alternative marine fuel supply chain in South Korea centred on Ulsan Port.

The investment – a continuation of the 'Plan to Establish an Alternative Marine Fuel Supply Chain' announced at the South Korean government's emergency economic ministerial meeting in November 2023 – aims to enhance the competitiveness of South Korea's ports by expanding dedicated storage for alternative marine fuels, such as green methanol, and establishing green shipping corridors to activate the supply of alternative marine fuel to domestic and foreign energy companies and global shipping lines.

It follows the signing of a memorandum of understanding (MoU) between UPA and Hyundai Oil Terminal in June 2024 that provides for a strategic collaboration to supply alternative marine fuel in Ulsan Port.

"This investment is part of UPA's efforts to create an alternative marine fuel supply chain to fulfill the government's policy. The agreement also marks the first time that UPA has acquired a direct stake in a tank terminal and its operations," says Kim Jae-gyun, UPA's president.

He adds: "We will be operating eco-friendly ships based at Ulsan Port, contributing to decarbonisation and creating new growth engines for Korea's shipping and port industry by establishing green shipping corridors between Korea and the US."

SIGNING OF THE INVESTMENT AGREEMENT. SOURCE: UPA

NEWS ANALYSIS

BOXSHIP OPERATORS BET ON LNG

By **Malcolm Latarche**

While the political situation in the Middle East appears to be worsening and widening, the impact on shipping is abating somewhat as the industry adapts to routeing around the Cape. The longer voyage has meant that surplus capacity in most sectors has been absorbed allowing freight rates to remain relatively high. The Baltic Dry in August was up 53% year on year while container freights had tripled over the same period.

At this time last year with cargo volumes and freight rates dropping like a stone, container ship operators looked to have saddled themselves with a major headache as new ships ordered at the height of the pandemic were just beginning to hit the water. Now the major players are heading back to the shipyards with a vengeance. Market analyst Vessels Values reported in mid-August that July's new orders for box ships had hit a two-year high with 57 vessels ordered not far short of the 65 ordered in June 2022. The number of new ships booked in July easily exceeded the 40 ships ordered in the first six months of this year.

The ordering spree looks set to continue and could even accelerate. Presenting its second quarter figures in early August, Maersk revealed it will be starting a fleet renewal programme and is close to finalising orders for 50 to 60 new container ships. Although it seems the plan is to keep fleet size at around 4.1-4.3 million TEU, the pace of the planned renewal is set at 160,000TEU annually. Maersk said it would order a total of 800,000TEU for delivery between 2026 and 2030. Not all of the ships will be Maersk-owned as 500,000TEU of the 800,000 will be new vessels taken on time charter.

SUISO FRONTIER, THE WORLD'S FIRST HYDROGEN CARRIER. IT IS ESTIMATED THAT OVER 400 HYDROGEN CARRYING SHIPS WILL SOON BE NEEDED FOR TRANSPORTING HYDROGEN AROUND THE GLOBE. SOURCE: HYSTRA

All of the new vessels will be equipped with dual-fuel engines but it seems that Maersk has dropped its long-held objection to LNG. Maersk would not rule out orders for LNG-fuelled ships and told investors it has commenced the work of securing offtake agreements for liquified bio-methane (bio-LNG). The company said its goal with the renewal programme is to increase to 25% of its fleet equipped with dual-fuel engines.

Rival MSC has taken the opposite stance to Maersk and has been quite happy to operate LNG-fuelled vessels. In mid-August it was announced that the Swiss-based owner had placed an order for 12 vessels of 19,000TEU capacity at Zhoushan Changhong International Shipbuilding. The vessels will be the largest boxships built at the yard.

MSC followed that order up with up to 18 new LNG dual-fuel ships. Shanghai Waigaoqiao Shipbuilding will be building six 19,000TEU ships and Penglai Jinglu eight 11,500TEU vessels with options for four more. These ships will also be dual-fuel and able to run on LNG.

The return to LNG after a surge of interest in methanol- and ammonia-fuelled vessels is almost certainly down to how LNG is treated by the EU in the FuelEU Maritime regulations. Most LNG-fuelled boxships will meet the requirements of the programme through to 2039 and possibly longer if run on synthetic or bio-LNG. As expected the surge of orders for LNG-fuelled boxships has been decried by environmental NGOs although most ship operators will argue that the promised green fuels are not happening at a rate anywhere needed for international shipping alone.

On the matter of future fuels, the International Chamber of Shipping (ICS) published a new report in early August identifying that heavy industry sectors are expected to dominate global hydrogen demand to 2050 and a fleet of over 400 hydrogen carrying ships would be needed for transporting hydrogen around the globe. The report was produced in collaboration with Professor Stefan Ulreich, Professor of Energy Economics at Biberach University of Applied Sciences, and ICS.

Europe has a target of 20 million tonnes of hydrogen per year by 2030, with half of that volume to come from imported sources. To meet this expected demand of the EU, the fleet will need to increase by up to 300 vessels for the EU2030 target alone.

NEWS EQUIPMENT

SHAFT BEARINGS

THORDON WATER-LUBRICATED BEARINGS SELECTED FOR ACCOR'S NEW WIND-ASSISTED CRUISE SHIPS

Thordon Bearings has received an order from French shipyard Chantiers de l'Atlantique to supply its COMPAC seawater-lubricated propeller shaft bearings for installation to a pair of new wind-assisted passenger ships operated by luxury travel operator Accor.

RENDERING OF *ORIENT EXPRESS CORINTHIAN*. SOURCE: MARTIN DARZACQ/ ACCOR SA

The contract marks Thordon's first reference aboard a Chantiers de l'Atlantique-built cruise ship and its first bearing installation on board a wind-powered vessel.

While three 100m-tall, 1,500m^2 SolidSail rigs, a wind sail system develop by the French shipbuilder, will contribute significantly to the newbuild vessels' propulsion, primary propulsive power will be through a conventional seawater-lubricated propeller shaft driven by an LNG-fuelled prime mover. Accor also plans to run the 220m-long ships on green hydrogen once the fuel is approved for ocean-going passenger ships.

Thordon's scope of supply to the twin screw vessels includes COMPAC seawater-lubricated bearings machined to fit 370mm-diameter propeller shafts.

Neil McDonald, Thordon's regional manager, Northern Europe & Africa, says: "For these environmentally focused vessels, an oil-lubricated propeller shaft bearing system was out of the question, and although Chantiers de l'Atlantique has experience with our COMPAC seawater-lubricated bearing system across its naval vessel newbuildings, we still had to go through a lengthy and complex tendering process."

Accor's first wind-assisted vessel, *Orient Express Corinthian*, which will be able to accommodate 120 passengers, is scheduled to set sail in 2026.

ENGINES

WINGD AND CMA CGM COLLABORATE ON FIRST VCR TECHNOLOGY DEPLOYMENT AT SEA

WinGD is to trial its Variable Compression Ratio (VCR) technology on board a vessel operated by French shipping line CMA CGM.

According to the Swiss marine power company, the collaboration marks the first field test for the new dual-fuel engine technology and follows successful factory tests showing significant efficiency improvements with both diesel and LNG fuel.

VCR dynamically adapts cylinder compression ratio in X-DF dual-fuel engines according to the fuel selection, ambient conditions and engine load, leading to lower fuel consumption and greenhouse gas emissions. The innovative technology, developed in partnership with Mitsui E&S DU Co. (MESDU) of Japan, marks the first use of adjustable compression ratio, normally a fixed design parameter, in any marine engine.

The CMA CGM trial comprises a long-term, full-scale test to confirm operability and reliability. Onboard testing is expected to begin following the drydocking of the vessel in September, when VCR will be installed on the ship's WinGD RT flex50DF dual-fuel engine.

"Partnering with leading shipping companies is vital to prove the benefits of new technologies in real-life operating conditions. We applaud CMA CGM for their vision in promoting sustainable shipping and for recognising the potential for VCR to further these ambitions," says Sebastian Hensel, WinGD's vice president of R&D.

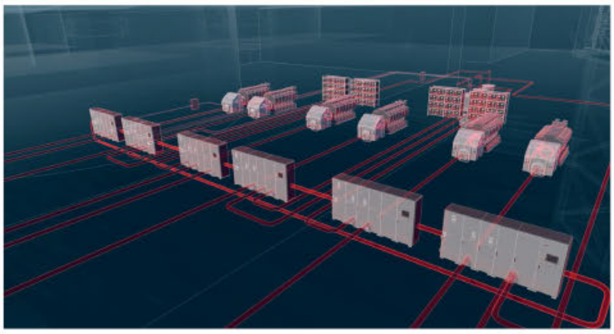
POWER SYSTEMS

CRUISE OPERATOR MODERNISES VESSEL WITH A NEW DC PLATFORM AND SHORE POWER

Germany-based cruise operator Phoenix Reisen has equipped its 1988-built ship *Amera* with DC technology and shore connection from Swiss technology company ABB as part of a programme to improve the sustainability of its fleet.

The 205m, 835-passenger capacity vessel is now equipped with ABB's Onboard DC Grid power system platform and shore connection for improved efficiency and safety, as well as lower emissions.

Following successful commissioning and sea trials, *Amera* has become the first cruise ship retrofitted with Onboard DC Grid.



ABB'S ONBOARD DC GRID. SOURCE: ABB

The project saw the replacement of the vessel's AC system with DC technology that allows for the simple integration of energy sources and loads in a compact, lightweight and functional setup, according to ABB.

The key benefits are said to include safer and more efficient vessel operations thanks to the system's high fault tolerance. "In addition, the vessel is future-proofed as it can be equipped to allow efficient integration of new, low-carbon energy sources such as batteries and fuel cells. This will also support operations in emission control areas such as the Norwegian fjords," ABB adds.

"We are working towards more efficient and environmentally friendly operations across our fleet and having completed the modernisation of *Amera* together with ABB, we are confident we are on the right track to achieve this objective," says Johannes Zurnieden, founder and CEO, Phoenix Reisen.

ENGINES

MAN ES UNVEILS METHANOL CONVERSION PACKAGE FOR FOUR-STROKE ENGINES

MAN Energy Solutions (ES) has announced that it is to offer a retrofit package for the conversion of conventional MAN four-stroke engines already in the field to dual-fuel methanol operation.

Customers will initially be able to convert existing MAN 48/60 engines to the latest MAN 51/60R-DF-M engine type with methanol capability.

According to the company, the conversion package has been under development for some time and has been rigorously tested at its Augsburg, Germany, plant since summer 2024.

MAN ES's after-sales brand MAN PrimeServ plans to convert the first four-stroke engines for a pilot customer in autumn 2025, at which stage the package will be made available to the general market.

SOURCE: MAN ES

Stefan Eefting, head of MAN PrimeServ Germany, says: "With our new methanol retrofit package, we can now offer customers an economically attractive opportunity to convert older engines to a future-proof type. In this way, we are protecting the climate together with our customers and ensure that their investments in our engines remain future-proof, with a very interesting ROI."

Alexander Knafl, head of Engineering R&D Four-Stroke at MAN Energy Solutions, adds that the company has gained extensive experience in methanol operation with the MAN 51/60R-DF-M in a series of tests.

"We have achieved pleasing results in both combustion management and methanol injection and are now focusing on further optimisation. Our aim is to ensure a consistently high engine efficiency, regardless of the fuel type, diesel or methanol," he says.

CLARKSONS RESEARCH SERVICES: HISTORIC AND SCHEDULED DELIVERY

Data extract from World Fleet Register available at **www.clarksons.net/wfr**

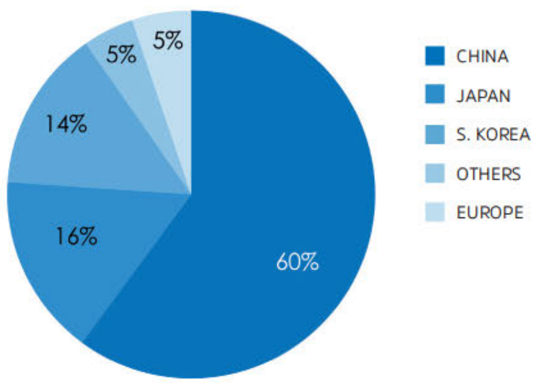
VESSEL TYPE	2013		2014		2015		2016		2017		2018	
	1st Half	2nd Half	1st Half	2nd Half	1st Half	2nd Half	1st Half	2nd Half	1st Half	2nd Half	1st Half	2nd Half
VLCC >= 200,000	21	9	14	10	9	11	23	24	29	21	21	18
Suezmax 125-200,000	23	4	4	4	7	3	8	19	35	22	25	7
Aframax 85-125,000	14	6	4	13	22	10	31	22	36	28	26	24
P'max Tankers 55-85,000	7	5	3	1	2	1	7	11	10	11	7	6
Products 25-55,000	50	29	49	49	60	57	60	42	39	23	27	22
Products 10-25,000	11	4	1	8	4	0	3	2	7	6	10	8
Chem & Spec. 10-55,000	6	13	12	11	36	29	43	38	38	33	45	41
Tankers < 10,000	34	36	27	23	14	17	21	14	23	37	44	43
Capesize > 100,000	63	40	56	38	46	42	65	39	55	20	30	21
Panamax 80-100,000	101	68	62	35	57	41	71	40	75	27	39	25
Panamax 70-80,000	34	42	42	20	19	4	1	2	6	1	2	2
Handymax 45-70,000	148	119	95	97	136	118	123	90	121	51	57	33
Handysize 10-45,000	115	83	100	70	114	87	87	52	73	35	53	47
Combos > 10,000	0	0	0	0	0	0	0	0	0	0	0	0
LNG Carriers	4	13	14	19	16	16	15	18	20	12	32	23
LPG Carriers	22	16	14	14	25	40	49	33	45	17	26	9
Containers > 8,000 teu	51	33	59	42	58	62	37	26	34	36	47	23
Containers 3-8,000 teu	46	29	26	25	18	6	2	0	2	5	7	3
Containers < 3,000 teu	31	21	22	31	28	36	44	29	36	42	54	40
Offshore	12	19	32	32	25	13	26	20	17	24	24	14
Cruise Vessels	6	0	3	2	5	1	8	2	7	3	8	4
Passenger Ferries	5	6	12	8	13	8	6	16	20	11	11	18
Others	98	84	74	58	67	49	50	56	50	56	50	49
TOTAL	**902**	**679**	**725**	**610**	**781**	**651**	**780**	**595**	**778**	**521**	**645**	**480**

DATA INCLUDES ALL VESSELS WITH LOA ESTIMATED AT >100M

THE ORDERBOOK BY YEAR OF DELIVERY ON THIS PAGE IS BASED ON REPORTED ORDERS AND SCHEDULED DELIVERY DATES AND DO NOT NECESSARILY REPRESENT THE EXPECTED PATTERN OF FUTURE DELIVERIES

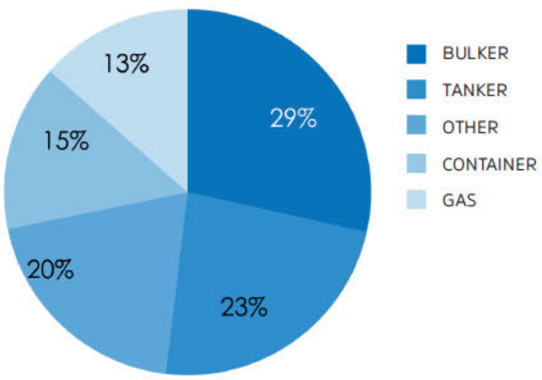
ALL DATA TAKEN AS OF **1ST JULY 2024**

ORDERBOOK BY BUILDER REGION (NUMBER OF VESSELS)

