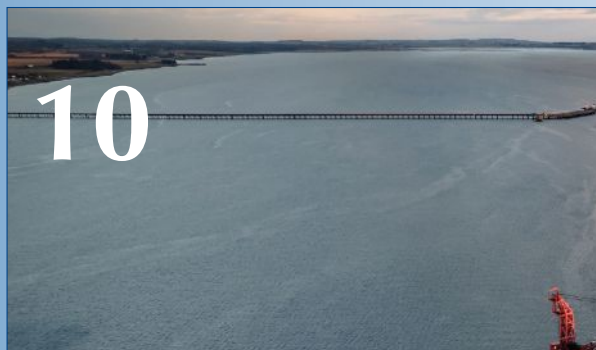


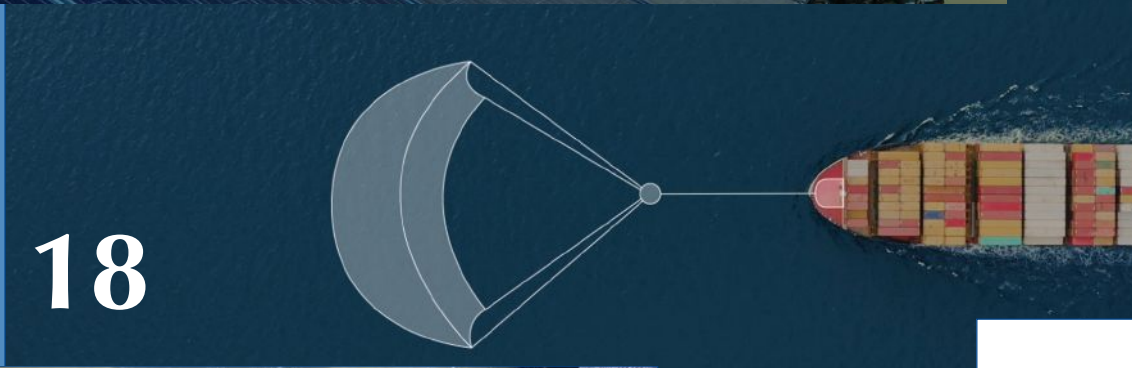
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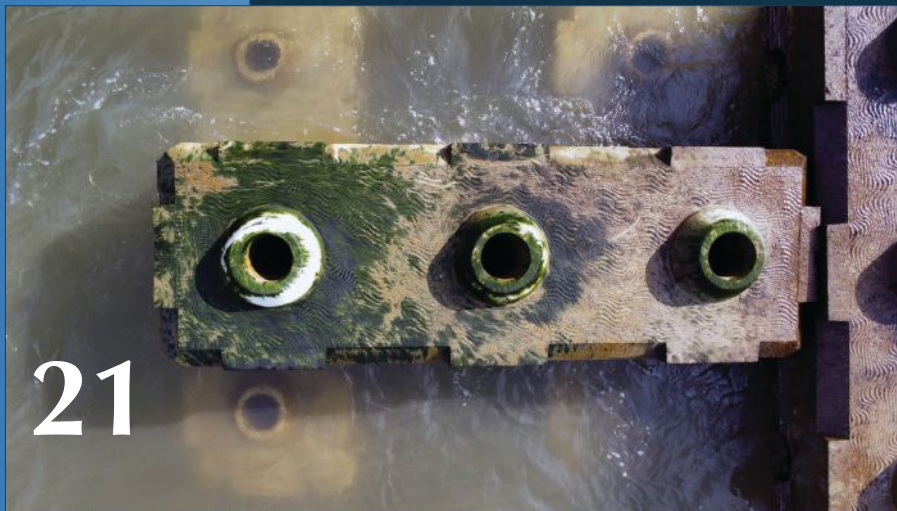
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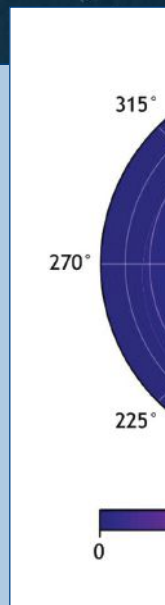
18



21



25





CONTENTS

AUGUST 2023
Volume 64, No. 8

FEATURES

10

THE PATH TO NET ZERO

Richard Sanders (*NORCE*) introduces OceanICU, a project that will develop climate decision support tools for public and private use.

14

THE POWER OF GREEN AMMONIA

Tom Zollner (*ABB*) discusses the world's first PtA plant that will convert electricity to other energy forms.

18

SAILING TOWARD SUSTAINABILITY

Mikko Nikkanen (*Vaisala*) explains wind-assisted ship propulsion technology.

21

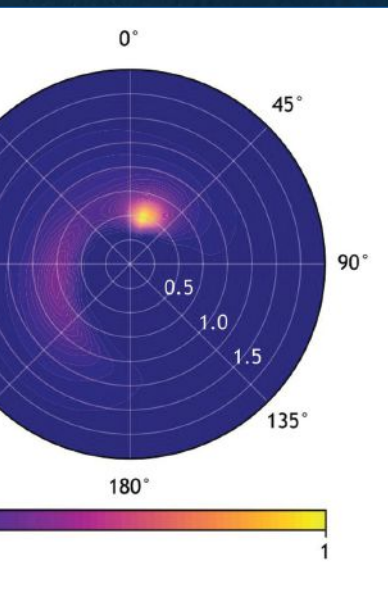
LIVING BREAKWATER

Jaime Ascencio and Leon Haines (*Reefy*) gives details of Reefblocks that interlock like LEGOs for coastal protection.

25

ELIMINATING WEATHER WINDOW WOES

Dr. Ali Cetin (*4Subsea*) outlines how machine learning can reduce overly conservative vessel ops.



DEPARTMENTS

6

Soundings

7

Editorial

31

International

33

Marine Renewables

34

Product Development

36

Marine Resources

38

Marine Electronics

40

Ocean Research

41

People

42

Contracts/Meetings

43

Soapbox

44

Professional Services Directory

45

Advertiser Index

COVER IMAGE

Norsepower's Rotor Sail tech on the bulk carrier *Sea Zhoushan*. (Credit: Norsepower)

NEXT MONTH

International Submarine Races ... Uni-Pact USVs for seafloor engineering ... 360° visualization of subsea assets and data ... Q&A: Dr. Jim Cairns, inventor of wet-mate connectors ... An overview of CHINARE submerged buoys.

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)) How Evolving Fish Stocks Affect Geopolitics. An Oregon State University (OSU) researcher has been awarded a three-year, \$1.4 million grant from the U.S. Department of Defense to lead a study about the movement of fish stocks due to changing climate conditions and the potential geopolitical tensions that could result from that shift. “Fisheries that exist today in the U.S. may move to Canadian or even Russian waters in 20 years,” said James Watson, an associate professor in OSU’s College of Earth, Ocean, and Atmospheric Sciences and the project’s principal investigator. “We will be exploring ways to measure those changes and the potential consequences of those changes, economically and politically, particularly in the Arctic and Pacific Oceans.” Watson’s project is titled: “Future Fish Wars: Chasing Ocean Ecosystem Wealth.” The researchers will use machine learning tools to build a database of past conflicts in the Arctic and Bering and Chukchi Seas to understand the historical context of disputes in that region, which has a known history of fishing conflicts. It is also a region where sea ice is declining rapidly, opening new areas for fishing and leading to shifts in where marine animals spend time. That data will be combined with economic data on fisheries and climate change models to develop models showing how climate change may impact where fish, and subsequently fishing, may move, the potential economic impacts on communities, and where those shifts could lead to conflict. “In addition to movement of the fishery, you can also have compression, where the fish and the fishery shift to a smaller space, which can also lead to issues if fleets from different nations try to get the same value out of the ocean even though it is compressed,” Watson said. “Using Earth systems modeling, we can establish where we are likely to see these kinds of issues arise. In today’s highly connected world, small tensions can quickly escalate and spiral out of control. If we can pinpoint when and where those tensions might occur, that could help prevent that.”

)) Upskilling Required for Maritime Workforce. DNV has published a study co-sponsored by the Singapore Maritime Foundation that examines the key drivers transforming the maritime industry and their impact on ship management and seafarers. The research draws on a comprehensive methodology combining literature review, expert consultations, and a survey of over 500 seafarers responsible for operating dry bulk, tanker, and container vessels globally. Of the many forces shaping the future of maritime, decarbonization and digitalization were identified to have the most profound impact on the future of seafarers and ship management leading up to 2030. Eighty-one percent of seafarers surveyed indicated that they require either partial or complete training to effectively work with the advanced technology that will be present on board future ships. Similarly, over 75 percent of the respondents expressed a requirement for partial or complete training on new fuel types such as LNG, batteries or synthetic fuels. This training deficit rose to 87 percent of survey respondents for emerging fuels such as ammonia, hydrogen and methanol. The study recommends seafarer training to be prioritized for fuels that are most likely to be predominant in the current decade, capitalizing on the ease of accessibility and range of modern training methods to improve skill deficits. It was also found that career advancement and development opportunities for seafarers will improve with the trend toward decarbonization and digitalization, complemented by the expected prevalence of complementary shore-based roles in the future.