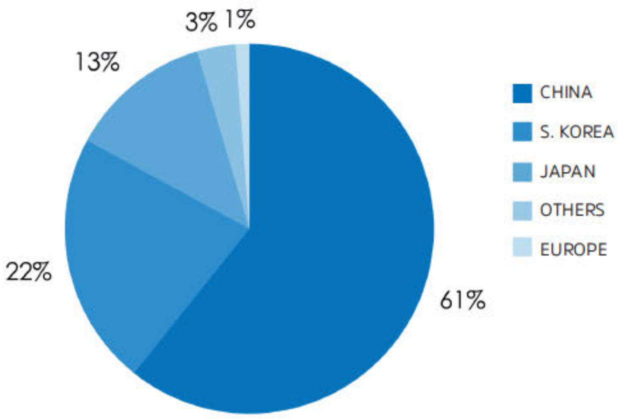


	2019		2020		2021		2022		2023		2024	Scheduled Orderbook		
	1st Half	2nd Half	1st Half	2nd Half	1st Half	2nd half	1st Half	2nd Half	1st Half	2nd Half	1st Half	2024	2025	2026
	39	29	22	15	23	12	24	18	17	5	1	1	5	26
	23	3	11	19	20	3	28	14	5	3	1	7	29	41
	41	12	12	6	28	25	21	18	24	14	16	16	60	56
	6	7	6	4	1	1	4	5	1	0	0	2	11	19
	50	46	43	29	39	37	35	23	22	11	10	27	79	102
	5	10	4	7	7	13	8	7	4	3	1	6	6	7
	34	28	32	25	25	24	24	26	17	15	25	26	91	57
	26	23	21	18	23	32	30	33	28	25	25	58	66	29
	31	49	65	48	52	36	28	22	34	22	27	13	36	36
	69	64	95	47	65	37	52	46	63	49	52	61	105	145
	1	4	3	0	0	1	8	13	11	8	12	12	17	5
	55	77	92	56	60	56	53	70	72	80	88	88	175	106
	53	45	48	46	88	59	68	94	84	66	71	104	139	54
	1	2	0	2	3	0	0	0	0	0	0	0	0	0
	22	20	16	21	35	30	17	16	14	25	25	50	93	93
	16	13	19	12	19	14	20	22	40	29	27	22	43	77
	27	23	13	22	28	26	22	27	40	47	69	65	113	79
	6	1	1	5	5	1	0	13	27	43	66	62	37	10
	49	57	44	57	55	49	54	76	85	116	123	94	65	25
	10	10	5	6	16	17	33	51	31	24	15	40	24	21
	12	10	6	8	8	14	8	13	8	11	5	12	15	12
	16	15	11	11	14	14	12	10	8	10	6	20	15	13
	57	56	41	73	84	93	90	93	60	66	72	168	244	163
	649	**604**	**610**	**537**	**698**	**594**	**639**	**710**	**695**	**672**	**737**	**954**	**1,468**	**1,171**

ORDERBOOK BY SECTOR (NUMBER OF VESSELS)



ORDERBOOK (DWT) BY BUILDER REGION



THE NETHERLANDS

RESILIENT DUTCH YARDS PLAY TO STRENGTHS

By **David Tinsley**

DISTINCTIVE, ALL-DUTCH EASYMAX DESIGN: THIRD-OF-CLASS *AMALIA* MADE HER DEBUT THIS YEAR. SOURCE: ROYAL WAGENBORG

Dutch government acknowledgement of the economic importance and vitality of the country's marine industries was implicit in the July announcement this year that the final allocation of money had been made from the National Growth Fund so as to realise the Maritime Masterplan.

The ambitious €210 million (US$229 million) programme is focused on the joint development and construction of at least 30 demonstration vessels to stimulate the transition to 'sustainable', climate-neutral shipping, nurturing technological advance in design and production. Front-runners in energy-related propulsion and integration studies will be hydrogen, methanol and LNG with carbon capture. Digital twin methodology and model-based systems engineering are crucial elements in the digital landscape of the Maritime Masterplan.

The initial research call has a funding depth of €85 million (US$93 million), and is to be followed by second and third calls in 2026 and 2029, respectively.

Vessels shaped by Dutch flair

In the meantime, the shipbuilding sector continues to draw on its own resources in ensuring continuity and international competitiveness, offering quality and craftsmanship at an acceptable price. Epitomising Dutch flair in the design, construction and operation of ultra fuel-efficient, versatile cargo ships, characteristically coupled with a dynamic but shrewd approach to new business opportunities, Wagenborg Shipping has bolstered investment in its EasyMax generation.

Playing to the northern shipowning, shipmanagement and logistic group's strengths in the dry cargo and project freight sectors, the innovative concept took first form in the 14,300dwt, 2017-commissioned *Egbert Wagenborg*. Second-of-class *Maxima* followed in 2021, with the third ship, *Amalia*, brought into service earlier this year, and the fourth example of the striking design, *Alexia*, now approaching completion by Royal Niestern Sander.

Encapsulating the guiding tenets of 'easy to build, easy to operate, easy to load', two further EasyMax vessels are due to be added to the fleet in 2025. As a response to intensified competition, and heightened environmental requirements, and targeting evolving and emergent fields of short-sea transportation and potentially also North Atlantic trade, the type leads the EEDI league table in its segment, with the lowest CO_2 footprint per tonne of cargo carried.

As well as being a product of the local shipbuilding industry at Delfzijl, where Wagenborg has its headquarters, the vessel series embodies a high proportion of Dutch content, underscoring the fact that the Netherlands, and the northernmost provinces in particular, remain firmly committed to national industrial production as a complement to technological

and practical maritime skills.

With an exceptionally high length-to-breadth ratio, and forward bridge and accommodation, the design embodies two holds (without understow) affording a total 625,000ft³ capacity for forestry goods, including timber, paper and cellulose, steel products, bulk commodities, breakbulk freight, and project shipments and indivisible items such as wind turbine components and other offshore equipment, machinery, and industrial plant.

The 2,999kW maximum continuous output of the medium-speed main engine is transmitted through a geared driveline to a controllable pitch propeller, mounted in a nozzle to maximise thrust. Sailing at 11knots on a draught of about 8.3m in good sea and wind conditions, with the shaft generator engaged, fuel consumption is approximately 9tonnes per day.

Marrying the objective of suitability for serial production with a sophisticated design that answers to shipowners' energy transition strategies, the Labrax 7280 cargo vessel class from Thecla Bodewes has generated substantial business for the group's Kampen yard. Featuring a modular diesel-electric propulsion setup and advanced power management system, the 7,300dwt trader developed in conjunction with Groot Ship Design gives a 329,700ft³ underdeck capacity on a hull length of 119m.

The sixth of 12 sisters booked by Vertom was launched at Kampen in July, and a further two vessels are on order for Carisbrooke Shipping.

Efficient and eco-friendly maritime transport solutions

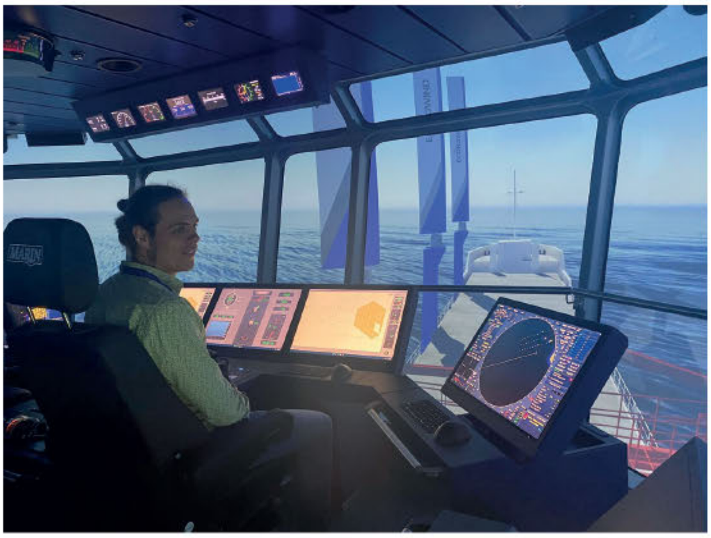
Groningen-based Conoship International has an outstanding reputation in the field of short-sea and small cargo vessel design, reflective of technical prowess complemented by commercial insight borne of close attunement to the shipowning and operating community. Recent and ongoing development of the CI portfolio shows a gravitation towards diesel-electric main power. Electric motors favour the use of a larger-diameter propeller in combination with an optimised aftship form, as expressed in the ConoDuctTail arrangement. This promotes high propulsive efficiency and allows for comparatively modest power in the electric propulsion motors. The company's initiatives as regards wind-assisted propulsion systems also infuse the latest design offerings.

Drawing on the concept and market receptivity to the CIP3600- and CIP3800-series diesel-electric coasters, Conoship has augmented its line-up with a 100m version at 6,375dwt. The CIP6300 type offers a highly competitive 317,000ft³ cargo volume in a single hold with tanktop strengthening to 15tonnes/m². The distributed power setup characterising the CIP family takes the form of four main gensets and two electric motors in the CIP6300 design, promising 4.8tonnes per day fuel consumption at maximum 10.5knots, down to 2.5tonnes/day sailing at 8knots.

The modular system and configuration provides for adaptation at economic cost, such as replacing the diesel generators with methanol-burning aggregates (and retrofitting methanol tanks), or substituting the whole with fuel cells and liquid hydrogen tanks. Furthermore, while the 3600 and 3800 types allow for the mounting of twin VentiFoils forward, at the fo'c's'le, the CIP6300 can accept an array of three VentoFoil sails (the latest version of VentiFoil) along the port side. Conoship says that adoption of the wind-assist solution has the potential to cut fuel consumption and CO_2 emissions by about 10%, depending on the sailing route.

Earlier this year, endorsement of the latest, future fuel-ready general cargo vessel class came by way of the design's nomination in an eight-ship construction contract awarded by Norwegian short-sea specialist Wilson ASA to Cochin Shipyard. The order features an

SIDE-LAUNCH AT KAMPEN: *VERTOM LISA*, SIXTH OF 12 LABRAX-TYPE DIESEL-ELECTRIC CARGO VESSELS FROM THECLA BODEWES. SOURCE: VERTOM



THE OPENING OF MARIN'S SEVEN OCEANS SIMULATOR CENTRE IS A SIGNIFICANT DEVELOPMENT FOR THE DUTCH MARITIME CLUSTER. SOURCE: CONOSHIP INTERNATIONAL

option to install three VentoFoil units on each vessel. The deal extends Wilson's newbuild programme at the Indian yard to 14, as six ships encapsulating the CIP3800 blueprint were booked there in June 2023.

Returning business for a Dutch product in the short-sea domain has also lately included two 6,750dwt ice-classed cargo vessels booked by Royal Bodewes from Finnish owner Meriaura.

The pair of 105m newbuilds of the EcoTrader series, due for delivery by the Hoogezand yard in January and December 2026, respectively, will be approximately 30% larger than the two EcoCoaster-type vessels *Eeva VG* and *Mirva VG* received by Meriaura in 2016. Like the EcoCoasters, the EcoTraders will be engineered to operate on biofuel derived from recycled raw material and produced by Meriaura subsidiary VG-Ecofuel.

Prominent short-sea tanker and dry cargo vessel owner Erik Thun has extended its fleet development programme this year by placing a further tranche of orders with Dutch shipbuilder Ferus Smit. The latest round of contracts comprises two further units of the 7,999dwt battery-hybrid R class tanker type, taking the newbuild series to eight, plus fifth and sixth examples of the 5,100dwt LakeVanernMAX multi-purpose cargo carrier design, maximised for trade through the Trollhattan Canal to Swedish inland ports on Lake Vaner.

The 14-ship production schedule is mainly concentrated at Ferus Smit's Westerbroek headquarters yard near Groningen, on the Winschoterdiep waterway, although a number of the newbuilds have been assigned to the Dutch builder's yard at Leer, just across the border in Germany. The 115m R (Resource Efficiency) class made its debut in February this year with the Leer-built *Thun Resource*, chartered to Swedish oil refiner Nynas.

The 9,540m^3-capacity R tankers are a derivation of the preceding E class commissioned by Thun from Ferus Smit between 2018 and 2021. Complying to Finnish-Swedish 1A ice class criteria, the newbuilds' trading capability ensures unfettered, all-year Baltic navigation.

The adaptive propulsion system minimises energy usage through recourse to a UPS (uninterruptible power supply) battery pack. The small-bore Wärtsilä medium-speed engine of around 1,950kW gives the option for operation on cleaner future fuels. Significantly, in announcing orders for the seventh and eighth units, Thun made reference to "our methanol-ready Resource Efficiency Class".

Bridging the gap between design and operation

Giving added depth and scope to the Dutch maritime cluster, the Seven Oceans Simulator centre (SOSc) was formally inaugurated in May this year at MARIN's Wageningen establishment. Claimed to be unique, SOSc will contribute to maritime safety and technology by realistically simulating the behaviour and interaction of ships and crews in challenging conditions and situations at sea. Advanced digital twinning on simulators will allow designers and sea-going personnel to work together to gain insights into performance under operational conditions before ships are built.

The centre will provide the wherewithal both for research, as into the application of virtual reality (VR) techniques and monitoring of autonomous vessels, and for crew preparation in keeping with the growing complexity and size of container ships and other types in the face of the increasing unpredictability of weather patterns.

SOSc features spherical simulators giving wrap-around, upward and downward projection, with a moving bridge, and a laboratory incorporating VR/AR (augmented reality) technologies, plus human factor management and observation techniques.

The wealth of collaborative research initiated by MARIN continues to be refreshed year-on-year, and a prospective addition to the workload is the STA-2 joint industry project (JIP). The original Sea Trials Analysis (STA) JIP conducted by MARIN with shipowners, yards and the classification sector yielded results that ultimately provided the basis for international standards to verify the performance of newly built and existing ships. Although the developed standard was a stark improvement over the previous methods, after many years of application there is now a perceived need for enhancement.

STA-2 JIP aims to refine the methodology and meet increasingly stringent demands on accuracy, while maintaining the current system's appeal as to practicality and transparency for sea trial managers and EEDI verifiers, for example. MARIN is looking to get the project under way by the end of 2024, and is inviting ship operators, builders, class societies and others to join the endeavour.

RULES & REGULATIONS

ISLE OF MAN SHIP REGISTRY SETS ITS COURSE FOR GREENER HORIZONS

By **Richard Halfhide**

CAMERON MITCHELL, CHIEF EXECUTIVE, ISLE OF MAN SHIP REGISTRY. SOURCE: IOMSR

Decarbonisation of the maritime industry is something that draws upon the efforts of many stakeholders, be that the assimilation of new fuels and engines, energy saving devices, or initiatives such as green corridors to incentivise shipowners and operators to adopt new technologies.

The role of flag states in that process is often maligned; one need only look at some of the negative reporting that often accompanies sessions of IMO's Marine Environment Protection Committee (MEPC), and the protracted efforts to arrive at a strategy for reducing GHG emissions, to form the impression that they embody maritime's more recalcitrant tendencies. But, like the owners whose vessels their fleets are composed of, registries are a mixture of laggards and those that prefer to take a more progressive position.

One flag state that's keen to identify itself in the latter camp is the Isle of Man Ship Registry (IOMSR). Like other 'white-listed' flag registries it's built its status on delivering a quality service at a competitive price, but as a not-for-profit organisation funded by the Isle of Man government, working under the broader umbrella of Isle of Man Maritime, it also has the latitude to address the challenge of decarbonisation more proactively than some of its competitors.

Two years ago, IOMSR introduced its Green Fee scheme, thereby becoming the first flag state to offer owners a discount (15%) on their annual registration fees if their ships were using green technologies, be that biofuel, alternative fuels, wind, or shoreside charging. The registry was not without previous in that regard, having already introduced initiatives such as reduced fees for newbuildings that exceeded EEDI requirements.

But in 2020 it had also broken new ground when it was the first flag to give design approval for a VLGC LPG conversion, in collaboration with owner BW LPG, on its vessel the *BW Gemini*, and other partners. This coincided with a decision to embed green thinking in the registry's philosophy during the Covid lockdown, according to Cameron Mitchell, IOMSR's chief executive.

"It gave us a lot of time for soul searching about what a forward-thinking flag state should look like, what best represented our core values and what we wanted to achieve," he says. "We held various away days, both the management team and the whole staff, looking at SMART objectives with risk versus benefit analysis using the SWOT tool. Regulations tell you how to do things, but the bigger role of the flag state is hopefully trying to influence operators into making more informed choices.

"We've got really smart senior surveyors in the office. They know a lot about all the codes and carriage requirements for dangerous goods. So we started thinking about what else we could offer clients and influence the shipping marketplace."

IOMSR began looking at other organisations best aligned with its values and shortly announced it had joined (again, becoming the first flag to do so) the Getting to Zero Coalition, the multi-party alliance that hopes to make zero-emission vessels and fuels by the end of this decade through promoting initiatives such as green corridors. Mindful to practise what it preached, IOMSR also began scrutinising its own operating model, particularly around the distances its surveyors would travel to conduct inspections.

"Our core survey team in the Isle of Man now only do inspections in Europe, generally speaking," notes Mitchell. "Then we have other contracted surveyors at key locations around the world, who might travel to another country but not great distances. Obviously, we had to ensure they were properly trained and originally this meant they were accompanied by our staff, but most are former navigational officers or senior engineers, or had worked for a class society, so they've all got a solid background."

IOMSR has also embraced remote general inspections, something which became invaluable during the pandemic and continues. Mitchell says much depends on how fully the operator has embraced digitalisation but this has also required the registry's surveyors to learn new skills.

Sustainable Development Goals

The United Nations' Sustainable Development Goals (SDGs), which were adopted by all UN members in 2015, are in part intended to help companies assess their own environmental performance and it's a duty that IOMSR has attempted to incorporate into its own operating model. One of the challenges, Mitchell explains, has been identifying SDGs which best represent the registry's goals without bringing it into opposition with the shipowners who pay for its services.

SDG No.9 – which covers 'Industry, innovation and infrastructure' – fits perfectly with IOMSR's stated aims when considering alternative designs and arrangements for fuel systems, as well as emerging technologies and wind-assisted propulsion. Pertinently, one of the registry's recent accomplishments was securing the registry of what's billed as the world's most powerful sailing cargo ship, the WindWings-equipped Newcastlemax bulk carrier *Berge Olympus*, to its fleet at the start of the year following its retrofitting.

But it doesn't stop there. Mitchell says: "With SDG No. 12 ['Responsible consumption and production'] although we're already ISO 14001 certified and have targets every year it's forced us to look at everything we could do in our operating model to improve consumption of resources.

"No.13 ['Climate action'] we tied to our work with the Getting to Zero Coalition but also in practical steps we brought in the Green Fee scheme. There were various other flags that had preferential rates for LNG carriers, or because a ship burned LNG, but nobody had considered the full suite. So we looked at all the [new] alternative fuels and what technologies are available that, if a shipowner fitted them to a ship, would reduce emissions."

Partly as a result of these endeavours, Mitchell says the IOMSR has also been tasked with representing the UK on an IMO working group that will assess the current state of all existing conventions and how well future fuels sit within these existing frameworks with regard to matters such as seafarer training (STCW) and hazard identification.

In addressing the final earmarked SDG, No. 14 – 'Sustainability of life below water' – the registry has become a member of the nonprofit organisation Eyesea, which maps global pollution and maritime hazards using an app. "One of the things we wanted to achieve is collective action, for seafarers and Isle of Man ships to start using the app and tracking marine pollution. It can be done anonymously and geopositions the pollution, but it also allows Eyesea to track it using tidal streams and weather patterns to see where that pollution ends up," says Mitchell.

These efforts to combat marine pollution have also led the IOMSR to join forces with a number of partners to co-sponsor the Luna Foundation's beach clean-up work at the Vasai Beach in Mumbai last year. Looking ahead, Mitchell says they are also exploring the possibility of supporting another SCG around human rights and ensuring better welfare support for seafarers, building upon work done with an app developed in conjunction with seafarer support association ISWAN.

Fostering collaboration

Although in the past IOMSR has shied away from membership of industry organisations (although not, Mitchell says, for any particular reason) it's now rethinking how it can better represent the interests of its clients. In the past few years it has joined InterCargo, Intertanko and the Asian Shipowners Association (60% of the vessels in its fleet are managed from Asia) and most recently the Maritime Anti-Corruption Network.

Mitchell strongly believes that IMO's decarbonisation targets aren't achievable without stakeholders working together, with greater data transparency being a significant part of that journey, something that's not currently the case with IMO's Global Integrated Shipping Information System (GISIS) system, where most of the data is not generally accessible. In 2022, IOMSR signed an MOU with FuelTrust, a US-based company. FuelTrust has developed an AI chemist capable of taking a bunker delivery note and working out the properties of that fuel, cross referencing with the ship engine details and fuel consumption, and calculating the emissions.

Ultimately the push for greater emissions transparency could lead to the traditional white, grey and black lists that quantify the performance of flags being extended beyond merely noting the ship deficiencies currently noted by Port State Control and incorporating a registry's environmental performance as well.

"I can't see the journey through MARPOL Annex VI slowing down. If we're using EEDI, EEXI and CII to set a standard – albeit those standards may change – and saying how green a ship or fleet is, then why wouldn't those same standards of reporting be asked of flags?

"Greater data transparency is key if shipping is to meet the IMO's 2050 target," he concludes.

THE IOM-FLAGGED *BW GEMINI* BECAME THE FIRST VLGC LPG

GREEN SHIPS

UECC'S BIOFUEL SWITCH INITIATIVE ADDS IMPETUS TO ITS SUSTAINABLE JOURNEY

By **Richard Halfhide**

AUTO ECO AND ITS SISTER *AUTO ENERGY* WERE AMONG THE EARLIEST LNG-FUELLED CAR CARRIERS

United European Car Carriers (UECC) is on a sustainability journey and while it's a route many have since embarked upon the company can certainly stake a claim to have been among the early pacesetters. A decade ago the Norwegian-headquartered ro-ro operator, which focuses on European short-sea transportation, ordered what became the first dual-fuel LNG pure car and truck carriers (PCTCs), *Auto Eco* and *Auto Energy* (delivered 2016).

UECC CEO Glenn Edvardsen explains: "Back in 2012, when we began planning for these vessels, the discussion around choice of fuel was nothing near what it is today. The only thing we were clear on was that we were not going to continue with oil. The choice of LNG was easy at the time because it was the most environmentally friendly fuel. Although we didn't know what the cost of LNG would be in the future, we made a decision and stuck to it."

Designed and built specifically for short-sea Baltic transportation, and thus to 1A Super ice class specifications, *Auto Eco* and *Auto Energy* also represented a significant scaling up in capacity from UECC's older fleet, allowing it to replace five vessels with just two. Bunkering infrastructure, specifically a purpose-built LNG bunkering vessel part owned by UECC's parent company NYK Line, was also key to making the project work.

No sooner had *Auto Eco* and *Auto Energy* been delivered than UECC began preparing for the next phase in its evolution. Following fresh investment in 2019, it ordered an additional three LNG battery hybrid PCTCs – *Auto Advance*, *Auto Achieve* and *Auto Aspire* (delivered 2021-22).

This new trio incorporated NOx Tier III compliant engines (two years ahead of it becoming mandatory for newbuildings operating in the Baltic region) and a design optimised both for the flexibility required for handling breakbulk and the increased weight of electric vehicles. A pioneering energy management system, utilising the battery for peak shaving and further emissions reduction, would come to serve as the blueprint for other operators.

UECC still has four older vessels that it has plans to replace with yet more innovative features. One safety factor likely to be high on the agenda is the increasingly prevalent risk of lithium-ion fires on board car carriers and the inclusion of more firefighting zones is a design factor under consideration. "We will definitely continue to invest for the future, that's for sure," says Edvardsen.

There has been no shortage of kudos for the company's commitment to a cleaner future, with UECC and *Auto Energy* being the recipients of multiple Greenports awards and most recently in 2023 the Ford World Excellence Award for Sustainability, beating tens of thousands of automotive suppliers in achieving the honour.

Fuel evolution

But even with significant investment transitioning towards alternative fuels is far from an overnight process. For the first five years after delivery of *Auto Eco* and *Auto Energy* liquefied methane constituted a negligible component of the UECC fleet's overall fuel consumption. By last year however around 35% of its requirements were being met by non-conventional fuels and while UECC currently projects that this figure will rise to 80% by the end of the decade there are optimistic predictions it could be revised to 100% if the current rate of progress continues.

Daniel Gent, UECC's energy and sustainability manager, readily admits he wasn't fully onboard when the company first began exploring LNG a decade ago. "I came from a commodity trading background and was very much of a black oil mentality. We had a vessel trading into the Baltic where there was an abundance of cheap Russian HFO and the cost of a scrubber on a newbuilding could have been paid off in 10 months. Ten years on we can see that such an investment would have been a noose around our neck."

Holistically speaking, UECC's fleet comfortably meets the requirements for CII compliance for the next few years. With regard to FuelEU Maritime, the European Union designed to gradually increase the share of renewable and low-carbon fuels being used within its territorial waters, it should remain in good stead until the middle of the next decade. Between them the LNG used by *Auto Eco* and *Auto Energy* equated to just over 5,000mt in tank-to-wake CO_2 emissions reduction across the UECC fleet by 2019. However, even greater benefits were to be realised as the company began incorporating the use of biofuels from 2020 onwards, jumping to just under 62,000mt last year (a reduction of more than 20%).

When it comes to biofuels, conventional wisdom within the maritime industry leans towards distillate-based fatty acid methyl esters (FAME). But, notwithstanding availability, the reliability, sustainability and provenance of some of these biofuels is regularly called into question. UECC's own pursuit of viable solutions would draw the company into a variety of novel bio feedstocks such as residual FAME and animal tallow.

Gent explains: "We needed to identify which of the fuels are promising before there's a rush on the market. With some of the fuels we found the storage capabilities weren't conducive with the cars on board. They have to be kept at such a high heat in the storage tank that it generates heat on the deck which is going to cause issues with rubber tyres."

Subsequently the company challenged biofuel producers to propose a cost-effective scalable solution and eventually settled upon cashew nutshell liquid (CNSL), a feedstock with extremely good sustainability credentials offering 95% well-to-wake emissions reduction. UECC is now with Netherlands-based fuel supplier ACT, engine maker Wärtsilä and Lloyd's Register for in an ongoing trial study on board one of its vessels. So far the results, with the vessel currently operating on a blend ratio of 30% CNSL, are proving extremely promising and it is hoped to eventually run it almost entirely on CNSL-based pure biodiesel (B100).

Sail for change

At the start of 2024, UECC developed its CO_2 Registry, an innovation that allows the company to transfer the benefits of clean fuel use to charterers in a transparent, independently verifiable manner. It paved the way for UECC's Sail for Change programme, which formally launched over the summer.

In July it marked 'Green Gas Month' by deploying liquified bio methane deployed on all five of UECC's LNG-fuelled car carriers, in what has been described as an industry first. The estimated well-to-wake emissions reduction for that month alone is reckoned by the company to have exceeded 8,000mt of CO_2. But a perhaps more significant facet is an innovative fuel switch scheme that allows customers to choose which fuel is used to carry its cargo.

DANIEL GENT, UECC ENERGY AND SUSTAINABILITY MANAGER

Gent explains: "Sail for Change is the opportunity for customers to make a direct positive impact by facilitating a fuel change. The customer says: 'I don't want you to transport my cargo with VLSFO or MGO, I want you to transport it with a biofuel'. You can be specific about the fuel; the customer might want CNSL, or animal tallow, and they can enact that through this programme."

UECC has already implemented Sail for Change with major customers such as BMW and works by aligning targets with the quantity of cargo being transported and the CO_2 it generates. The key to being able to offer such a product was developing a commonly agreed methodology for calculating CO_2 emissions on ro-ro vessels. Previously some groups based their calculation on grammes of CO_2 per tonne-km, while others opted for cubic metres per km.

To resolve the matter UECC approached the Association of European Vehicle Logistics (ECG) to develop a new industry standard for short-sea ro-ro transportation; this method considers the characteristics of each vehicle and determines how many grammes of CO_2 are produced by every unit.

"We decide with the customer how many grammes of CO_2 they want to reduce by, e.g. 20,000tonnes (which is approx. 5,000 units), make the fuel switch and introduce some alternative fuel on a mass balance basis. If we have a service with five vessels running on it that customer might have their volume spread evenly across all five vessels, but it might not be practical to have the biofuel on board all five vessels. So one vessel might have the biofuel on board but the emissions reduction savings are allocated only to that customer in a traceable way that cannot be duplicated," says Gent.

Upon completion of the arrangement the customer receives an Impact Statement from the UECC CO_2 Registry stating what has happened and, crucially, the Proof of Sustainability reference required by the EU for the fuel used, along with the feedstock, Bunker Delivery Note and logs from the ship's engine room. Because the industry calculation methodology UECC helped develop excludes the use of biofuel it has no bearing on the carbon intensity reported to the customer. Consequently those who opt not to use biofuels cannot make a claim for reducing emissions, even though their cargo may in actuality be travelling on a vessel using such a fuel blend.

According to Gent it's a further example of UECC's commitment to leading by example in sustainable shipping, establishing best practices and innovative solutions that push the boundaries of what can be done to make the industry greener.

"This sector feels very much like the Wild West at the moment, and we're trying to be the sheriff in our own little corner," he concludes.

WIND PROPULSION

A PERFECT STORM BREWING FOR WIND PROPULSION ERA 2.0

By **Gavin Allwright**, secretary general, International Windship Association

In 1860, just before he became president, Abraham Lincoln gave a speech featuring one of my favourite quotes regarding wind power.

"Of all the forces of nature, I should think the wind contains the largest amount of motive power … And yet it has not, so far in the world's history, become properly valued as motive power. It is applied extensively and advantageously to sail vessels in navigation. Add to this a few windmills and pumps and you have about all. As yet the wind is an untamed, unharnessed force, and quite possibly one of the greatest discoveries hereafter to be made will be the taming and harnessing of it."

He was, of course, correct. Though it took over a century for modern wind turbines to start harnessing this inexhaustible, abundant and free energy source on the land.

Unfortunately, while harnessing the energy of the wind took off, the previously favoured use of wind energy by ships tailed off and eventually disappeared in all major maritime sectors apart from the leisure and racing worlds.

The good news is that this maritime trend is now being reversed. However, as with any new technology adoption or energy transition there is the need to deliver on three main pillars which build a foundation of trust in the systems and solutions:
1. Robustness and Safety
2. Validation and Viability
3. Economic and Accessibility

The need for standards sits as the base stone to these pillars but also there must be a challenge to unfounded or outdated positive perceptions of the existing system and of course challenging the negative perceptions of the incoming or disruptive approaches and solutions. All of these matter when it comes to the adoption of wind propulsion systems and each of these foundation pillars are in varying stages of development, as you might expect.