)) UK Offshore Wind Needs Massive Boost to Meet 2030 Goal. To meet U.K. government targets to grow offshore wind power capacity from 13.7 to 50 GW by 2030, a 265 percent increase, ABB estimates that 24 more wind farms with an average 1.5 GW capacity need to become operational during the next seven years. If achieved, the U.K.’s electricity supply from offshore wind will jump from 18 to 62 percent, delivering renewable energy to every U.K. household, approximately 29.98 million homes, with a surplus available to export and power a further 37 million homes in neighboring countries. Offshore wind currently powers 15.28 million U.K. homes annually.

)) MTS Turns 60. In the early 1960s, a group of business, academic, and government leaders recognized the need for a professional society to bring together scientists, engineers, and others interested in the rapidly growing fields of ocean technology and marine affairs. They convened a committee to establish the character, name, objectives and basic policies of the Marine Technology Society (MTS), which was launched as a nonprofit corporation in June 1963. MTS members represent all facets of marine technology: industry, education, government and policy making. Since its inception, MTS has increased its international presence, significantly broadened its educational component, and developed strong communication capabilities. As a demonstration of its dedication to developing the future workforce, MTS has established an Early Career Ocean Professionals Section, created initiatives such as the EMERGE program and the MTS Career Center, and continues to facilitate collaboration through TechSurges and other signature events. “With a rapid expansion of the ocean information economy there comes a requirement to develop career pathways, alternative credentialing and certification programs, and inclusive recruitment mechanisms to grow the ocean workforce,” said Chris Ostrander, MTS CEO. “We will continue to tackle these challenges and opportunities in the society’s next chapter.” In celebration of its 60th anniversary, MTS is reflecting on the technological advancements that were made by the many talented individuals and pioneering organizations over the past six decades by sharing the history and stories behind the innovation: mtsociety.org/mts-60-years. **ST**

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It's Time for a Clean Ocean Energy Future

Climate change is the single biggest threat facing our ocean. For decades, the fossil fuel industry has knowingly driven climate change and caused massive amounts of ocean pollution and destruction, from oil spills to a maze of abandoned oil wells and pipelines crisscrossing the ocean floor.

For our ocean, the climate and us, it's time to leave fossil fuels as a dirty relic of our energy past and move on to a renewable and 100 percent clean ocean energy future by 2050. To achieve this, we will need to phase out and remove dirty oil and gas infrastructure offshore, called decommissioning, while rapidly and responsibly scaling renewable ocean energy, which can power the world four times over and help solve the climate crisis.

According to the International Energy Agency and the International Renewable Energy Agency, the world needs to deploy 2,000 GW of offshore wind energy by 2050 to meet net-zero scenarios that avert catastrophic climate change. On average, that amounts to 70 GW of new offshore wind energy per year. There are 115 sovereign nations with enough offshore wind to generate power, but, so far, only 19 countries have operational offshore wind power, amounting to about 60 GW. We have a long way to go, and the current rate of offshore renewable energy development isn't happening quickly enough to reach our climate goals.

Here in the U.S., we're at a promising moment after the passage of the Bipartisan Infrastructure Law and Inflation Reduction Act, which invest millions of dollars in offshore wind and marine energy through funding and incentives. This is a down payment toward a clean ocean energy future that must be paired with significant additional public and private investment in transmission and grid infrastructure upgrades.

Scaling up renewable ocean energy means a lot of new steel in the water. But we don't have to replicate the mess the fossil fuel industry created. Offshore renewables can and should be expanded and sited in a way that is environmentally responsible, just, equitable and considerate of communities most impacted by historic and ongoing fossil fuel extraction and energy development. Responsible development will also come with co-benefits. For example, using shorter offshore transmission cable lengths will minimize human conflicts and environmental impacts and massively reduce costs and grid connection delays.

As we scale offshore wind, we need to simultaneously remove dirty oil and gas infrastructure. By law, fossil fuel companies are responsible for cleaning up the messes they create. But they haven't always done so. In the Gulf of Mexico alone, the fossil fuel industry has left more than 18,000 mi. of unused pipeline on the ocean floor, and more than 14,000 nonproducing wells that aren't properly plugged and may be leaking oil or methane. This snarl on the seafloor can also impede the safe and efficient routing of transmission lines for offshore wind energy.

Instead of holding fossil fuel companies accountable, regulatory agencies have granted workarounds and exemptions. We must change the rules and policies that govern decommissioning to ensure fossil fuel companies are actually required to clean up their offshore infrastructure, to ensure they pay the full cost of decommissioning activities, and to make sure they carry out decommissioning responsibly, with no additional harm to ocean ecosystems.

We have a lot of work ahead of us. But the demand for clean energy is skyrocketing, and calls for accountability and action on climate change are louder than ever. This is the moment to go all in and create a cleaner, more sustainable world for our ocean and us. **ST**

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APRIL

Offshore Technology/Alternative Energy & Ocean Engineering

****** *Offshore Technology Conference*, May 1-4, Houston, TX

****** *XPONENTIAL 2023*, May 8-11, Denver, CO

****** *UDT 2023*, May 9-11, Rostock, Germany

MAY

Communications, Telemetry, Data Processing

****** *OCEANS 2023 Limerick*, June 5-8, Limerick, Ireland

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Serving the Global Ocean C

The Path to Net Zero

OceanICU to Develop Climate Decision Support Tools for All to Use

By Richard Sanders

Reducing carbon emissions to net zero is now a global priority. Within the EU, the target of the Green Deal is to make operations carbon neutral by 2050, and countries on other continents are beginning to adopt similar targets. This change, however, is much easier said than done.

Many of our emissions are directly measurable (e.g., shipping emissions) and, in principle, directly reducible

by switching to alternative energy supplies, but what about indirect emissions that impact the natural world, particularly the carbon cycle? As we begin to exploit more remote maritime resources, the potential to disturb the ocean becomes ever larger.

What is needed are data regarding the likely impacts of key processes so that informed decisions can be made regarding the future rollout and licensing of key indus-



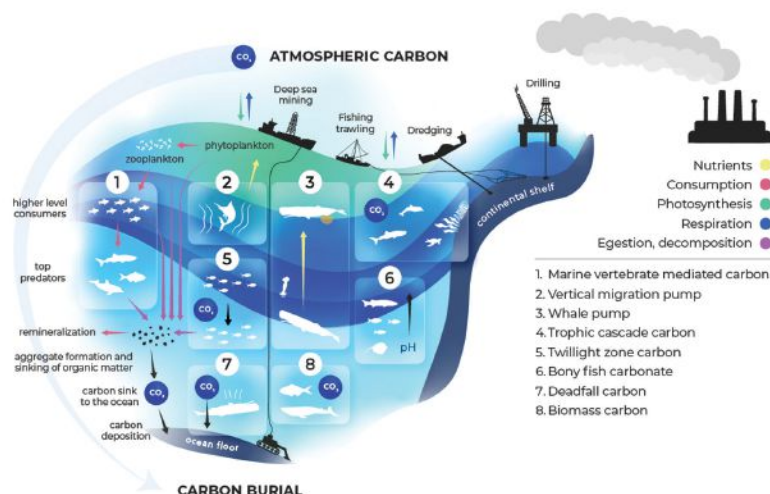
Oil rigs in the ocean. OceanICU will create decision support tools for industry groups to balance resource extraction with conservation.

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(Left) The fishing industry is one of the OceanICU stakeholder groups. (Below) Credit: Seascope Belgium – Pieter Torrez.

Biological C pump processes considered in OceanICU



Infographic created by Seascope Belgium for the OceanICU Horizon Europe project, adapted from Lutz and Martin 2014, Figure 2. A conceptual diagram of marine vertebrate carbon services | Version 1.3



tries. Data can support decisions on investment, target resources and the timing of resource exploitation, for example. Providing this information, packaged in a way that nonspecialists can use, is the ambition of a large new EU program called OceanICU – Improving Carbon Understanding.

OceanICU and Industry

Our chosen target sectors are the fishing industry and the mining, trawling, dredging and drilling sectors. These ocean industries have the potential to alter the natural ocean carbon cycle, by, for example, selective extraction of key species and, hence, a restructuring of food webs, or by putting clouds of sediment into the water column that can interfere with predation or alter the density of sinking material.

It's possible that small adjustments to working practices could make a big difference to the indirect carbon footprint of these industries, but we don't have enough information to make informed judgments yet.

This inability fundamentally results from a lack of understanding of how ocean biological processes that store carbon in the Earth's interior operate. We know that these processes together can store enough carbon to keep atmospheric levels up to 40 percent lower than they were in the preindustrial era, and we also know to the first order how they operate with plankton at the sea surface, making organic matter via photosynthesis, a fraction of which sinks into the interior, where it is stored over long time scales before being re-emitted.

There are key knowledge gaps relevant to industrial processes. These include the role of fish in driving carbon

flux and the depth that sinking material reaches before it dissolves and becomes stored in the interior, a factor that we know is crucial in driving the overall role of ocean biological processes in the global carbon cycle. Do fish, for example, prey on key taxa in the oceans that intercept sinking particles and, therefore, serve to accelerate downward flux and carbon storage, or, alternatively, do they actively consume these sinking particles such that their removal would accelerate downward flux? The answers to these questions are likely to be highly region specific, and the impact of a particular fishery on ocean carbon storage will depend on a myriad of factors, including local fishing patterns as well as local ecosystem structure.

Similarly, processes that disturb the seafloor have the potential to operate in opposing ways on the ocean carbon cycle. It's safe to assume that any organic carbon dissolved in sediment that enters the

water column during dredging will remain in the water column once the sediment resettles, but what is the effect of the sediment itself: Could it distort the local ecosystem, disturbing food webs and the production of sinking material, or does it add mass to the sinking material to accelerate carbon sinking?