GAVIN ALLWRIGHT

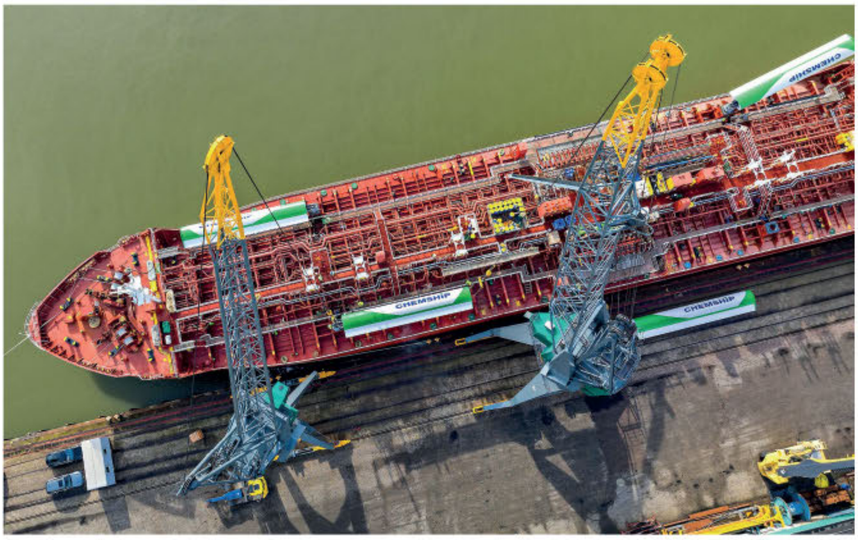
The upcoming Wind Propulsion Conference hosted by the Royal Institution of Naval Architects, in association with the International Windship Association (22-23 October, IMO HQ, London), will have an extensive range of papers tackling many of the issues in the first two categories, focusing on the first two pillars which encompass design, technology, operations and standards. These two pillars then lay the groundwork for tackling the third pillar, the supply chain, business models and economic challenges that are required to further accelerate that scaling process.

If we tackle that third pillar first and ask, where exactly are we on the innovation dissemination curve? As we go to print there are 45 wind propulsion solutions installed on commercial vessels of sizes over 400gt across almost all the main sectors of shipping. This amounts to over three million deadweight tonnes of shipping capacity. Alongside this growing wind use there are 10 'wind-ready' vessels, i.e. those with all of the foundation work completed but without the wind propulsion technologies components installed. This wind-powered fleet is further complemented by 10 traditionally rigged small cruise vessels and a dozen or so small sail cargo vessels under 400gt in addition to indigenous sail fisheries and cargo vessels operating in the Indian Ocean and Pacific etc.

Large wind-powered vessels are primarily to be found in the bulker, tanker, ro-ro and general cargo segments and the total number is likely to double over the next 12 months. If the pipeline of orders continues with the current trends, the number of wind installed vessels will at least double each year going forward. We will also see more technologies coming into the market and within these numbers, there is a growing trend for primary wind vessels coming into the fleet (four by the end of 2024, with an additional 10 on order or under construction for delivery in 2025-26).

We have recently seen indicators that suggest we are approaching an inflexion point from the supply side with a series of fleet order announcements being made. UK-based Union Maritime has announced 34 tankers ships will be outfitted with various wind propulsion technologies for delivery between 2025-2027. Japan-

WIND PROPULSION SOLUTIONS HAVE BEEN INSTALLED ON COMMERCIAL VESSELS ACROSS ALMOST ALL THE MAIN SECTORS OF SHIPPING, INCLUDING CHEMSHIP'S *CHEMICAL CHALLENGER*, THE FIRST CHEMICAL TANKER TO BE EQUIPPED WITH THE SUSTAINABLE TECHNOLOGY. SOURCE: CHEMSHIP



based Mitsui O.S.K Lines (MOL) plans to launch 25 vessels equipped with its rigid wing sail system by 2030, increasing to 80 by 2035 and other potential projects in the pipeline. France-based Louis Dreyfus Armateurs (LDA) has ordered three newbuild ro-ro vessels with six rigs each and for primary wind development. French company TOWT has taken delivery of the first two small, 1,200dwt cargo vessels with six more on order for operation by 2026. When it comes to wind-ready vessels, we already have a fleet of six 50,000dwt tankers operated by Capital Ship Management Corp.

However, what are the key levers that need to be pulled and elements that need to be in place to ensure that this trend continues? These are the levers that add energy to the trends and optimisation momentum within this field and ultimately help bridge the 'chasm' between the first movers or innovators and early adopters (15% of the industry) and the later adopters making up much of the rest.

These levers have grown in strength significantly over the last 18 months, especially since the second Wind Propulsion Conference held in February 2023. The pressure has been mounting substantially from the policy perspective, with the IMO GHG Strategy agreed in July last year and the pressure growing to deliver on those ambitions (EEDI, EEXI, CII and the debates around a global fuel standard and a carbon pricing mechanism which are now firmly on the horizon). Regional policy is also starting to bite or is pending, with some national carbon pricing and decarbonisation frameworks in place, while arguably the most impactful is the inclusion of shipping into the EU ETS trading scheme, ratcheting up from 40% to its full level over the next two years and the introduction of the FuelEU Maritime regulations in the next few months (including its additional bonus reward for wind propulsion installed).

Cargo owners have been increasingly vocal about reducing their Scope 3 emissions, with projects such as The Zero Emission Maritime Buyers Alliance (ZEMBA), an initiative of Cargo Owners for Zero Emission Vessels (coZEV) putting out tenders for low- or zero-emissions maritime transport, including cargo owners Amazon, Ikea, Unilever etc., and the Michelin-led Cargo Owners'

MOL HAS CONTINUOUSLY MEASURED THE PERFORMANCE OF ITS PROPRIETARY WIND CHALLENGER SYSTEM ON BULKER *SHOFU MARU* SINCE ITS DELIVERY IN OCTOBER 2022, CONFIRMING FUEL SAVINGS OF UP TO 17% ON ITS VOYAGES. THE COMPANY PLANS TO LAUNCH 25 VESSELS EQUIPPED WITH THE SYSTEM BY 2030. SOURCE: MOL

EACH OF LDA'S NEWBUILD RO-RO VESSELS WILL BE POWERED BY A COMBINATION OF SIX FLETTNER ROTORS. SOURCE: LDA

Association, newly created by France Supply Chain and the Association des Utilisateurs de transport de Fret (AUTF) which has specified wind propulsion within their similar tenders, leading to orders of 10 wind-assist and alternative dual fuel-powered container vessels, reportedly already under construction in South Korea for delivery from 2026 onwards. Other pressures are mounting with the market realisation that the cost of new alternative low- or zero-GHG fuels is going to be very high for the foreseeable future and the infrastructure to deliver those will also take considerable time and expense to build out. Fuel supply and price volatility also feed into those concerns.

Finally, the elephant in the room is the climate change pressure, with an unprecedented acceleration in the deterioration of the situation, along with the CO_2 sequestering saturation of the oceans and loss of biodiversity which are all feeding into concern around 'tipping points' rather than smooth linear decline and this concern adds weight to the arguments for immediately deployable solutions, such as wind propulsion.

These pressures are all pointing from the demand side, at the need for innovation inflexion points as early as possible, i.e. steep inclines and exponential scaling as soon as possible and certainly before the first IMO indicative checkpoint in 2030 (20-30% reduction). The CE Delft report *Shipping GHG Emissions 2030: Analysis of the Maximum Technical Abatement Potential*, presented to IMO in 2023, clearly indicated a sustained roll out of energy efficiency measures, speed reduction, wind propulsion along with 5-10% new low emissions fuels could deliver between 28-47% reduction in emissions by 2030. This report didn't go into additional benefits accrued through the alignment of voyage optimisation and wind propulsion systems and other integration potential.

However, it is from the supply side that we need to see matching trends to deliver on the potential of wind propulsion across the board as we approach that inflexion point on the innovation 'S-curve' somewhere between 2026-27, only approximately 18 months away.

So, looping back to the first two pillars I described at the start of this article. The conference in October will, of course, tackle the issues of robustness and safety along with validation and viability.

Robustness – Here we must answer the questions on whether technologies, their materials and the design of wind optimised vessels are up to the task as the demands for these technologies and the next wave of ultra-low and zero-emissions ships is growing. The conference will feature a raft of papers dedicated to these issues ranging from design examples for cruise and container ships through to iterative, holistic design techniques utilising digital twins etc.

Safety – Safety is of course a critical issue. At the end of last year we saw the publication of an appraisal of wind propulsion systems by European Maritime Safety Agency (EMSA) and while there are clear issues where more knowledge and regulatory alignment is required, that appraisal concluded that while there are areas of concern, no major risk was identified that can't be resolved. Therefore, there is still much work to be done and in October we will hear from classification societies their perspective on the regulatory framework, HAZID/HAZOP considerations and experiences gained.

Validation – Validation and standard approaches are vital foundations on which to build accurate performance models which in turn are key to developing trustworthy business cases. Much work has been undertaken in this field, however further integration into the 'system of systems' that is a modern ship is a key area for further integration and here what can't be calculated accurately can't be improved upon. Thus, there is the need for appropriate testing approaches and continued analysis of how existing wind propulsion systems and the new solutions and design that are entering the toolbox. As in previous years there will be a strong focus on aerodynamics, deploying accurate sensor arrays and techniques and manoeuvring and seakeeping impacts from wind propulsion systems. We will also get insights into industry standards development and the recent recommendations and guidelines proposed by the ITTC and an overview of the challenges of protecting intellectual property in the marine sector.

Viability – Here we come to the crunch, the viability of wind propulsion solutions can be boiled down to performance, how these carefully designed, tested and fabricated solutions actually perform in reality and here we will hear from experience in the field, from methods of optimising systems, with an eye on trim, leeway and rudder angle impacts, options for bilge keels and fins through to in-service measurement approaches and how operational experience measures up to simulated data.

If you would like to place yourself in the eye of this 'perfect storm' fuelling the uptake of wind propulsion, then come and join us at Wind Propulsion 2024, hosted by RINA at IMO Headquarters in London, 22-23 October 2024, and sponsored by bound4blue and Vaisala.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ADVANCEMENTS IN SAILS

By **Alberto Llopis Pascual**, head of aerodynamics, bound4blue

LOUIS DREYFUS ARMATEURS' *VILLE DE BORDEAUX* WITH ITS THREE 22M ESAILS. THE INSTALLATION IS THE FIRST OF A FIXED SUCTION SAIL ON A RO-RO VESSEL

Since the decline of commercial sail-powered vessels, there has been remarkable progress in sail technology, driven by a renewed interest in sustainable maritime solutions. The modern sail has evolved far beyond the traditional cloth structures once used on clipper ships. Today's sails benefit from advanced designs, innovative materials, increased surface areas, and the integration of autonomous control systems and weather optimisation software. These enhancements have collectively revolutionised sail performance, allowing modern sails to harness up to seven times more wind force than their historical counterparts.

One of the key developments in this area is the size and shape of sails. These have been optimised using computational fluid dynamics (CFD) to maximise lift and minimise drag, further enhancing their efficiency. Autonomous control systems now enable real-time adjustments to sail trim and positioning, ensuring that the sails are always operating at peak efficiency regardless of changing wind conditions.

However, the resurgence of sails in commercial shipping is not about returning to an era of fully wind-powered vessels. Instead, sails are being integrated as part of a broader hybrid approach, where they complement other advanced propulsion technologies. This hybrid model is essential for meeting the shipping industry's decarbonisation goals.

Origin of suction sails

The concept of using suction to enhance the performance of aerodynamic surfaces is not new. It dates back to the 1930s when the National Advisory Committee for Aeronautics (NACA), which later became NASA, conducted pioneering research on suction wings. These studies aimed to reduce the fuel consumption of aircraft by improving the aerodynamic efficiency of their wings. NACA's experiments demonstrated that by strategically sucking air through small perforations on the wing surface, turbulent airflow could be controlled, leading to a reduction in drag and a corresponding 8% improvement in fuel efficiency. However, the technology did not gain industrial application due to the strict safety standards that aviation must adhere to.

Fast forward to the early 1980s, and the principle of suction was adapted for maritime use by the Cousteau Foundation. Captain Jacques-Yves Cousteau, best known for his oceanographic research and the iconic vessel *Calypso*, sought to create a new, environmentally friendly exploratory ship. Motivated by the growing awareness of natural resource depletion and the environmental impact of human activities, Cousteau envisioned a ship that utilised wind-assisted propulsion. This led to the development of the TurboVoile, the first suction sail, designed by a research team under the Cousteau Foundation.

The TurboVoile featured a thick, aerodynamic profile that leveraged suction to generate exceptionally high lift forces. Unlike the slender suction wings of the 1930s, which were designed to improve efficiency by reducing drag, the TurboVoile's design focused on maximising lift. The result was a sail capable of generating lift forces six to seven times greater than those of a conventional wing sail. The TurboVoile was tested on two vessels, *Moulin à Vent* and *Alcyone*, with the latter embarking on extensive sea trials around the world, demonstrating the sail's potential in real-world conditions.

The success of the TurboVoile highlighted the potential for suction-based sails to play a significant role in the future of maritime propulsion. By combining the principles of aerodynamic efficiency with the sheer power of wind, suction sails represent a promising avenue for reducing the carbon footprint of the shipping industry while maintaining the operational capabilities of modern vessels.

Enhancing the performance

Taking the lessons learnt from the development of the Turbovoile, bound4blue set out to improve the performance of the suction sail. The culmination of this work is the eSAIL: a fully autonomous suction sail that delivers 20% more lift for the same power when compared to the Turbovoile.

How did we achieve this increase in performance? This is thanks to modern computers which allow us to design and optimise the eSAIL. These tools allow us to calculate and simulate how changes to the shape and position of certain components can affect the performance of the sail in a quick manner.

The methodology used by bound4blue was presented at the Wind Propulsion 2023 Conference (*Aerodynamic optimisation of the eSAIL®, bound4blue's suction sail for wind-assisted vessel propulsion*). The paper described the methods used to optimise the performance of the eSAIL using CFD simulations. The complexity of these simulations meant we initially had to make sure the tools were accurate, which was achieved by using the TurboVoile data as validation points.

Once our tools were able to correctly capture the physics and predict lift and drag forces, parametric studies were conducted to understand how many design variables affect the performance. This allowed us to identify the best geometry which was used to design the eSAIL.

The validation process did not end there, as we sought to confirm the performance seen in the simulations. This was done by conducting wind tunnel testing, tunnel-like facility which simulates flow around a body. These facilities provide crucial data in terms of forces and pressure, which can be used to validate tools. In our case, the results showed very strong agreement between both datasets.

Ultimately, this gives us confidence in our tools and results meaning we can keep pushing to add more complexity to our simulations.

Where should they POINT?

The aerodynamics were obviously thrilled with the results obtained. However, they did not stop there and have continued to improve their knowledge, their tools with the objective of continuously improving the performance of the eSAIL.

One example of this is a tool to predict the aerodynamic behaviour of two or more suction sails in vicinity of each other. A tool we have called POINT (POtential INterference Tool) and that we will be presenting at the Wind Propulsion 2024 Conference.

Before we explain how the tool works, it is important to understand what we mean by "aerodynamic interference". When two or more aerodynamic bodies are close to each other, they will affect each other in such a way that the performance will not be as simple as the sum between all bodies. To put it simply, 1 plus 1 does not equal 2. In fact, the total will depend on many factors: how close are the bodies? What wind direction and wind speed? Are there any bodies on the ship which can affect them like cranes or cabins?