First Stage of Research

What is required to address these questions is a great deal of fundamental data that we currently do not have on how marine ecosystems process carbon in the ocean and for the data to be embedded in models of ocean circulation and biology. OceanICU will address all these stages and then use the new understanding to produce tools to help ocean users make informed decisions on how to manage their activities along their own path to net zero.

Creating a baseline understanding of the ocean carbon cycle is

important because the ocean serves as a significant sink for carbon, slowing climate change, reducing its impacts and giving us more time to adapt to and mitigate the consequences. The first stage of OceanICU will involve scientists from across Europe creating a baseline of understanding of how the ocean carbon cycle operates and its current status. Every year, observations of CO₂ at the sea surface are used in conjunction with satellites to make an estimate of uptake at the sea surface. These are reported to the UN Conference of the Parties (COP) by the Global Carbon Project and compared to the best available models of ocean carbon uptake.

In recent years, a significant discrepancy has evolved between modeled and data-based estimates of ocean carbon uptake. Addressing the causes for this discrepancy is high priority for OceanICU, with early indications suggesting that increasing the density of observations in the Southern Ocean will be an important factor. Currently, autonomous floats lack the capacity to directly measure surface ocean carbon, and developing technology to address this issue is an active research area within other EU-funded projects. Another key region is the coast, where important processes around rivers and wetlands both store and emit climatically active trace gases. Building a blueprint for a coastal ocean CO₂ monitoring system and translating this to possible end-users for integration into national carbon budgets is another high priority for OceanICU.

Second Stage of Research

The second stage will involve OceanICU scientists going to sea to explore topics as diverse as the role of whales in the ocean carbon cycle and the role of fire in depositing fertilizing nutrients into the open ocean. Currently, we have a good quantitative understanding of the lower stages of the food chain, including small plants, phytoplankton and the major organisms that eat or graze them. What is lacking is understanding of a wide range of other processes, and OceanICU will





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focus on these to explore whether they are quantitatively significant in the ocean carbon cycle.

Subsequently, we will devise simple mathematical representation of quantitatively significant processes as a prelude to incorporating them into the sophisticated numerical models we use to predict the future evolution of climate and human impacts. This “filtering” stage is important because adding even just one new process to a large model is computationally intensive.

This activity will lead to a series of actions that use these improved numerical models to estimate the importance of fisheries and other industrial resource extraction processes. It has only recently been recognized that fish play important roles in the ocean carbon cycle by consuming and packaging material so that it can sink more effectively, including via their bodies sinking to the seafloor when they die. This results in significant spatial overlap between the areas of high fishery activity and ocean carbon absorption, and it's clear that future fishing trajectories may have the potential to further impact the ocean carbon cycle. Similarly, the large-scale industrialization of both coastal shelf waters via, e.g., the installation of wind turbines and potentially of the deep ocean via the extraction of trace elements from deep-sea nodules and metal-rich crust at mid-ocean ridges may be important factors given the potential these activities have for injecting large quantities of particles into the water column.

While new biological knowledge is key to predicting the impact of these processes on the ocean carbon cycle, the scale of human industry plays an important role. The combined effect of a particular extraction industry on the ocean carbon cycle is a function of how it impacts biological processes and how intensively these extraction processes operate. Information on this latter element is therefore crucial, and OceanICU plans an intensive program of interactions with key industry bodies to understand likely future resource extraction scenarios.

This program should enable the construction of coupled human-ocean modeling systems that allow for the tensions between resource extraction pathways, the benefits they bring to human society and the carbon impact of these activities to be explored. Ultimately, delivering the Green Deal requires us to find economic growth scenarios that minimize or eliminate damage to the natural systems that regulate our climate.

Decision Support Tools

The requirement that all sectors of society participate in the grand challenge of reducing emissions while main-

taining the drive to improve living conditions for people around the world means that we cannot simply rely on large complex models to help people make decisions. We face a challenge in translating these results into useful advice for nonspecialists in the form of “decision support tools.” We are all familiar with such tools in, for

example, healthcare or retirement planning scenarios that we face in everyday life, where complex medical or pension information is translated into simple checklists and flow charts to enable us to make important decisions based on the latest data.

Our ambition within OceanICU is to produce similar sets of tools that enable nonspecialists to explore the trade-offs between different courses of action, seeking the optimal solution that maximizes the climate and economic benefits of their actions. These decision support tools will be distributed freely, with the aim to embed them within the large-scale decision making tools that policy makers are increasingly using, such as digital twins. We anticipate that the results from OceanICU will inform global policy development via, for example, the Intergovernmental Panel on Climate Change, which regularly produces independent assessments of the state of the climate system.

Within the last five years, it has been widely recognized that in addition to a climate crisis we are experiencing a biodiversity crisis, and the two are inextricably linked. This means that we must begin to consider not only the climate impacts of our actions but also the biodiversity impacts. OceanICU will bring these somewhat disparate communities together to integrate these factors into the decision support tool concept.

Of course, none of this work can take place without the active involvement of those outside OceanICU. Engaging civil society, industry, regulators, governments and scientists is key to addressing the climate crisis. OceanICU will build partnerships with these groups, with an emphasis on young people as they grow into future leaders. If you would like to get involved, we welcome you to reach out to the author at: rsan@norceresearch.no.

You can follow OceanICU on LinkedIn at OceanICU project and on Twitter at @oceanicu_carbon. **ST**

Richard Sanders works at NORCE in Bergen and serves as coordinator of the Horizon Europe OceanICU project. He has participated on a broad range of ocean biological pump projects over the last 25 years and has recently moved into a more policy-facing role as director of the Ocean Thematic Centre in the Integrated Carbon Observation System. Prior to his move to Bergen, he served as chair of the Ocean Biogeochemistry and Ecosystems Research Group in the U.K. National Oceanography Centre. He holds an honorary chair in ocean biogeochemistry at the University of Southampton in the U.K.



The Power of Green Ammonia

World's First PtA Plant to Convert Electricity to Other Energy Forms

By Tom Zöllner

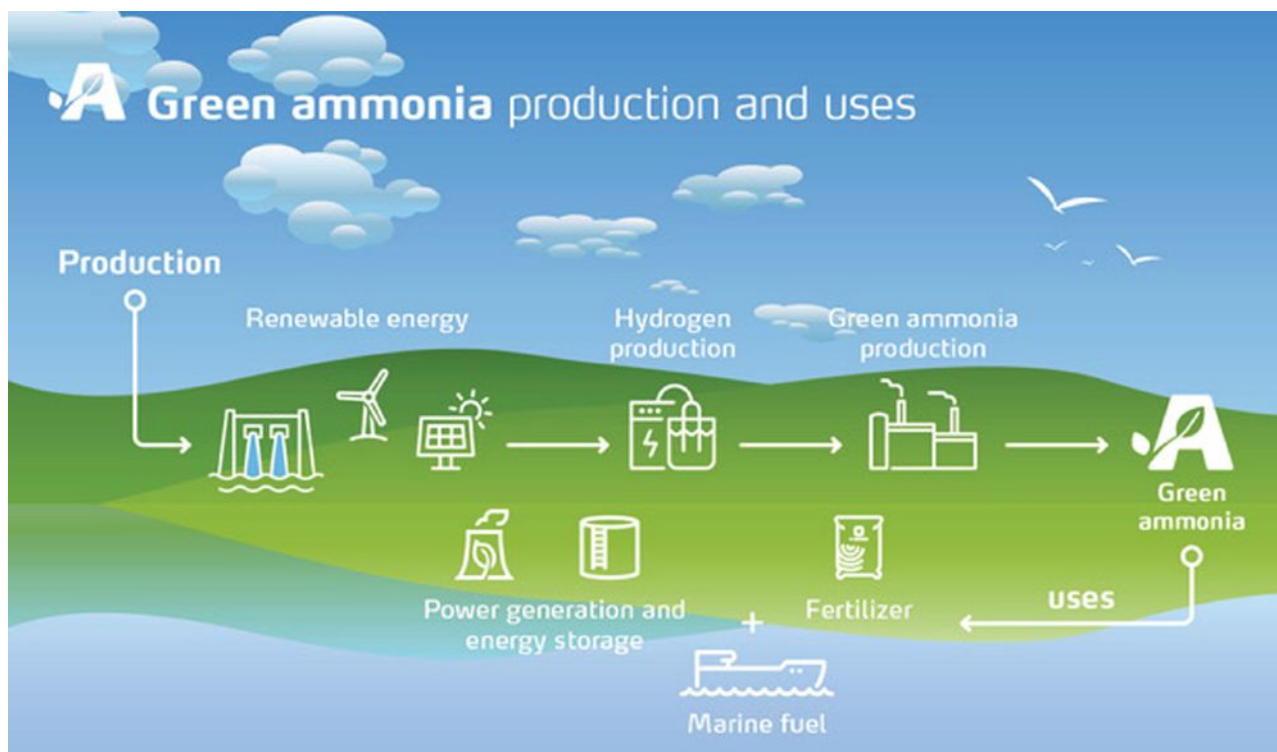
As you sit down to read this, history is being made in the region of Lemvig in West Jutland, Denmark. Here, near the unassuming town of Ramme, construction is under way on the world's first dynamic "green ammonia" (PtA) plant connected directly to renewable energy. The pioneering "power-to-X" plant—a 10-MW Danish Energy Technology Development and Demonstration Program (EUDP) partnership between Skovgaard Energy, Topsoe and Vestas, in collaboration with ABB—is designed to convert green electricity to other forms of energy, such as green fuels.

Like other power-to-X plants, Lemvig directly supports

the energy transition by allowing wind or solar energy to be stored in other, more durable forms, which, until now, has been a significant challenge. This new facility is unique in that it is dynamic: It doesn't use electricity from the grid, and it runs in so-called "island mode" instead, which we will discuss in depth later in this article.

The X Factor

First, let's briefly look at power-to-X. Put simply, the process uses renewable electricity—in the case of Lemvig, power from six V80-2.0 MW Vestas wind turbines and 50-MW solar panels—to create an energy carrier





The world's first dynamic green PtA plant will operate in Lemvig, Denmark, converting electricity to other forms of energy for various applications.

such as renewable hydrogen (the “X”) using electrolysis, whereby water is split into hydrogen (H_2) and oxygen (O_2). The hydrogen created can power transport or be used in industry.

If, using electrolysis, hydrogen is processed one step further by adding nitrogen, liquid ammonia is created, which contains a lot more energy than hydrogen, making it ideal for heavy transport, such as shipping, an industry that accounts for around 2 percent of global energy-related CO_2 emissions.

Ammonia is also a lot easier to distribute than hydrogen because the infrastructure is already in place, making it simpler to commercialize in the short term. The global green ammonia market was worth \$16.4 million in 2021 and is set to grow by approximately \$6.5 million by 2030.

In this article, we will take a closer look at the dynamic PtA project in Denmark; the role of both green ammonia and green hydrogen in the global energy transition; how ABB is enabling the stable and reliable control and integration of renewables to power low-carbon fuel production at Lemvig and other onshore and offshore facilities; and how companies can supercharge their clean energy developments by powering production with wind as an energy source rather than fossil fuels.

A Dynamic Solution

So, what do we mean when we say that Lemvig is a “dynamic” facility? Traditional centralized power grids generate electricity on a large scale at fossil fuel and nuclear power plants, providing constant and reliable power that is matched to demand profiles that are established and well understood. In this way, production and demand are (usually) balanced to avoid frequency fluctuations.

As coal and nuclear power plants are phased out in favor of renewable energy sources such as wind and solar, and more items that are erratic in terms of demand, such as electric vehicles, are connected to the grid, the

electricity demand becomes increasingly distributed and unstable.

Without the backup of grid-level energy storage, renewables are intermittent because of varying weather conditions and source availability. The need to utilize the maximum amount of renewable power when it is available means strong fluctuations in generated power in the grid at any one time.

Dynamic power plants are unique in that they can produce green fuels when the sun shines and the wind blows—and gear production down when neither energy source is present. Other types of power-to-X plants are directly connected to the power grid, meaning they are not as agile in terms of being able to adapt to fluctuations in renewable energy.

In a world first, the PtA plant at Lemvig will run on energy from its own wind turbines and avoid using electricity from the existing power grid. This is known as running the plant in island mode, meaning Skovgaard can utilize those hours where there is already sufficient energy on the grid (excess wind power, say) and/or the market price of electricity is more conducive to production of green ammonia than providing electricity to the grid.

The aim of the pilot project is to test how this can best be done, particularly how the various assets involved in the Lemvig plant operate together, so that ultimately the plant makes economic sense.

Green Ammonia: Clean, Efficient and Cost-Effective

The benefits of the new wind-to-ammonia plant go beyond generating fuel for heavy transport. Green ammonia can also be utilized as an agricultural fertilizer. The majority of ammonia production for artificial fertilizer is currently produced using fossil fuels; in fact, around 1 percent of global CO_2 emissions are believed to come from traditional ammonia production.

Topsoe has designed the plant's fully dynamic ammonia technology to both secure optimal production and

“Once operational, the Lemvig plant will ... help lower the OPEX of low-carbon fuel production by leveraging offshore wind power”

adapt to inherent fluctuations in power output from wind turbines and solar panels. The ammonia plant will interface to a green hydrogen solution developed by Vestas, integrating electrolysis with wind and solar in one smart control system. The renewable energy generation will also be connected directly to the national grid so that surplus power can be sold into the network.

Once operational, the Lemvig plant will not only help lower the OPEX of low-carbon fuel production by leveraging offshore wind power—in line with Skovgaard Energy's aim of building a dynamic, scalable and cost-optimized facility—it will help reduce the operator's overall carbon footprint by preventing 8,200 tons of carbon dioxide from being emitted into the atmosphere every year.

Demand for low-carbon fuels, gas or liquid fuels from renewable electricity is growing. According to S&P Global, the Power-to-X pipeline through 2030 exceeds 11 GW, compared with 100 MW in 2020.

A report presented at the World Economic Forum in January argues that mandates requiring the use of green ammonia to make fertilizers could kick-start the hydrogen economy. As well as replacing fossil fuels in fertilizer production, this has the potential to reduce the costs of green ammonia and green hydrogen, enabling their use as fuels in shipping, steel production and for energy storage.

As mentioned, the Lemvig plant will be powered with 50 MW of new solar panels and 12 MW of existing Vestas wind turbines and is scheduled to produce 5,000 tons of green ammonia annually from renewable power when it is brought online in early 2024. In terms of funding, the partnership of Skovgaard Energy, Topsoe and Vestas received 81 million Danish krone (including around \$12 million USD) in funding from the EUDP.

ABB Automation and Electrification Solutions at Lemvig

ABB will be responsible for electrical integration and advanced process control of the full power-to-ammonia plant operating in highly dynamic mode at Lemvig. ABB's solutions are designed to deliver full visibility of production, maximizing efficiency and ensuring the optimal use of energy.

ABB's scope of work includes full electrical integration for the plant, with control and management of the process as a whole. ABB experts will supply automation and electrical distribution from the electrolysis process for further processing of hydrogen to ammonia—and everything in between.

ABB Ability System 800xA is our flagship distributed control system (DCS), electrical control system and safety system for improved engineering efficiency, operator performance, and asset utilization. It can replace existing

electrical supervisory control and data acquisition (SCADA), electrical control, older DCS, safety, programmable logic controller human-machine interface (PLC HMI), DCS HMI and video surveillance systems with a single solution.

At Lemvig, System 800xA will be used to manage the production of ammonia and all other plant operations, with the option of adding ABB's scalable energy management system, OPTIMAX, at a later stage. OPTIMAX allows for the constant surveillance and optimum control of energy production, consumption and storage, and operates largely autonomously. This learning system calculates the optimum energy flow on the basis of predictive data and compensates for deviations in real time.

The Power of Collaboration

ABB's involvement in the pioneering PtA project in Denmark is the latest addition to the company's portfolio of renewable energy projects. ABB is currently collaborating with renewable hydrogen company Lhyfe and Skyborn, a leader in renewable energy, on a wind-to-green-hydrogen project.

The goal is to jointly realize and optimize SouthH2Port, one of Europe's most ambitious renewable hydrogen projects. The new hydrogen production plant in Söderhamn, Sweden, will be operated by Lhyfe and Skyborn and connected to Skyborn's 1-GW offshore wind farm in nearby Storgundet.

When fully operational, SouthH2Port is set to produce around 240 tons of hydrogen per day, with an installed capacity of 600 MW, making it one of Europe's largest suppliers of renewable hydrogen.

In the green hydrogen and energy storage space, ABB is part of the Deep Purple Consortium hydrogen subsea storage project in Kongsberg, Norway. This pilot uses excess wind power to split water into hydrogen and oxygen by electrolysis. Freshwater for the electrolysis process is produced from seawater using reverse osmosis, and the hydrogen is sent down to the seabed, where it is stored under pressure.

Furthermore, during those periods where wind energy cannot satisfy demand, fuel cells will convert the stored hydrogen back into electricity, supplied in the same cable to the consumer. For its part, ABB is integrating automation, electrical and digital solutions that will help operate the pilot plant.

The work doesn't stop there. ABB is also helping maximize energy efficiency by supplying a full electrification and automation package for the HYBRIT (Hydrogen Breakthrough Ironmaking Technology) pilot plant in Sweden, which aims to reduce carbon emissions in the steel industry by replacing coal with hydrogen in

the steel-making process. The initiative by SSAB, LKAB and Vattenfall utilizes wind and hydropower to power its water electrolysis plant and has the potential to reduce Sweden's CO₂ emissions by 10 percent.

The Future of Energy Generation

In the future, more and more power plants are set to follow the template established by the ground-breaking PtA project in Denmark: They will run in island mode so as not to leech power from the grid; they will convert electricity from renewable sources, such as wind and solar PV, to other forms of energy, such as hydrogen and ammonia, that can be utilized or stored; and they will take advantage of those times when there is a surplus of clean energy on the main grid and put the excess electricity to good use.

The project will also leverage the huge potential of green ammonia in the global effort to substitute fossil fuels with sustainable alternatives. The cost of green ammonia is currently significantly higher than that of comparable ammonia from fossil fuel. Lemvig will therefore help prove the efficacy of Topsoe and Vestas' dynamic, scalable and cost-effective solution—and boost the business case and attractiveness of green ammonia as a substitute for polluting fossil fuels in the global energy mix.