To understand how all these variables affect the performance of the eSAILs, we could run CFD simulations in the same way we did to predict the performance of a single eSAIL. However, the computational cost will escalate quickly due to the size and complexity of the simulations. Therefore, a mathematical tool was developed which would allow us to run much quicker simulations (meaning less cost) but one that is sufficiently accurate when compared to CFD simulations. ■

This is just a brief overview of the development work of the aerodynamics team at bound4blue. More detailed information will be presented at the Wind Propulsion 2024 Conference to be held from 22-23 October in London.

TWO 17M-HIGH ESAILS HAVE BEEN SUCCESSFULLY INSTALLED ON THE GENERAL CARGO VESSEL *EEMS TRAVELLER*, OWNED BY AMASUS

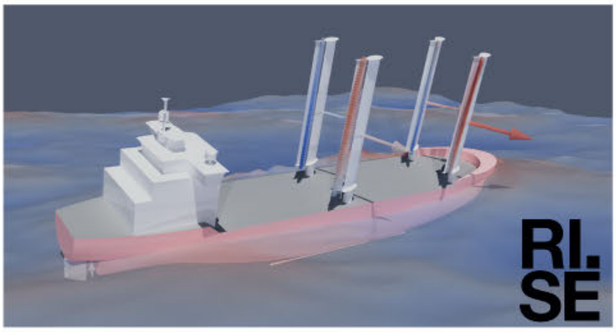
CONFERENCE PREVIEW: WIND PROPULSION 2024

Since its inauguration in 2019, the now annual Wind Propulsion Conference has become an essential event for the maritime community, with attending speakers and delegates spanning the technology companies, academia, shipowners and industry associations. Against a backdrop of tightening environmental regulations and an increasing need to develop and apply innovative alternative power and propulsion technology for ships, this year's conference – hosted by RINA in association with the International Windship Association and to be held on 22-23 October at IMO's historic headquarters in the heart of London – promises to be another must-attend event.

Wind Propulsion 2024's carefully curated agenda will bring those attending fully up to speed with the recent technological, design and policy developments shaping the future landscape for wind propulsion technology. The conference is designed to include regular breaks to provide delegates with the opportunity to network, engage in one-on-one conversations and knowledge share.

This year, Lars Robert Pedersen, deputy secretary general of BIMCO, will deliver the conference's opening keynote speech. Speakers at the two-day event also include experts from bound4blue, ABS, DNV, Bureau Veritas, SINTEF Ocean, Sumitomo Heavy Industries Marine & Engineering, Hapag-Lloyd, MARIN, BAR Technologies, the University of Southampton, Delft University of Technology and Research Institutes Sweden (RISE), amongst others. A preliminary programme is available to view on the RINA website, but to get a flavour of what attendees can expect, *TNA* spoke to a few of the presenters:

Wouter Van der Velden, Dassault Systèmes: "Our presentation showcases how unified engineering software solutions enhances the aerodynamic performance and structural integrity of wind propulsion systems, providing a sustainable alternative to traditional fuel-based propulsion. Dassault Systèmes' PowerFLOW



LEARN MORE ABOUT SEAKEEPING AND MANOEUVRING SIMULATIONS FOR WIND-POWERED VESSELS AT THE DESIGN STAGE FROM STAVROS KONTOS, RISE

is crucial in this advancement, utilising the Lattice Boltzmann Method to simulate realistic wind behaviour in complex maritime environments. Its automatic meshing and parallel processing capabilities improve efficiency, offering designers precise insights to develop innovative and cost-effective wind propulsion solutions with significant environmental and economic benefits."

Anders Alterskjær, SINTEF Ocean: "In collaboration with SINTEF Ocean and 12 other partners, Hurtigruten Norway, through the SeaZero project, is aiming to develop zero-emission ships specially adapted to the Norwegian coast for the long-established 'Coastal Express Route'. Key to enabling zero-emission operations within maritime sector in general and also for Hurtigruten is reducing energy consumption to a minimum. Although the potential of wind propulsion technologies has by now been verified in a number of projects, studies and full-scale installations, the Hurtigruten case poses a few specific challenges with respect to incorporating wind propulsion in the vessel design and operation. Our presentation focuses on some of these challenges, such as interaction with other energy saving technologies, stability and weight requirements, numerous bridge and power cable passings, rapidly varying wind conditions and, last but not least, manoeuvring in the narrow Norwegian fjords. We'll present what we have learned through our efforts to overcome these challenges and what energy savings we predict can be achieved."

Anton Kisjes, MARIN: "Obviously, it is of paramount importance that emission and fuel savings are maximised for wind propulsion to reach its biggest potential. However, as installations get bigger, their impact on operation increases, including on manoeuvring and seakeeping. The question is how safety, operability and compliance changes with substantial wind propulsion. Within the OPTIWISE project, collaborating with Chantiers de l' Atlantique, MARIN had the opportunity to develop and test a new set-up in our manoeuvring and seakeeping model basin. This set-up allows us to model the aerodynamic

SINTEF OCEAN WILL SHARE LESSONS LEARNT FROM ITS COLLABORATION WITH HURTIGRUTEN NORWAY loads of the most powerful wind propulsion systems and arbitrary manoeuvres in controlled wave conditions. The performance of the set-up and a case vessel are presented in our paper and presentation."

Stavros Kontos, RISE: "To minimise the risk for unexpected poor manoeuvring properties after installation of a wind propulsion system, a thorough assessment should be carried out early, when design changes are still easy to implement. In our paper, we show how multi-fidelity time domain simulations can be used to efficiently assess the manoeuvrability and safety of a wind-powered vessel at an early design stage. Such simulations can also be valuable in discussions with classification societies and other stakeholders."

Lefteris Karaminas, ABS: "If you are a shipowner, technical manager, or charterer considering sponsoring a wind-assisted propulsion system project then come join us at the conference where I'll be presenting a methodology on the prediction of propulsion fuel consumption savings, including examples, and sharing findings and recommendations from HAZID/HAZOP workshops."

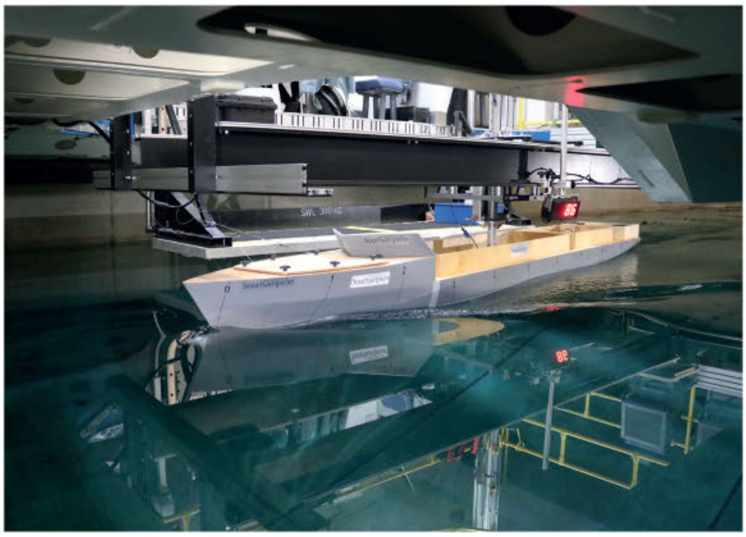
Konstantinos Fakiolas, FINOCEAN Ltd: "FINOCEAN's presentation topic signifies the high importance for any WASP system investment to be adjoined with highly accurate and enhanced wind measuring techniques. Especially for medium to large and very large commercial cargo ships, WASP systems installed on the deck are large sized units which encounter a variety of incoming wind conditions and profiles, depending on their relative location and distancing. The use of existing ship's bridge anemometer as a sole input for wind measurements is not reliable and can either cause under-performance of WASP units or even unwanted over-performance that cannot be properly adjusted as optimal for the whole ship-WASP units system.

"In the paper, alternative wind sensing methods are presented and analysed with particular focus provided to fibre optic sensors which have shown proof of benefits for enhancing WASP performance. Study cases are analysed which demonstrate the relative performance gains and other useful benefits derived from fibre optic wind sensing, such as structural load analysis on WASP units. The topic is meant to raise awareness to the conference participants for the critical usefulness to include within any WASP system installation such advanced and accurate wind sensing which would boost performance with quite low added CAPEX."

Maxime Garenaux, MARIN: "To make the most of wind-assisted ship propulsion requires the industry to reshape conventional ship design practices. The traditionally separate fields, such as hydrodynamics and aerodynamics, or even powering, manoeuvring and seakeeping, are increasingly more linked with wind propulsion. Design choices in one field affect choices in another. For this reason, MARIN has developed new holistic design methods, and a versatile early assessment tool called CREATOR. The tool allows the variation of design choices throughout hull design, appendages, propulsion and wind propulsion and it can quickly resolve the impact not only on powering but also manoeuvring, seakeeping and long-term performance using voyage simulation with routing. The outcomes can be used in optimisation to find the optimal ship while satisfying constraints such as limiting ship motions or minimum cargo capacity. During the Wind Propulsion 2024, MARIN will give a demonstration of CREATOR applied to a bulk carrier fitted with rotor sails."

Saeed Hosseinzadeh, University of Southampton: "Our research, part of the Winds of Change Clean Maritime Demonstration project funded by UKShore and administered by Innovate UK, investigates the potential of wind propulsion technology to decarbonise the UK's maritime sector. The project is led by Dr Joseph Banks from the University of Southampton's Maritime Engineering research group, developing software tools to accurately predict the performance of vessels fitted with wind sail technologies, specifically the FastRig wingsails developed by Smart Green Shipping. The two-year programme includes testing a retractable 20m-high FastRig wingsail retrofitted on a commercial ship, combining innovative numerical simulations with experiments in Southampton's 138m Boldrewood towing tank and RJ Mitchell wind tunnel. The study provides a solid foundation for understanding the hydrodynamic challenges and opportunities presented by wind-assisted propulsion in modern shipping and our findings contribute substantially to the development of performance prediction algorithms, offering a foundation for more accurate modelling and optimisation of wind-assisted vessels."

To register for Wind Propulsion 2024 or for more information, please visit https://rina.org.uk/events/events-programme/wind-propulsion-2024.



EXPERIMENTS IN THE UNIVERSITY OF SOUTHAMPTON'S BOLDREWOOD TOWING TANK HAVE HELPED BUILD A SOLID FOUNDATION FOR UNDERSTANDING THE HYDRODYNAMIC CHALLENGES AND OPPORTUNITIES PRESENTED BY WIND-ASSISTED PROPULSION

SEA-CARGO AS'S *SC CONNECTOR* RO-RO VESSEL EQUIPPED WITH NORSEPOWER ROTOR SAILS. SOURCE: NORSEPOWER

HARNESSING WIND POWER FOR THE NEXT GENERATION OF SUSTAINABLE SHIPPING

By **Mikko Nikkanen**, head of maritime, weather and environment, Vaisala

With annual international shipping CO_2 emissions doubling since 1990 and now accounting for roughly 10% of global transportation emissions, the maritime shipping sector sits at a crossroads in the fight against climate change. Players across the global shipping industry must find new ways to embrace and deliver decarbonisation efforts that shift to a better world.

Among the most promising innovations is wind-assisted ship propulsion (WASP), a blend of traditional sailing practices with modern engineering. Wind-assisted vessels incorporate rigid sails, rotors or wing-like structures to enhance traditional engine power. The result is a vessel purpose-built to effectively cut down carbon emissions.

However, the success of wind-assisted shipping is only possible if one critical factor is addressed – the ability to precisely measure and utilise wind power in real time.

Regardless of the specific WASP technology used, the reliability and undisturbed nature of wind data are fundamental, and wind data traditionally used for navigation and the data required for WASP propulsion require a critical distinction.

Traditional cup anemometers, the old way of measuring maritime wind, no longer suffice for modern wind-assisted shipping due to their susceptibility to interference from the ship's structure. This gap in the ecosystem underscores the need for advanced wind measurement technologies, with LiDAR (light detection and ranging) technology shining as the clear answer.

The role of accurate wind measurement in wind-assisted ship propulsion

While the concept of harnessing wind for propulsion is simple, implementing it effectively can be complex. WASP systems rely heavily on real-time, accurate and reliable wind data to maximise thrust and efficiency. Unlike traditional wind measurements for navigation, which primarily facilitate course corrections, WASP systems demand much finer accuracy. Inaccurate data translates into lost propulsion energy that cannot be recovered, and every gust that is not optimally harnessed equates to a loss in clean energy potential.

Obtaining these reliable wind measurements on a moving vessel presents a unique challenge. Traditional anemometers are no longer adequate for the needs of modern WASP systems, as these sensors can be easily blocked or masked, and the ship's own superstructures can create turbulence, distorting the readings. What's more, the inaccurate placement of anemometers can also lead to a significant variance in wind speed measurements, sometimes by as much

MIKKO NIKKANEN

as over 50%. Even ultrasonic anemometers – widely used with new vessels and WASP systems – face the masking impact challenge.

Although ultrasonic anemometers offer better and more trustworthy technology, it is not until they are combined with wind LiDARs do the measurements show progress in improving the accuracy of wind data in WASP systems.

Cutting-edge technologies driving the future of wind-assisted ship propulsion

To fully leverage wind power in the maritime industry, decision-makers must address the shortcomings of traditional anemometers. Modern, fulfilling options are now available for more efficient and effective WASP systems.

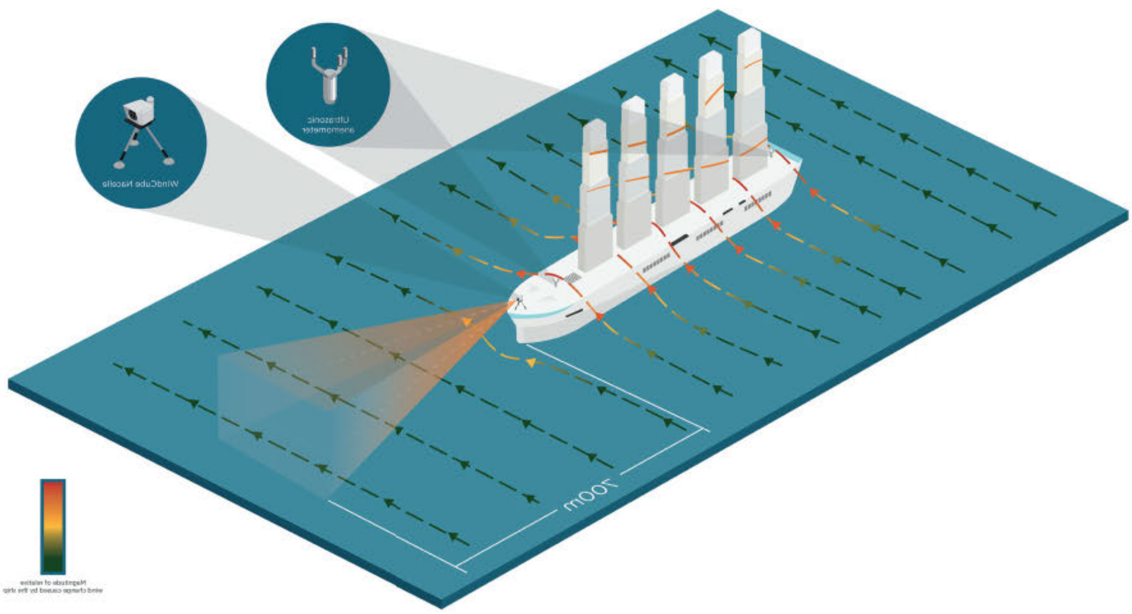
Unlike cup anemometers, ultrasonic anemometers use sound waves to measure wind speed and direction, offering higher accuracy and reliability than their mechanical counterparts. With no moving parts, they are also more durable in harsh marine environments. By adding multiple ultrasonic anemometers on different sides of the vessel, operators can secure the constant flow and the quality of the wind data. Installing multiple sensors in various locations – the bow, bridge and stern – avoids total blockage situations. This approach ensures a constant flow of quality wind data, even if one or more sensors are affected by the ship's superstructure.