It is becoming increasingly obvious that there is no silver bullet to climate change; instead, we need to find

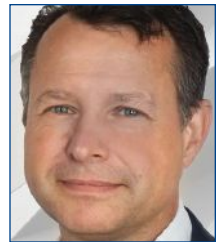
a combination of solutions to lower CO₂ emissions. Substitute fuels have a significant role to play here in that they can store that precious energy for use later, when it is really needed.

With energy prices spiking and security of supply at the top of world leaders' agendas in the wake of the COVID-19 pandemic and the ongoing conflict in Ukraine, innovative energy projects such as the one in Denmark, based on collaboration and knowledge sharing, promise to help alleviate that pressure, reduce greenhouse gas emissions and create a safer, more sustainable world for all.

References

For a list of references, contact: tori.brown@admiralconsultancy.com. **ST**

Tom Zöllner is head of the Energy Industries business at ABB Denmark, bringing more than 15 years of experience to this leadership role. Zöllner started his career at ABB in 2014, initially in finance before moving into management. He holds an M.S. in finance from the Copenhagen Business School in Denmark.



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Sailing Toward Sustainability

Wind-Assisted Ship Propulsion

By Mikko Nikkanen

From Viking boats to the colossal cargo ships of the present day, maritime technology has profoundly shaped human civilization and global commerce. Today, as companies face growing concerns over climate change and the urgent need to transition to a lower-carbon economy, the maritime industry is on the cusp of yet another significant transformation.

Wind-assisted ship propulsion (WASP) is a ground-breaking technology that blends the ancient art of sailing with modern technology, significantly decreasing reliance on fossil fuels. Wind LiDAR, a remote wind-sensing technology that uses light in the form of a pulsed laser, is one of the technologies supporting this maritime revolution. LiDAR's advanced wind measurement capabilities are an essential component, complementing wind propulsion system performance optimization and empowering shipping companies to maximize the wind's power.

Wind LiDAR shows almost limitless development potential and has already become standard for accurate wind measurements in the wind energy industry. Most wind turbines use an anemometer to regulate the turbine, but the wind on top of a turbine is affected by the turbine itself. Remote wind sensing technology developed by Vaisala allows for the measurement of the

undisturbed wind field. Similarly, ship structures or sails can highly affect the wind aboard a ship. Wind LiDAR gives a promising solution for accurate measurement of the reference wind and for the performance optimization of wind-assisted vessels. Remote sensing has advanced wind energy to new heights and will do the same for wind-assisted shipping.

Companies piloting wind LiDAR combined with onboard wind anemometers are working to bring wind-assisted propulsion research, design and system optimization to the next level. At the forefront of this transformational change are companies such as Norsepower and MARIN, which are researching wind LiDAR technology to chart a course toward a greener future for maritime shipping.

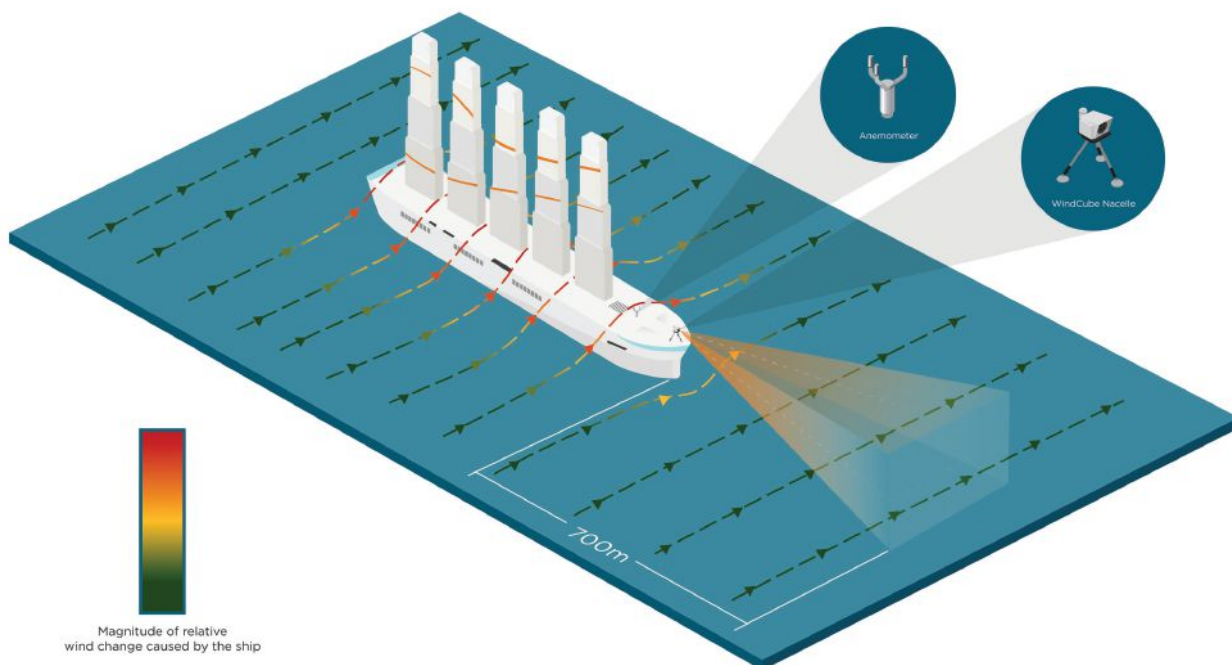
Pioneering Cleaner Shipping with Rotor Sails

Norsepower is the world's leading mechanical sail provider for commercial shipping. Its product Norsepower Rotor Sail is making significant advancements toward decarbonization of the whole shipping industry.

The Norsepower Rotor Sail is a modernized version of the Flettner rotor. It uses a minimal amount of the ship's electric power to rotate cylinder-shaped rotors on the

Wind-assisted ship propulsion combines the power of wind sailing with modern tech.



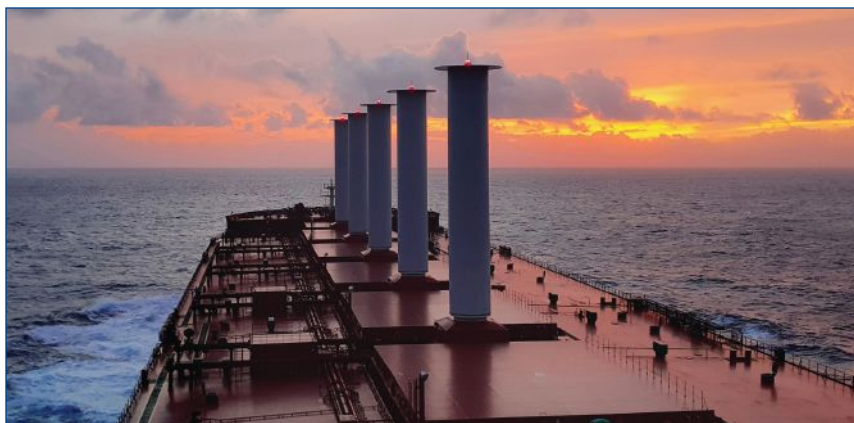


ship's deck. The Rotor Sail utilizes the Magnus effect to produce additional thrust and reduce fuel usage and CO₂ emissions for cargo, cruising and other types of ships. Rotation, together with wind, generates a powerful thrust that can typically reduce fuel consumption by 20 to 25 percent or even more when used in a maritime vessel, making it a valuable tool in the battle against climate change.

For such a complex and innovative system to work efficiently, it requires accurate, reliable, dependable wind sensors. After a successful trial period, the company found that the wind measurement device that provided the most accurate measurements was Vaisala's WINDCAP Ultrasonic Wind Sensor WMT700.

The robust ultrasonic anemometer uses sound waves to measure wind speed and direction. The WMT700 is not just accurate and durable but also heat resistant, equipped with optional transducer, arm and body heaters—making the anemometer perfect for all maritime conditions, including severe icing, strong winds and heavy precipitation.

The precise measurements delivered by the WMT700 allow Norsepower to fully optimize the performance of their product, making the most out of gusts of wind. The assurance that comes from this data-driven approach not only enhances operational efficiency but also instills a profound sense of certainty. With the peace of mind that Norsepower Rotor Sails are performing at peak efficiency around the clock, the company is empowered to continue striving for more sustainable shipping by researching the usage of wind LiDARs for WASP optimization with promising results for future development.



(Top) An illustration of the performance of wind sensor and wind LiDAR in relation to different wind conditions on a vessel. (Bottom) Norsepower's Rotor Sail tech on the bulk carrier Sea Zhoushan. (Credit: Norsepower)

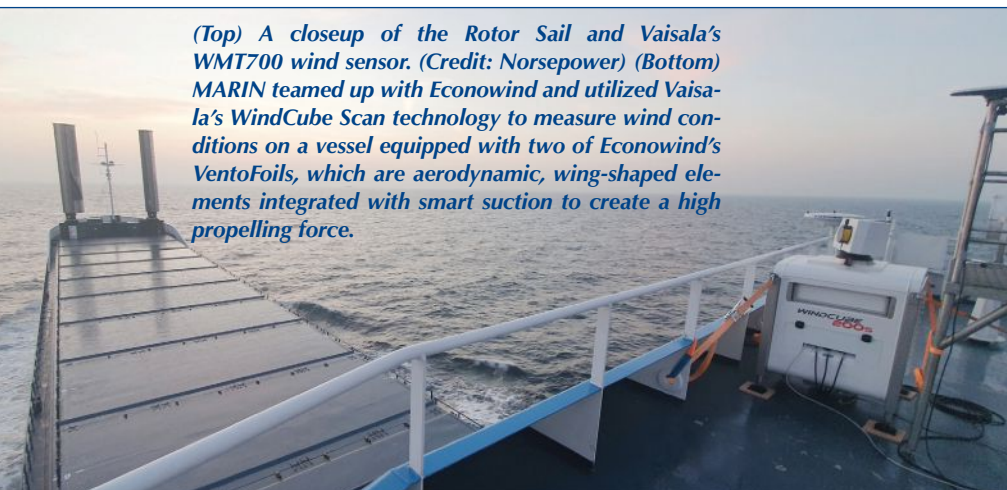
Enhancing Wind-Assisted Ship Propulsion With Remote Wind Monitoring

The Maritime Research Institute Netherlands, or MARIN, is a research organization making strides in wind-assisted ship propulsion. MARIN utilizes software, model test facilities, simulators and full-scale monitoring to enhance its research capabilities to ultimately make ships cleaner, safer and smarter. Next to predictions from model tests and calculations, MARIN puts particular focus on the ship in actual operations. To understand the behavior of a wind-assisted ship in real-world conditions, capturing the wind profile surrounding a vessel is of crucial importance.

To achieve this, MARIN teamed up with Econowind, a ship design and engineering company dedicated to WASP, for a unique offshore wind measurement campaign. The researchers utilized Vaisala's WindCube



(Top) A closeup of the Rotor Sail and Vaisala's WMT700 wind sensor. (Credit: Norsepower) (Bottom) MARIN teamed up with Econowind and utilized Vaisala's WindCube Scan technology to measure wind conditions on a vessel equipped with two of Econowind's VentoFoil, which are aerodynamic, wing-shaped elements integrated with smart suction to create a high propelling force.



Scan technology, an industry-trusted standard for accurate and reliable wind measurements, to measure wind conditions on a vessel equipped with two of Econowind's VentoFoil, which are aerodynamic, wing-shaped elements integrated with smart suction to create a high propelling force.

Scanning WindCube LiDAR provides 3D scanning at ranges over 10 km, creating an undisturbed, high-resolution 3D wind field without additional wind measurement devices. The data collected are essential for assessing the real-world performance of a wind propulsion system, as it provides a comprehensive understanding of the wind profile surrounding a vessel. This wind data are crucial for researchers and operators as they can better anticipate conditions and optimize the ship's propulsion sys-

tem to harness the maximum potential of the surrounding winds.

The trial, which took place 40 nautical mi. off the coast of the Netherlands, was successful, with the WindCube LiDAR accurately capturing the wind conditions. The resulting data from this trial provided MARIN and Econowind with unprecedented insight into optimizing the VentoFoil, setting the stage for ongoing research. Thanks to the information gathered, the companies plan to evaluate LiDAR measurements in more severe conditions and potentially develop a correction method using synchronous motion data if significant ship motions affect LiDAR measurements.

The Future of Wind-Assisted Ship Propulsion

The successful pilots of innovative usage of Vaisala wind LiDAR measurement technology with Norsepower's Rotor Sail product and MARIN's wind-assisted propulsion research highlight the critical role of precise wind data in harnessing wind power for maritime shipping. As an increasing number of industries transition from fossil fuels to address climate change and air quality concerns, technologies such as WASP prove to be feasible and vital for creating more sustainable shipping operations.

The International Maritime Organization has set ambitious CO₂ reduction targets for the shipping industry, aiming for a 70 percent reduction by 2050. Meeting these targets will require a significant shift in how ships are powered. With the wind being a free and abundant energy source, WASP presents a viable and sustainable solution for the maritime industry.

Highly accurate onboard wind anemometers and further research on the use of wind LiDAR technology are propelling this shift. The precision and reliability offered by ultrasonic anemometers and remote wind monitoring systems that can detect the undisturbed wind ahead of the vessel empower shipping companies to fully leverage wind conditions, optimize propulsion power and ultimately reduce their environmental footprint. As businesses sail toward a more sustainable future, the winds of change are clearly blowing in favor of forward-thinking companies that are steering the industry toward a cleaner future. **ST**

Mikko Nikkanen leads strategy and development for Vaisala's Maritime and Ports segment. He has established Vaisala's maritime focus in modern weather awareness solutions, bringing 20 years of global sales and business development experience to build innovative solutions with various partner ecosystems.



Living Breakwater

Reefblocks Interlock for Coastal Protection

By Jaime Ascencio • Leon Haines

Reefy is a groundbreaking startup that is revolutionizing coastal engineering and marine conservation. Drawing upon the respective expertise of the co-founders in coastal engineering and marine biology, the company has developed an innovative solution to safeguard shorelines and promote biodiversity: a sustainable living breakwater.

Motivated to find the optimal balance between waves and nature, Reefy's comprehensive solution is a pioneering system of mega-size modular "Reefblocks" that can be assembled underwater like LEGOs to create a stable

breakwater while fostering a thriving habitat for marine life. These elongated blocks have been hydrodynamically designed to ensure stability, combining a mass of 7 metric tons with an integrated tunnel system that allows water pressure to dissipate on all sides of the structure, effectively preventing uplift caused by incoming waves.

Through a LEGO-like connector system, the blocks interlock, forming a massive and resilient structure composed of individually stable elements. The permeable designs facilitated by interlocking elongated elements create underwater channels, enabling water flow and



Reefblocks interlock like LEGOs to create breakwater habitats that house marine life and protect coastlines from powerful waves.



(Clockwise) Waves breaking on a line of interconnected Reefblocks. One of the first blocks to be set for the breakwater project off Rotterdam. A Reefblock being lowered into the water.

fish migration while reducing wave reflection, thereby maximizing the breakwater's effectiveness.

Development Testing

In 2020, Reefy conducted physical model tests in the renowned 110-m-long "Eastern Scheldt" wave flume at Deltares' testing facilities in Delft. The technology was rigorously validated against hurricane forces, with a reference site in Mexico serving as the benchmark. The experiments encompassed various ecological designs, including overhangs and channel environments, to simulate an ecological breakwater, ultimately showcasing the system's exceptional stability and wave attenuation capabilities, even under complex configurations. These tests substantiated the Reefy system's versatility, maintaining its primary function as coastal protection while accommodating ecological preservation.

Three Habitat Levels

Reefy has fostered close collaboration with reef restoration organizations and two prominent zoo aquariums in the Netherlands. This collaboration has facilitated the development of three levels of habitat complexity applied to the system to promote biodiversity: micro, meso and macro habitats.

At the micro level, the reef blocks boast a porous and textured surface that encourages the formation of a biofilm, essential for attracting and protecting reef-building species such as corals and oysters. This living layer not only enhances the structural integrity of the breakwater but also exhibits resilience in the face of sea level rise and storms, rendering the entire solution more climate resilient.

At the meso level, the interlocked blocks create crevices where small invertebrates can seek shelter, complemented by the integrated tunnel system that serves as a habitat for fish and lobsters.

On a macro level, the Reefy system distinguishes itself through its vast scale. As breakwater projects can span kilometers in length, the underwater labyrinth and habitat created by the Reefy system are unparalleled. By enhancing permeability, diversity and structural complexity in the design, the breakwater not only serves its primary function but also becomes a foundation for a new ecosystem.





Living Breakwater

In March 2023, Reefy achieved a significant milestone by successfully installing its first living breakwater project in collaboration with the municipality of Rotterdam, the National Ministry of Infrastructure and Boskalis. This pilot project aims to test different layouts of Reefy's sustainable living breakwater, seamlessly blending engineering and biology to create a solution that bolsters marine infrastructure robustness while fostering thriving natural ecosystems.

Situated in the Maas River, the project connects the sea to the port and city of Rotterdam, where the government envisions the creation of ecological foreshores to protect the shoreline against rising sea levels and establish an intertidal habitat for birds and migrating fish. The

Reefblocks serve the purpose of shielding this vulnerable coastline from the powerful waves generated by tankers and container ships passing through the port.

The installation process involved the use of a large crane ship to position the blocks onto a level foundation layer of rock. Due to limited visibility underwater, the team devised an innovative installation method utilizing a GPS-guided crane system. This system enabled the operator to stack the blocks underwater, akin to assembling LEGO pieces, while referencing a computer model displayed on the screen. Remarkably, all 17 blocks were successfully placed and stacked in just a single afternoon.

To ensure the stability and ecological health of the living breakwater, ongoing monitoring efforts will be undertaken. Drones, GPS stations, eDNA analysis and visual

“Through a LEGO-like connector system, the blocks interlock, forming a massive and resilient structure composed of individually stable elements.”

observations will be employed over the next 1.5 years to gather data and insights in preparation for a monumental 4-km breakwater project scheduled for 2025 off Rotterdam.

This pioneering project has served as a crucial steppingstone for Reefy, enabling the startup to actualize its visionary approach. Collaborating closely with the city of Rotterdam and Rijkswaterstaat, Reefy has been able to validate its reef innovations and offer a resilient and sustainable solution to protect shorelines and preserve biodiversity. Through its unwavering dedication and interdisciplinary expertise, Reefy is reshaping the future of

coastal engineering and marine conservation, paving the way for a harmonious coexistence between human infrastructure and the natural world. **ST**

Jaime Ascencio is the co-founder and CEO of Reefy. After studying civil engineering in Mexico, he followed his passion for the ocean to work as a business developer in the Caribbean. By supervising all kinds of solutions to stop erosion, he discovered that existing artificial reefs are unstable if used for coastal protection because the structures collide with themselves or other objects, or damage the environment. Wanting to learn how waves and nature interact to find a better solution, he moved to the Netherlands to study coastal engineering at Delft University of Technology (TU Delft). During his academic journey, he saw that a solution was needed world-wide, and no project was taking the right steps to make it happen at the time. Therefore, he did an additional year of entrepreneurship at TU Delft, where Reefy started.