But as alluded to previously, the most revolutionary advancement in maritime wind measurement is the addition of LiDAR technology. Wind LiDARs use laser beams to measure wind speed and direction at various distances from the ship, offering a comprehensive overview of the surrounding, undisturbed wind field.

When a vessel is equipped with a WASP system, the availability of undisturbed raw wind data validates its performance. As experienced in recent sea trials, equipping the vessel with a wind LiDAR instrument enables systems to continuously measure actual wind conditions – unaffected by the ship's structures – and compare these readings to data from ultrasonic anemometers. This correlation allows for the refinement of optimisation algorithms within the WASP system, maximising thrust potential.

Maritime shipping now rapidly adopts LiDAR technology, previously proven in the wind turbine industry for correcting power performance, due to its numerous benefits. For example, horizontally measuring LiDAR devices can remotely measure wind conditions hundreds of metres away, beyond the influence of the ship's structure, ensuring highly accurate data. With there vertical profiling capabilities, LiDAR instruments can also assess wind at varying heights, providing crucial insights into the wind shear profile for optimal sail positioning. And scanning wind LiDAR systems can survey a vast area around the ship, covering several kilometres, thus offering a comprehensive view of the wind field.

By delivering precise and dependable wind measurements, wind LiDARs enhance the performance of



ULTRASONIC ANEMOMETERS COMBINED WITH THE WIND LIDAR IMPROVE THE ACCURACY OF WIND DATA IN WASP SYSTEMS

WASP systems, leading to even greater fuel savings and reduced emissions.

Pioneering sea trials in wind-assisted maritime transport

Norsepower, a leading wind propulsion technology company, uses Vaisala WindCube Nacelle to push the boundaries of efficiency and sustainability, showcasing how cutting-edge wind measurement technology can optimise the performance of its proprietary rotor sail.

Norsepower's rotor sail technology, a modernised version of the Flettner rotor, has already demonstrated impressive fuel savings of 5% to 25% in third-party verifications. However, the company recognised that to maximise these benefits, it needed to overcome a crucial challenge: obtaining accurate, undisturbed wind data.

In a four-month sea trial aboard the *SC Connector* ro-ro vessel, the horizontal profiling wind LiDAR system provided precise measurements of the free stream wind up to 700m away at 20 simultaneous distances. This undisturbed wind data allowed Norsepower to align its rotor sail thrust measurements with unprecedented accuracy.

The implications of this collaboration are far-reaching. By comparing the LiDAR data with the rotor sail's thrust measurements, Norsepower can fine-tune its control systems, ensuring optimal performance in various wind conditions. This level of precision not only enhances the energy efficiency of vessels equipped with rotor sails but also significantly contributes to maritime industrywide decarbonisation goals.

The unique collaboration between Norsepower and Vaisala exemplifies how integrating advanced wind measurement technology with innovative propulsion systems can drive the maritime industry in the direction of a more sustainable future.

Unlocking the future of LiDAR in wind-assisted ship propulsion

Wind-assisted vessels represent a permanent shift toward greener maritime practices. As this technology advances, accurate data made possible through LiDAR technology will significantly enhance:

- *Sea Trials and Performance Validation*: LiDAR technology already aids in performance validation for WASP vessels by providing undisturbed wind data essential for accurate assessments. The systems process data from LiDAR sensors to ensure reliability and validate wind-assisted propulsion systems, as exemplified by the Norsepower rotor sail aboard the *SC Connector* ro-ro vessel.
- *Automated Safety Release for Sudden Wind Gusts*: LiDAR can significantly enhance safety by detecting approaching wind gusts and enabling an automatic safety release mechanism. Although this application is yet to be implemented, it holds substantial potential. LiDAR could enable a controlled response or shut down by alerting the WASP system to imminent gusts, safeguarding the vessel and crew.
- *Dynamic and Automated WASP Optimisation*: Real-time LiDAR data helps with the automatic optimisation of sails or rotors. This application, still under development, promises to provide solutions that dynamically adjust WASP components to enhance performance based on current and upcoming wind conditions.

Innovators like Vaisala and Norsepower – operating at the forefront of developing and implementing sophisticated wind measurement and propulsion systems – equip the maritime sector to tackle the challenges of modern shipping. Cutting-edge wind measurement and monitoring tools provide a promising solution to substantially lower the industry's carbon emissions, and WASP is the future of maritime shipping. Continued investment in these technologies will enable the industry to achieve remarkable fuel savings and emissions reductions, steering the maritime world toward a cleaner, more sustainable future. With the right technologies in place, the maritime industry can chart the right course to meet its sustainability goals. ■

VAISALA WINDCUBE NACELLE HORIZONTAL PROFILING WIND LIDAR INSTALLED ON *SC CONNECTOR* BESIDE THE NORSEPOWER ROTOR SAIL

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The conference will provide an opportunity for human factors experts, naval architects, bridge officers and others to get together and discuss recent developments. It will focus on lessons learned from interventions and applied research that were successful, or even more interesting, unexpected or bad results. For example, implementation of new automation on board that worked out differently or behavioral interventions that had unexpected effects. It is all about applied research that provides learned lessons for future Human Factor research, specifically for the Maritime domain.

As part of the conference, the delegates will have a unique opportunity to visit the new Seven Oceans Simulator centre of MARIN on 10th October 2024, where the attendees will have a chance to:

- Tour in the brand new Seven Oceans Simulator centre.
- Attend a workshop on how to design a bridge layout for special purpose vessels with physical mock-ups.
- Attend a workshop measuring human performance covering eye-tracking, emotion recognition, heart rate variability and galvanic skin response.

..... and more!

https://rina.org.uk/events/events-programme/human-factors-2024/

The Royal Institution of Naval Architects Presents:

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In Partnership With: IDA Maritim

Rapid technological development in the field of Maritime Autonomy is creating opportunities for the marine industry as well as challenges for the regulatory framework. Recent years have seen various ship projects involving coastal and ocean-going routes with different degrees of autonomy being tested. These will have significant implications for naval architects, shipbuilders, shipping companies, and maritime systems providers.

In December 2024, the International Maritime Organization (IMO) will host the 109th session of the Maritime Safety Committee (MSC) where the Maritime Autonomous Surface Ships (MASS) group will meet again. The Royal Institution of Naval Architects and the Danish Society of Engineers (IDA Maritime) are organising the 3rd Autonomous ship conference on 20-21 November 2024 ahead of the IMO meeting.

Scan the QR Code for more information

Conference Topics:

- IMO MASS Code Development
- Maritime remote-control technology
- Automated onboard systems
- Autonomous technology
- E-navigation
- Safety and Security
- Impact on maritime workforce
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BAR TECHNOLOGIES' WINDWINGS LEAD THE WAY IN WIND PROPULSION INNOVATION

By **Simon Schofield**, chief technology officer, BAR Technologies

BERGE BULK'S *BERGE OLYMPUS* WITH FOUR 37.5M WINDWINGS DEPLOYED

The shipping industry is undergoing a paradigm shift, with wind propulsion emerging as a cornerstone in the urgent need to reduce fuel consumption and emissions in alignment with the International Maritime Organization's (IMO) 2050 targets. Among the various wind propulsion technologies now gaining traction, BAR Technologies' WindWings are proving to be a market leader, delivering unparalleled performance and reliability.

With the recent launch of the 20m and 24m WindWing models, BAR Technologies is now building on the global success of the 37.5m variant, cementing WindWings as the gold standard for wind propulsion in commercial shipping.

The three-element rigid wing design

WindWings are distinguished by their patented three-element rigid wing design, which marks a significant step forward in maritime wind propulsion.

Unlike traditional single-element sails or two-element rigid wings, the innovative three-element configuration of WindWings maximises lift by operating much like an aircraft wing. However, its design achieves a lift coefficient approximately 2.5 times greater than that of a single element wing, translating into significant forward thrust. As a result, vessels equipped with WindWings achieve substantial reductions in fuel consumption and emissions by reducing the load on the main engine.

The three-element design not only enhances thrust, but it also offers simplicity and low maintenance advantages over more complex systems such as rotors and suction sails. By avoiding the need for many moving parts and complex mechanisms, WindWings ensure easier operation and lower ongoing maintenance requirements.

The advanced design is grounded in extensive research of global wind patterns and shipping routes conducted by BAR Technologies. The company has utilised this data to optimise WindWings for real-world maritime conditions, ensuring consistent performance across a wide range of wind speeds, wind directions, and global shipping routes.

This extensive research and testing are crucial for handling the diverse and often challenging environments encountered in global shipping, including in-port operations.

Empirical evidence from real-world case studies

The real-world performance of WindWings has been rigorously validated through multiple case studies, such as the *Pyxis Ocean* and *Berge Olympus*, with independent verification recently provided by DNV-Maritime, a globally recognised authority in maritime certification.

In an interim report published in May 2024, DNV-Maritime reported that the two WindWings installed on the *Pyxis Ocean*, a Kamsarmax bulk carrier, reduced the vessel's energy consumption by 32% per nautical mile under favourable conditions. This reduction translates into average global savings of 1.5tonnes of fuel per wing per day and a corresponding decrease of 4.7tonnes of CO_2 emissions.

These real-world results have been consistently observed across a variety of global routes, providing shipowners with confidence in the system's performance. BAR Technologies' commitment to transparency and accuracy in performance claims is underscored using rigorous simulations that account for a wide range of operational scenarios, including adverse weather conditions, and the company subsequently guarantees the proven fuel savings to every shipowner.

Expanding the fleet: the new 20-24m models

Building on the success of the 37.5m WindWings, BAR Technologies has introduced two new 20m and 24m models to expand the applicability of the technology across a wider range of vessels. These smaller, lightweight wings retain all the technological advantages of the larger model but are designed to cater to smaller vessels, such as handysize bulkers and chemical tankers, effectively increasing the potential fleet size for WindWings deployment by nearly 50%.

The modular design of WindWings allows for straightforward integration and scalability, ensuring that shipowners can customise the installation to meet specific vessel requirements. This flexibility makes WindWings an attractive option for both retrofits and newbuilds, offering a tailored solution that maximises efficiency and return on investment.

Automation and optimisation: maximising efficiency

A key innovation in the wider WindWings system is its integration of advanced automation and optimisation tools, which are critical to maximising the system's performance. The Wing Control System (WCS) automates the operation of the wings, including control of wing orientation, camber, and safety systems. This allows for seamless operation with minimal manual intervention, reducing the load on the crew and ensuring consistent performance.

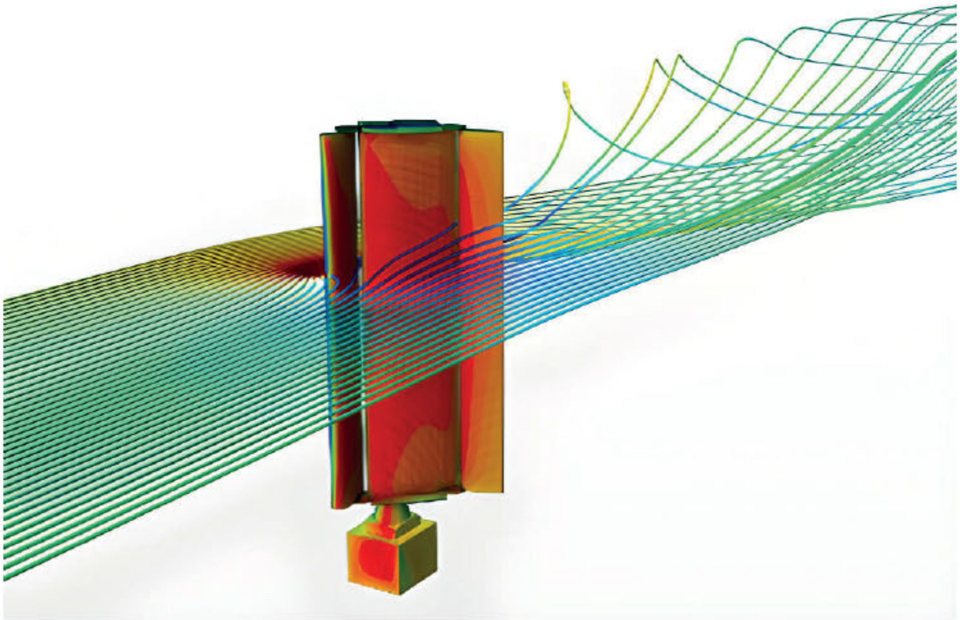
Central to the automation suite is the ShipSEAT software, a bespoke software solution that optimises wing performance in real time by adjusting the wing's alignment and shape to match prevailing wind conditions. ShipSEAT factors in variables such as wind speed, direction, and the vessel's operational profile to achieve optimal thrust and fuel efficiency. This real-time optimisation ensures that the WindWings are always positioned for maximum efficiency, further reducing fuel consumption and emissions.

Additionally, the WindWings system includes ShipSEATRouting, a sophisticated routing tool designed specifically for wind-assisted vessels. This web-based interface, accessible both ashore and on board, provides automated route planning and execution, helping vessels exploit favourable wind conditions while avoiding adverse weather.

These advanced capabilities enhance the operational flexibility and efficiency of WindWing-assisted ships, making the technology a practical solution for a wide range of maritime operations.

Seamless integration and operation

One major challenge with new technology is that shipowners often worry about the complexity of integration and operation. However, BAR Technologies has addressed these concerns with a straightforward process for commissioning, installing, and operating WindWings.



AERODYNAMIC SIMULATION OF THE 37.5M WINDWING

This process typically begins with a detailed feasibility study, including a bespoke performance analysis based on a vessel's specific routes and operational profile. Following this, a tailored business case and performance analysis are documented, aligning expectations and ensuring that the installation meets a shipowner's needs.

The integration phase involves selecting the appropriate WindWing model, completing the necessary production and class approval processes, and installing the system on the vessel. BAR Technologies provides support throughout this process, ensuring a smooth and efficient installation.

After installation, sea trials are conducted to verify that the system performs as expected. Following these trials, the vessel and the WindWing technology are monitored continuously during service, with regular reviews of routing, performance, fuel savings and emissions reductions. WindWings are delivered with a performance guarantee from BAR Technologies.

Growing influence and new partnerships

A significant example of WindWings' growing influence in the shipping industry is the recent collaboration with Union Maritime, which follows the successful deployment and testing of WindWings on *Pyxis Ocean* and *Berge Olympus* in 2023.

In June 2024, Union Maritime committed to deploying WindWings on 34 of its newbuild vessels, including 14 LR2s, 12 chemical tankers, and eight MRs. The order not only reflects Union Maritime's confidence in WindWings, but also the technology's potential to drive operational efficiencies and reduce emissions across the global fleet.

But the partnership between Union Maritime and BAR Technologies has gone one step further. Union Maritime is working closely with BAR Technologies' shareholders on a significant strategic equity investment, signalling a long-term commitment to the development and integration of BAR Technologies' wind propulsion technology.

This collaboration highlights the strategic alignment between Union Maritime and BAR Technologies and underscores the central role that WindWings are set to play in the future of global shipping.

The future of wind propulsion

As the shipping industry faces increasing pressure to cut fuel consumption and reduce emissions, wind propulsion technologies like WindWings have emerged as a compelling solution.

ON BOARD *PYXIS OCEAN* WITH TWO OF THE 37.5M WINDWINGS STOWED

With evolving policies and regulations, such as the EU ETS and FuelEU, as well as forthcoming measures from countries like Turkey and South Korea, wind propulsion systems are expected to become even more attractive and economically viable. The favourable payback times of WindWings, now well under five years, is further enhancing their appeal.

BAR Technologies has pioneered a technology that not only delivers tangible, proven benefits but also offers a comprehensive, user-friendly system for seamless integration into existing operations. The success of the 37.5m WindWing has established it as the industry standard for large bulkers and tankers, while the new 20m and 24m models promise to set a similar benchmark for smaller vessels.

The Royal Institution of Naval Architects Presents:

Technical Conference: Managing CII and Associated Challenges 2025

21-22 January 2025, IMO HQ, London, United Kingdom

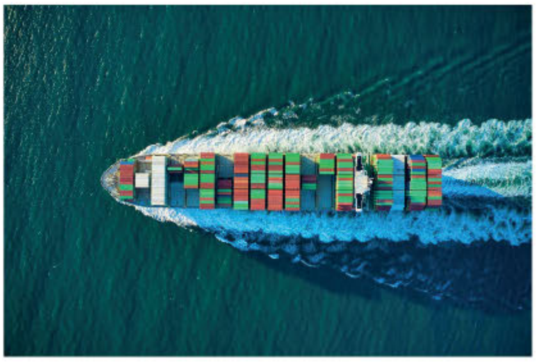
SAVE THE DATE

Carbon Intensity Indicator (CII) – What is it?

The Carbon Intensity Indicator (CII) is a mandatory rating measure for ships, developed by the International Maritime Organization (IMO), that came into effect on 1st January 2023.

As part of its commitment to addressing climate change, the IMO has been working on the development of a Carbon Intensity Indicator (CII) for international shipping. The CII is intended to measure the carbon efficiency of ships and assess their relative carbon emissions performance. The concept of the CII was introduced in the IMO's Initial Strategy on Reduction of GHG Emissions from Ships, adopted in 2018. The strategy sets out a vision to reduce total annual greenhouse gas emissions from international shipping.

The CII is intended to be a key tool to assess and monitor the carbon intensity of ships, providing a standardized and transparent measure for evaluating their energy efficiency and emissions performance. It is expected to be a dynamic indicator that can be updated periodically to reflect technological advancements and best practices. However many sectors of the maritime industry have expressed concerns regarding the unintended consequences of implementation of CII.



Scan the QR Code
for more information

In January 2024, the Royal Institution of Naval Architects (RINA) hosted the first Technical Conference on Managing CII and Associated Challenges at the IMO Headquarters in London. The conference resulted in bringing together 90+ industry stakeholders who exchanged feedback and insight on CII's first year. The 2024 conference, supported by SPNL and the Nautical Institute, allowed the delegates an opportunity to hear from two keynote speakers – Mr. Tianbing Huang, Deputy Director, Sub-Division of Protective Measures, Marine Environment Division, IMO and Julien Boulland, Global market leader for sustainable shipping within Bureau Veritas Marine & Offshore, head-office commercial team, among many other presentations including from companies such as Ardmore Shipping; d'amico società di navigazione spa; MSC Cruise Management (UK) Ltd; DNV; Mærsk Mc-Kinney Møller Center for Zero Carbon Shipping; International Chamber of Shipping; Royal Caribbean Group; and many more.

The IMO must conduct a review of the CII before 1 January 2026, and following initial feedback, changes are expected to CII, though it is not yet clear on what the final outcome will be. The Royal Institution of Naval Architects is proposing a follow up conference in January 2025, and is inviting companies to share how they manage performance as a system, and to explain how continuous improvement in energy efficiency may be achieved.

Conference Topics:

- Experience with managing and complying with CII
- Challenges with implementation of corrective actions
- Experience with effectiveness of corrective actions
- Lessons learnt
- Intersection with commercial and contractual issues
- Best practice energy efficiency management approaches

https://rina.org.uk/events/events-programme/technical-conference-managing-cii-and-associated-challenges-2025/

CAD/CAM/CAE

INTEGRATION OF PIPING LAYOUT EVOLVES SHIP STABILITY ASSESSMENT TOWARDS REALITY

By **Justin Phaff**, SARC BV

An external damage might not only flood a damaged compartment but extend through openings or compartment connections further into the vessel. In stability regulations, this often is described as progressive flooding. PIAS accommodates this phenomenon by a sub-system that dates back to the 1990s called Complex Intermediate Stages of Flooding. It works on the basis of non-uniform preset filling percentages per compartment and, where necessary, supplemented by virtual compartment connections. Although as such it works well and is widely used, this sub-system was never conceived for intensive usage. It has served the program users well over the past decades, however it has some limitations:

- Only virtual connections between compartments are supported. That means that a point in 3D space can be assigned as being 'the connection location', without any physical object connected to that point.
- Only one single location is supported as a connection point between two tanks.
- Data input and output is only in text.
- The computation of time to equalisation is supported, this however only for a single compartment connected to the sea and as a disconnected calculation, not integrated in the stability computation and assessment.

Considerations and development that let to evolvement

Since its establishment in 1980, SARC has been active in the shipbuilding industry developing software for, among other things, hull shape design, stability calculations and loading computer software. Its integrated computer program for ship design is PIAS, which is an acronym for Program for the Integral Approach of Ship design. PIAS comprises modules for the design of hull and internal geometry and for the computation and assessment of, among others, intact stability, deterministic and probabilistic damage stability, longitudinal strength, resistance and propulsion.

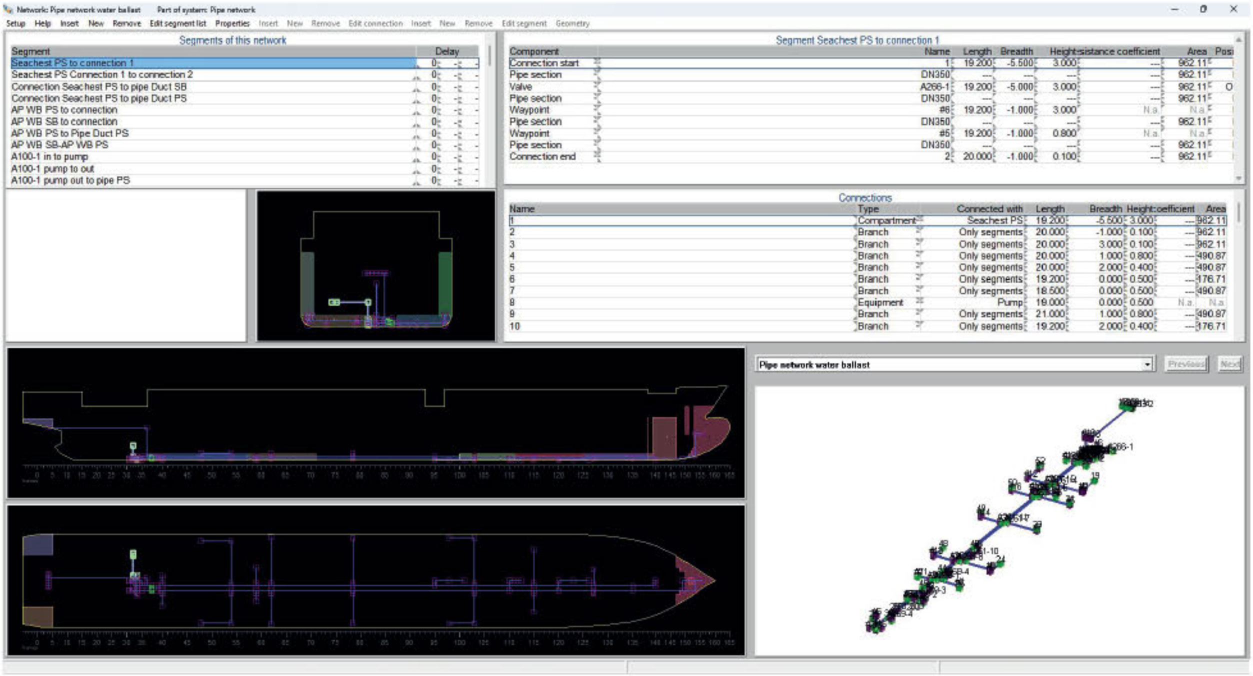
At SARC we anticipated an ever-increasing attention of ship designers to the effects of filling and flooding through holes, openings, ducts and pipes, caused by stringent rules and increasing scrutiny by authorities and classification societies. Rules and regulations address the aspects of openings, internal connections and damage to piping systems numerously. IACS Unified Interpretations, for example, states: "Progressive flooding through internal pipes: in case of damage of an internal pipe which is connected to an undamaged compartment, the undamaged compartment should also be flooded, unless arrangements are fitted which can prevent further flooding of the undamaged compartment." Another example is taken from IMO (2020) [1] on probabilistic damage stability: "The factor s_i is to be taken as zero in those cases where the final waterline immerses the lower edge of openings through which progressive flooding may take place and such flooding is not accounted for in the calculation of factor s_i. Such openings shall include air pipes, ventilations and openings which are closed by means of weathertight doors or hatch covers." Finally, MSC (2020) [2] links consequences to equalisation times by cross-flooding arrangements, which are constructed to reduce the heel in the final equilibrium condition, with thresholds of one and 10 minutes.

In recent years advances in modelling of algorithms on internal flooding after damage have been made. With an eye on these developments, dedicated decisions and software development have resulted in a new PIAS subsystem for next-level damage stability assessments, including major effects of internal flooding and its progression.

Paving the way for a new method in PIAS

Based on pipe connections, the new system is built on the DEPXI standard. This extensive standard describes a wide variety of entities. Five entities have been chosen for the modelling of the shipboard piping system:

- Equipment that is connected to a pipeline but is not a part of the latter such as an engine or a chiller. Equipment plays no role in the computations, it is defined for the completeness of the definition and drawings.
- Piping system – which is a collection of pipes belonging to the same type of application. For example, 'Ballast water' or 'Methanol'.
- Piping network – a closed system of connected pipes which belongs to a piping system. A piping network is the core of the piping data structure.
- Piping segment – a branch of the piping network, that extends between two points without sub-branching in between.
- Piping connection – a part located at the extremities of piping segments, which are:
  - At a branch, where multiple piping segments meet.
  - At the outside of the vessel as unprotected openings connecting with the atmosphere.
  - At the outside of the vessel as an opening



GUI PIPING

with a Weathertight Air Pipe Closing Device (WAPCD)

- With a compartment, a connection to a tank or compartment at a certain location.
- With equipment, a connection to a piece of equipment at a certain location.
- With a piping component, as a part located in a piping segment. A piping component can be, for example, a waypoint, elbow, valve, pressure relief valve, reducer, check valve, internal WAPCD or a pipe section.

The inclusion of the connections between compartments in their actual arrangement brings the assessment of damage stability a step closer to reality. The damage stability is assessed based on initial damage cases and the flooding of undamaged compartments through pipe or duct connections with damaged compartments. In that sense, damage cases are no longer necessarily static with predefined stages of flooding but have evolved to cases where the initial damage case is defined, the progress of additional flooding can be assessed time dependant and with consideration of the flow characteristics of the connections between the damaged and undamaged compartments.

Flow characteristics depend on numerous aspects of which the frictional resistance of pipes is a complex matter. The frictional resistance will be determined based on, amongst others, the following user-defined information: cross-sectional shape, cross-sectional dimension and a resistance coefficient. The coefficient can be determined from one of three available methods. Another complex matter is the energy loss due to fluid outflow from a pipe. For flow resistance of pipes and components, IMO has adopted three resolutions. These treat the reduction of velocity as similar but not equal. In order to harmonise these regulations, as well as to accommodate more than a single pipe outlet, the user can choose between the denominator or user-defined outflow energy loss. Both options enable users to adapt the calculations to the specific application and needs of each calculation.

Where does the way lead to in PIAS?

The damage stability calculations based on the new piping-based system has been developed with the aim to create a framework for next-level damage stability assessments, which is suitable for large-scale application and comprehensible for the commonly trained naval architect. The presented piping networks, combined with existing representations of loading conditions, hull shape and compartments provide two categories to compute the damage stability; as a time-domain analysis and as an analysis divided over stages of flooding.

The first category, time-domain analysis, is based on the physical method that one or more compartments will be flooded over time. This system has a clear understandable physical meaning and represents the reality better than the conventional system of intermediate stage of flooding. Moreover, time is an aspect in some stability criteria and time-to-capsize assessments.

The analysis as per stages of flooding is the second system, which models the flooding in stages and independent of time. The implementation of this system has been developed on standard stability regulations where the concept of intermediate stages of flooding is applied with fixed percentages, i.e. 25%, 50%, 75% and 100%. Also, compartments may not always be flooded with the same percentages, a small connection between compartments may lead to a slower flooding than the damaged compartment.

Maintaining the notion of percentual stages of flooding is based on the fundamental concept in present stability regulations, which is familiar to authorities and

Network: Pipe network water ballast

Part of system: Pipe network

Connections in this network

Name	Second name	Type	Connected with	Cf	Area	Length	Breadth	Height
1		Compartment	Seachest PS	0.350	962.11	19.200	-5.500	3.000
2		Branch	-	0.350	962.11	20.000	-1.000	0.100
3		Branch	-	0.350	962.11	20.000	3.000	0.100
4		Branch	-	0.350	490.87	20.000	1.000	0.800
5		Branch	-	0.350	490.87	20.000	2.000	0.400
6	Pump	Branch	-	0.350	176.71	19.200	0.000	0.500
7		Branch	-	0.350	490.87	18.500	0.000	0.500
8		Equipment	Pump	0.350	490.87	19.000	0.000	0.500
9		Branch	-	0.350	490.87	21.000	1.000	0.800
10		Branch	-	0.350	176.71	19.200	2.000	0.400
11		Branch	-	0.350	490.87	18.500	2.000	0.400
12		Equipment	Pump	0.350	490.87	19.000	2.000	0.400
13		Branch	-	0.350	490.87	21.000	2.000	0.400
14		Compartment	27 AP WB PS	0.350	78.54	2.100	-1.430	6.650
15		Branch	-	0.350	78.54	2.100	-0.500	6.650
16		Branch	-	0.350	78.54	22.000	1.000	0.800
17		Compartment	28 AP WB SB	0.350	78.54	2.100	1.430	6.650
18		Branch	-	0.350	78.54	2.100	0.500	6.650
19		Compartment	25 WT 6 WB PS	0.350	314.16	33.000	-8.000	1.432
20		Compartment	23 DB 6 WB PS	0.350	314.16	25.125	-1.000	0.100
21		Compartment	21 WT 5 WB PS	0.350	314.16	47.000	-8.750	1.432
22		Compartment	19 DB 5 WB PS	0.350	314.16	44.000	-2.700	0.100
23		Compartment	13 AH 4 WB PS	0.350	314.16	63.500	-8.500	1.430

EXAMPLE OUTPUT

easy to understand. This concept has been labelled fractional, because in the essence compartments are filled by fractional amounts of the final volume. Additionally, a delay is available to specify a lagging in time. This finalises a simple system that supports the conventional intermediate stages and a bit beyond.