Leon Haines is the co-founder and CTO of Reefy. He studied integrated coastal zone management in the Netherlands, majoring in marine biology. As a passionate diver and scuba instructor, Haines spent five years after his studies working in coral reef restoration in Thailand, the Maldives and Indonesia. In 2018 he founded Conservation Diver Indonesia, where he trained students and volunteers in all the ins and outs of coral reef conservation. Convinced of a way to create a larger impact by upscaling reef restoration through infrastructure projects, he joined Jaime Ascencio to found Reefy.



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Eliminating Weather Window Woes

Machine Learning Can Reduce Overly Conservative Vessel Ops

By Dr. Ali Cetin

Determining the impact of severe weather systems and powerful waves on vessel operations has long been a costly and potentially hazardous task for the offshore oil and gas industry. Any uncertainties in these predictions may result in unnecessary schedule delays, budget inflation and risk to life. To confidently predict and tighten weather windows, existing assumptions and calculations based on conventional response amplitude operators (RAOs) should be challenged and improved.

4Subsea, a Subsea7 company, has developed a machine learning (ML) approach to enhance standard RAOs with advanced digital data. The model uses sea state forecasts to predict the range of vessel responses and, in the absence of sufficient data, uses existing RAO data.

The model was recently trialled on a pipe-laying vessel operating offshore Brazil. The results clearly demonstrated that not only did it largely surpass the “best” available existing RAO, it can also improve wave-vessel response predictions while extending knowledge of RAOs and their limitations.

Reducing Over-Conservatism

Accurately describing the wave-vessel interaction is essential for operators to eliminate both economic and environmental concerns, such as fuel consumption and payload capacity. Such responses are typically calculated through wave spectra and appropriate RAOs. This conventional approach entails establishing limiting sea states for initial engineering analysis and for short-to-medium term prediction of vessel responses based on forecasted sea states during ongoing operations. The latter aspect is particularly critical for onboard decision support systems, as it provides a foundation for statistical inference regarding limiting conditions. These limiting conditions can then be used to derive useful metrics, such as standard deviation and zero-crossing period, to enable informed decision making.

Ideally, the response spectrum for a given degree of

freedom is the product of the corresponding RAO and the wave spectrum. However, the accuracy of the estimated response spectra depends on the accuracy of the RAO and the wave spectra, and in real-world scenarios neither of these can be known with certainty. RAOs obtained by means of conventional approaches, such as strip theory or advanced simulation software, may yield sufficiently accurate RAOs for practical use, but the uncertainty lies in whether the assumptions and conditions utilized are appropriate. Furthermore, it is not feasible to verify the validity of conventional RAOs without noteworthy engineering effort.

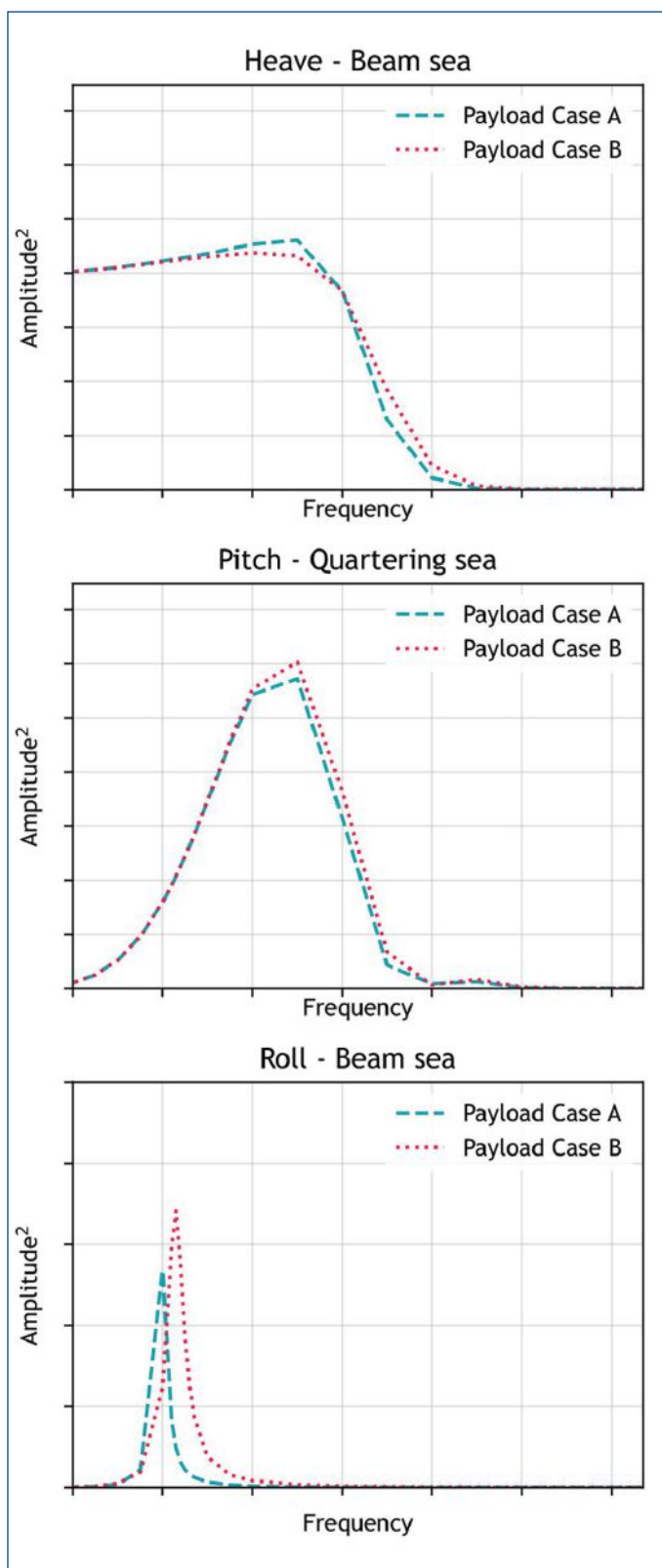
Using observed data, 4Subsea’s technology is classified as a supervised ML model and may be considered as a type of RAO “tuning.” The application aims to give operators greater confidence to allow a vessel to operate closer to its limits.

Methodology

The model utilizes a set of splines to describe a 2D surface that approximates the RAO. The parameters that fully describe the model may be summarized as: the collection of all spline coefficients; the common spline knots; and the directions where the RAO is approximated by a dedicated spline. Hyperparameters can be used to tune the model and must be determined through cross-validation.

While one of the main advantages of the proposed approximation is that it is highly flexible and can fit almost any curve/surface, the drawback in practical usage is that splines can easily overfit. In principle, the flexibility can be controlled by adjusting the hyperparameters. However, a more practical approach used in this methodology is regularization, which entails adding penalty terms to the cost function in order to prevent overfitting.

While any suitable optimization method may be used to minimize the cost function, a nonlinear least squares method can be used to efficiently curtail the cost func-



(Above) RAOs for different payload cases for selected directions related to a pipe-laying vessel operating in the Campos/Santos Basin. Note that heave and pitch RAOs are barely affected by the payload, whereas roll is severely affected. (Top middle) Summary of 2D wave spectra, the normalized total energy, i.e., sum of all spectra scaled.

tion. Furthermore, sensitivity to outliers may be reduced by utilizing a least-squares algorithm with robust cost function.

The response spectrum can be aggregated to many useful statistics that are more suitable for performance metrics, such as spectrum moments and zero-crossing period. Here, response standard deviation, a common measure utilized in engineering analyses, is suggested. This can be calculated directly from the response spectrum.

A common practice in ML is to split the data into exclusive sets in connection with training, cross validation and testing. However, it is crucial to ensure that information does not leak across the different sets. This is a particular issue when dealing with time-dependent environmental data, such as sea states and, consequently, wave spectra. In practice, this will lead to model overfitting and inflate the performance metrics used for cross-validation and testing.

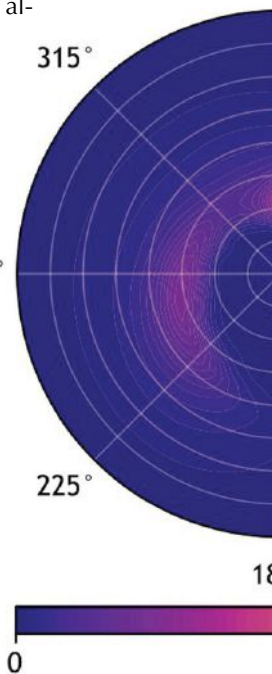
Blocked shuffling is a suggested counter measure where the data are first sorted chronologically and divided into blocks. The blocks are then shuffled and assigned to the different sets. In addition, data stratification with respect to vessel heading is advised.