Imagine a compartment that is divided by a half-height bulkhead. Water can flow in a waterfall over the full length of the bulkhead edge, possibly without backflow when rolling back to the other side. When the compartment would only be connected through a small diameter pipe, it would not allow significant fluid to transfer during the roll period. To differentiate between the two example cases, a 'minimum cross-sectional area for instantaneous fluid passage' can be specified. This user defined program setting allows the flow when the actual area is larger than this minimum and blocks the flow if the actual area is less than this minimum.

In calculations regarding larger angle stability the transferring fluid may not result in a significant increase of the heeling moment and the time between time steps may not suffice for the vessel to heel. While analysing the stability in time-domain, to solve this issue the GZ curve is computed without time effects while the ingressed or shifted fluid during heel in the next time step is omitted. For each time step a complete stability report could be computed, however the amount of GZ evaluations can be defined by the user. For each time step at the least draft, trim, heel and fluid quantities are available.

Expected embracement by users and authorities

Developing software that deals with phenomena in a different manner always raises questions around how users and authorities will appreciate the working of the software and the results it will produce.

The design of our piping software and its underlying algorithms, data structures and choices are well documented in a specification document, a scientific paper (Koelman, 2024 [3]) and a bit more extensively in the manual. Additionally, design considerations or sketches from the implementation record can be made available on request.

That should enable inspection bodies to perform their independent verification of the proper functioning of the software. A reassuring idea, incidentally, is that a time domain calculation is explicitly supported by regulations such as MSC (2020). Concerning the ship design verification, i.e. the appraisal of damage stability computations, the clarity of the input data will only improve. Where with older PIAS's compartment connection facility the physical reality was to be translated into tables with numbers representing virtual 'connection', now the basis is a topological and geometrical model which is easy to verify, as demonstrated by the report of the input.

Outlook for the future

Looking towards the near future, the next development of this system will comprise time domain computations integrated in probabilistic damage stability. In this way, the exceedance of the maximum allowable equalisation time can automatically be determined and incorporated in the table of results of damage cases and their probabilities, and ultimately in the attained subdivision index. Moreover, the introduction of damage to pipes is a development that will be added to the system. In PIAS's probabilistic damage stability module, for example, the damage cases are presently generated on the basis of compartment boundaries. This will be extended to include piping edges and corners as well.

Resuming, the new PIAS sub-system Piping offers users a clear, structured interface and menus where piping systems of various levels of complexity and their specific characters can be modelled. By including an intuitive definition of compartment connections with the piping systems, Piping is aimed to evolve stability assessment towards reality. SARC trusts that the newest addition to its software will help users assess stability in a modern manner that will be accepted and understood by authorities and users. ■

More information on the development of Piping can be found at the SARC website hwww.sarc.nl.

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MARITIME HISTORY & HERITAGE

2024: A BICENTENNIAL AND A CENTENARY FOR PADDLEWHEEL STEAMERS

Relics of a bygone age they may be, but paddle steamers continue to enjoy a devoted following, with two UK-based survivors celebrating anniversaries this year

By **Mark Barton**, RINA historian

TURNER'S PAINTING OF *FIGHTING TEMERAIRE*. SOURCE: THE NATIONAL GALLERY

The well-known 1838 painting *The Fighting Temeraire* by Turner is often seen as marking the end of the era of sail. But look more closely – the old sailing vessel is depicted as a pale ghost ship, while her sturdy tug *London* is painted in vivid relief. It would be reasonable to suggest therefore that the painting could also be seen as celebrating the new technology of paddlewheel steamers. And this year, 2024, marks the centenary of two historic British paddle steamers that are still in operation and 200 years since paddle steamers were first used in action by the Royal Navy.

It is 100 years since the launch of the PS *Kingswear Castle*, which, linked with the Dartmouth Steam Railway, still operates on the River Dart. Meanwhile, the PS *Medway Queen*, also celebrating her centenary, is open to visitors at Gillingham. Furthermore, 1824, 200 years ago, saw the first use by Britain of a steamship in action, when the *Lightning* accompanied the bomb vessels in the attack on Algiers, as part of British endeavours to end the slave trade.[1]

Paddle steamers were first used in Britain in 1802, when the *Charlotte Dundas* towed two 70ton barges along part of the Forth & Clyde Canal. By 1812, advances in boiler and cylinder design enabled the first commercial steamboat service, when a Scottish hotelier used the *Comet* as a ferry from his hotel to Glasgow. The Royal Navy used the new technology as early as 1813, when it locally hired a steamship the *Swiftsure* to transport Royal Marines in the Great Lakes campaign in North America.[2]

The earliest steamships propelled themselves using either two paddles mounted on the sides, or one centrally mounted paddle. It is a feature of side-mounted paddlewheels that led to a term all mariners now know, the Bridge. Originally, each wheel was mounted under a box and, to improve visibility, the officer of the watch moved from his traditional position on the quarterdeck to stand on the top of the wheel box to direct the ship.

A walkway was added to provide easy access from one wheel box to the other and this 'bridge' soon became the preferred position for the officer of the watch and, while the actual feature disappeared from ships, the term remained.

Naval steamers

The Royal Navy acquired its first steamship in 1822, the 238ton paddle steamer also called the *Comet*. The aforementioned *Lightning* followed in 1823. Such

A 1:96 REPLICA OF HMS *LIGHTNING*. SOURCE: NATIONAL MARITIME MUSEUM

THE TUG OF WAR BETWEEN *RATTLER* AND *ALECTO* WAS STILL FONDLY RECALLED LONG AFTER THE EVENT, AS IN THIS 1911 CIGARETTE CARD

PADDLE STEAMERS SUCH AS *DELTA QUEEN* REMAIN A POPULAR ATTRACTION ALONG THE MISSISSIPPI AND ITS TRIBUTARIES

vessels were first commissioned and permitted the title 'HMS' in 1827 by a decision of the Duke of Clarence, later William IV, who was a fan of the new technology.

Lightning's engineer John Chapender provides the Royal Navy with its first surviving naval engineering correspondence. Even in 1826, his writing largely reflected on the engineering standards and how favourable the inspection of his ship had been.

By 1829, there was a total of 12 paddlewheel steamships in RN service. Strictly speaking, the *Comet* was not the earliest steam vessel employed by the RN. The Royal Navy inherited another *Lightning* when the Post Office Packet Service vessels were transferred to the RN in 1837. This one, renamed *Monkey* as it entered the Service, had been built in 1821.

Paddle steamers soon faced competition from the screw propeller, although it took many decades before paddle steamers would be relegated to the status of heritage vessel. On 3 April 1845, a public demonstration was held off Great Yarmouth, pitting the screw-propelled *Rattler* against the paddle steamer *Alecto* in a tug of war. *Rattler* was the outright winner, pulling the *Alecto* backwards at a steady speed, although the ships were not evenly matched in horsepower *Rattler* having nearly double that of *Alecto*, but the Admiralty trials had already drawn their conclusion and this was to convince the public.

Pros and cons

Paddle steamers had advantages and disadvantages for military activities. Paddle wheels were very exposed to damage by enemy fire and prevented a broadside being fitted. They were better suited therefore as support vessels for harbours rather than fighting vessels, particularly as they were well-suited to shallow-water operations and other specialist naval operations.

Paddlewheel steamers are particularly suited to river work, and have become strongly associated with the Mississippi, where several still operate. It is also why they were used by the Royal Navy in ending the slave trade, as they could get up the rivers and operate in the shallow water so enabled it to be tackled closer to the source. This role led to coaling stations being established as early as 1827 in the Gulf of Guinea.[3]

The 411ton paddle steamer *Hugh Lindsay*, with two 80-HP steam engines, made the first steam passage from India to Suez. It left Bombay on 20 March 1830

HUGH LINDSAY (BUILT 1829) PIONEERED THE MAIL ROUTE BETWEEN SUEZ AND BOMBAY. SOURCE: MARK BARTON for its maiden voyage to Suez, carrying a single passenger and 306 pieces of private mail. Designed with bunker space for only five-and-a-half days' consumption of coal, the ship's captain was obliged to load enough coal for 11 days to get the ship the 1,641 miles to the coaling station at Aden. *Hugh Lindsay*'s decks were almost awash and its paddles could barely turn, being so low in the water. He had calculated well. When the *Hugh Lindsay* arrived off Aden on 31 March having completed the first leg solely under steam, only six hours' worth of coal remained. After re-coaling, the ship headed to Mocha to land the official dispatches. It arrived at Suez on 22 April. The complete voyage of 3,000 miles had taken 22 days and 16 hours including stoppages. From Suez, the mail went overland to Alexandria and then by packet steamer to London.

The World Wars saw the requisition of paddlewheel steamers for service, in particular as minesweepers. For example, the excursion paddle steamer *Cambria*, built in 1895 and usually on the Cardiff-Ilfracombe route, was pressed into service in both World Wars. In WW1, it was commissioned as HMS *Cambridge* and in WW2 as HMS *Plinlimmon* and it took part in the evacuation of Dunkirk. It then served on the Tyne and as an accommodation ship at Harwich.

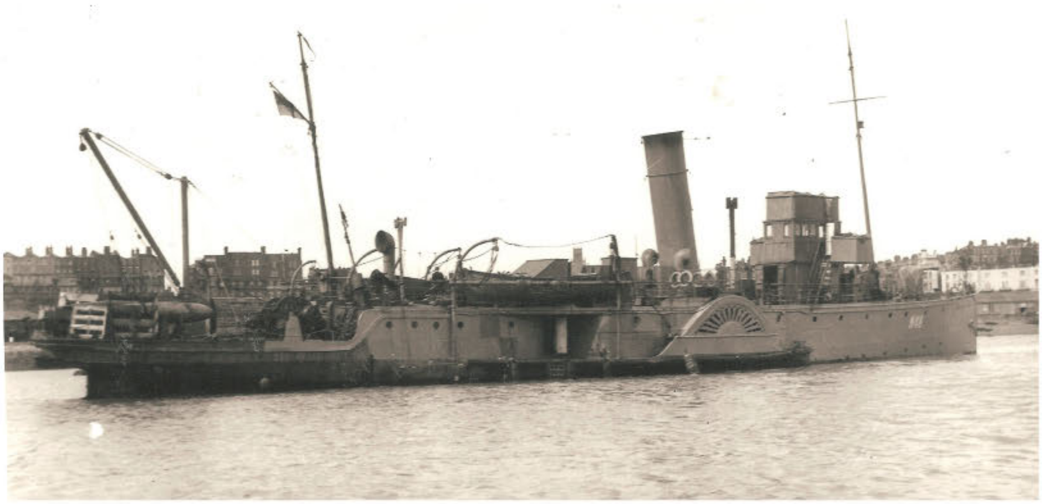
In WW1, paddle steamers proved useful enough that the Royal Navy had 32 of them built, based on the design of one of the requisitioned vessels and they were known as the Racecourse class. Two of these went into civilian service in the 1920s and were taken back for minesweeping again in 1939.

The surviving few

The UK now has just seven significant paddle steamers that appear to have a future and five small ones. The 1946-built SS *Waverley* operates largely as a historic attraction. The 1953 *Maid of the Loch* is undergoing preservation to restore it to operation on Loch Lomond. The small *Monarch* is seeking a buyer to preserve it. *Wingfield Castle* is a museum at Hartlepool and *Tattershall Castle* is a bar moored at the Embankment in London near the RINA headquarters. The other two are much older and celebrate their centenary this year.

The *Medway Queen* entered service on the Strood-Chatham-Southend-Herne Bay route in 1924 and, apart from occasional excursions elsewhere, including the 1937 Coronation Naval Review at Spithead, served on the route until WW2. Requisitioned for the Royal Navy in 1939, it was converted for mine-sweeping, initially out of Harwich and, later, Dover. It also played a key part in 'Operation Dynamo', the Dunkirk evacuation, making seven return trips across the channel. It is estimated it evacuated 7,000 men and shot down three Axis aircraft. As HMS *Medway Queen* it remained an active minesweeper until late 1943 when it became an accommodation ship for a few months, before, in April 1944, being attached to a mine-sweeping training base. After the war it was refitted and returned to civilian use. Unable to compete with newer-type vessels the *Medway Queen* made its last voyage to Southend in 1963.

KINGSWEAR CASTLE, THE UK'S LAST SURVIVING COAL-POWERED PADDLE STEAMER



HMS *MEDWAY QUEEN* DURING ITS YEARS OF NAVAL SERVICE. SOURCE: PSPS COLLECTION

Medway Queen became a marina club house, restaurant and nightclub at Binfield on the Isle of Wight and for a while shared the role with another paddlewheel steamer, *Ryde Queen*, but the business closed in 1974. Next, it was bought by a group of Kent businessmen, and despite sinking as they tried to get the vessel out of the marina, it was refloated and moved back to the River Medway in 1984. The current Medway Queen Preservation Society was formed in 1985 and are now the owners. Restoration continues, including a complete hull rebuild in 2013 and it is now at Gillingham Pier, Kent, where it is open to visitors on Saturdays.

The *Kingswear Castle* is the last operating coal-fired paddle steamer in the UK (SS *Waverly* runs on oil). It was built in 1924 at Philip & Son of Dartmouth, although its engines are older, dating back to 1904. *Kingswear Castle*'s role, taking nearly 500 passengers and cargo up and down the River Dart between Totnes and Dartmouth, has changed very little. The vessel has always had a link with the adjacent steam railway. In 1859 Charles Seal Hayne founded the Dartmouth Steam Packet Company Ltd which is now part of the Dartmouth Steam Railway & River Boat Company. PS *Kingswear Castle* was loaned to the US Navy during WW II for use as a harbour tender.

It returned to its previous role until 1965 when the last three remaining paddle steamers on the Dart were replaced by newer screw vessels. Of these three, *Totnes Castle* sank whilst being towed to Plymouth, *Compton Castle* became a floating restaurant at Kingsbridge and then moved to Truro (where its hull survives to this day) leaving *Kingswear Castle* to be purchased by the Paddle Steamer Preservation Society. With their purchase, it left the Dart and after a short spell operating from Binfield, moved to Chatham where the society spent 15 years restoring the vessel and from 1985 using it for river trips on the Medway.

In 2013, *Kingswear Castle* returned to its home waters of the River Dart after an absence of 47 years. While, like all old ships, it has had considerable updates throughout its life, its is still powered by its original engine, which is older than the vessel. Based at Dartmouth, along with the *Cardiff Castle* and *Dart Explorer*, it operates river cruise trips viewing the estuary castles, Britannia Royal Naval College and towards Agatha Christie's Greenway Estate and Dittisham, over the summer months (May to September).

Both of these beautiful and historic ships are worth a visit, and readers wishing to know more or visit the *Medway Queen* should visit https://www.medwayqueen.co.uk/history.html and those wishing to have a trip on the *Kingswear Castle* which is how this vessel gets preserved, can get tickets and see the timetable at https://www.dartmouthrailriver.co.uk/paddle-steamer ■

References & Footnotes

1. PENN, G, *Up Funnel, Down Screw,* (Hollis & Carter, 1955, p19).
2. ALEXANDER, C., *The Royal Marine Battalions in the War of 1812* (The Trafalgar Chronicle 2017) p112.
3. Two of the initial ones were on leased land on the island of Fernando Po. Named San Carlos and Port Clarence, these are where Luba and the capital Malaba now are. Two others were created in Nigeria, one at Bonny, now an oil depot and Lagos. GUNN, J., *Outsourcing African Labor: Kru Migratory Workers in Global Ports, Estates and Battlefields until the End of the 19th Century* (Walter de Gruyter GmbH & Co KG, 19 Jul 2021).

MEDWAY QUEEN NOWADAYS RESIDES AT GILLINGHAM PIER IN KENT. SOURCE: MARK BARTON

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