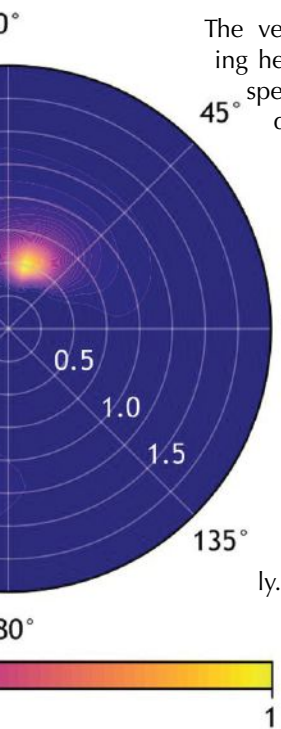
There are two key limitations in the proposed model. First, the vessel properties are assumed to be stationary, i.e., the RAO is assumed to be constant. This assumption may render the model inappropriate for certain degrees of freedom for some vessel types. Therefore, the model may not be appropriate for estimating roll power spectra of ship-shaped vessels undergoing significant draft variations.

Second, the wave spectra used for model training and predictions are assumed to be exact and rely on forecasted wave spectra, which are inherently uncertain like any other type of weather forecast. On the other hand, systematic errors and biases in the wave spectra will influence the model of the estimated RAO. It is therefore critical to use the same type of wave spectra for training and prediction. The same applies if the model is trained on data from a narrow geographic region, as bias and errors in the wave spectra may be localized.

Field Trial

The model was applied on a pipe-laying vessel operating in the Campos/Santos Basin, offshore Brazil that traditionally performed RAOs across its engineering assessments. As the payload of pipe-laying vessels constantly changes due to the nature of their work, this affects the wave-vessel interaction. Therefore, the test was limited to heave and pitch responses.





The vessel was fitted with sensors measuring heave, pitch, roll, heading, position and speed continuously. The degrees of freedom are measured with an inertial measurement unit (51.2 Hz), while heading/position/speed were reported by the onboard navigation system (1 Hz). Data were continuously captured, contextualized, and uploaded to an onshore time-series database over a period of 493 days and were complemented with 2D wave spectrum forecasts acquired through a commercial weather service provider. The forecasts were updated twice a day with temporal and spatial resolutions of 3 hr. and $0.25^\circ \times 0.25^\circ$ grids, respectively.

Wave spectra from the grid point nearest the vessel were used. Here, the wave spectrum represents the instantaneous sea state at a given grid point, at a specific time, so it is never older than 12 hr. The model shows waves are concentrated from the southwest and relatively spread from the Atlantic Ocean. This is typical for the region where two different swell wave systems are present. As each wave spectrum is paired with a response spectrum to form a data point, the response spectrum is derived from approximately 30 min. of heave/pitch measurements centered around the forecast time.

Data were preprocessed before they were used in the model. The data set initially contained more than 3,600 data points but was reduced to just under 1,800 applicable data points after filtering to the predetermined set of criteria. This ensured testing only considered periods where the vessel motions were negligible (since the model assumes zero speed) and where the vessel was close to the location of the weather forecast (yielding reliable input data). To alleviate information “leakage,” data were blocked into 90-hr. sequences or 30 data points before being split into 80 percent training and 20 percent test sets.

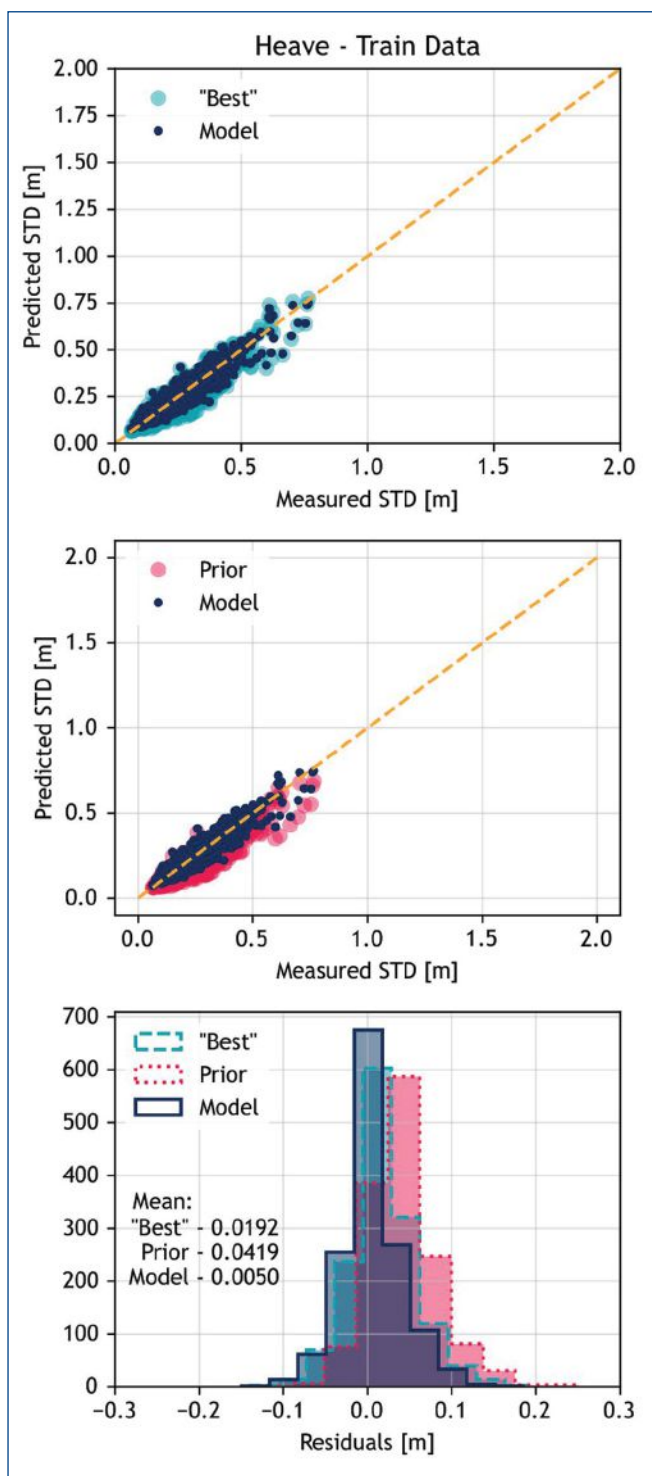
For the purpose of this case study, RAOs of several similar ships were considered and the one that yielded the lowest score metric was selected for model regularization, i.e., prior RAO. Comparing predictions based on the data, plus inaccurate prior RAO as well as the “best” RAO, better highlights the potential benefit the present model may offer in realistic scenarios.

Results

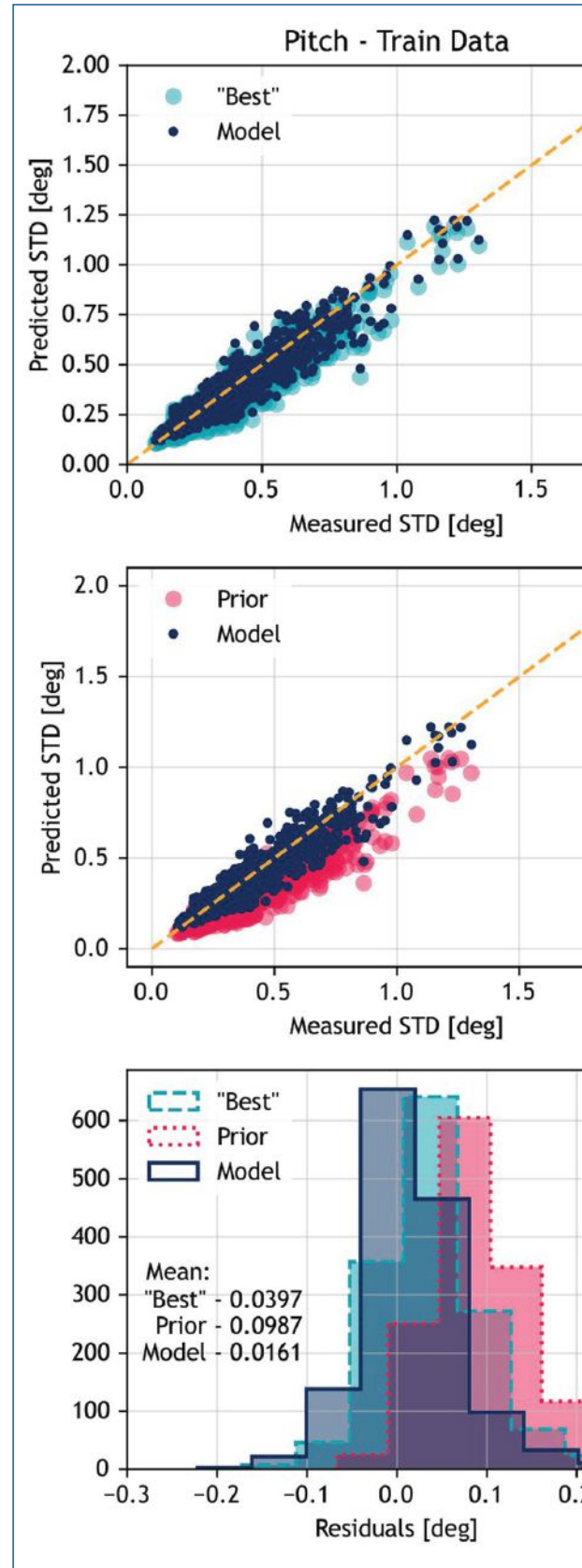
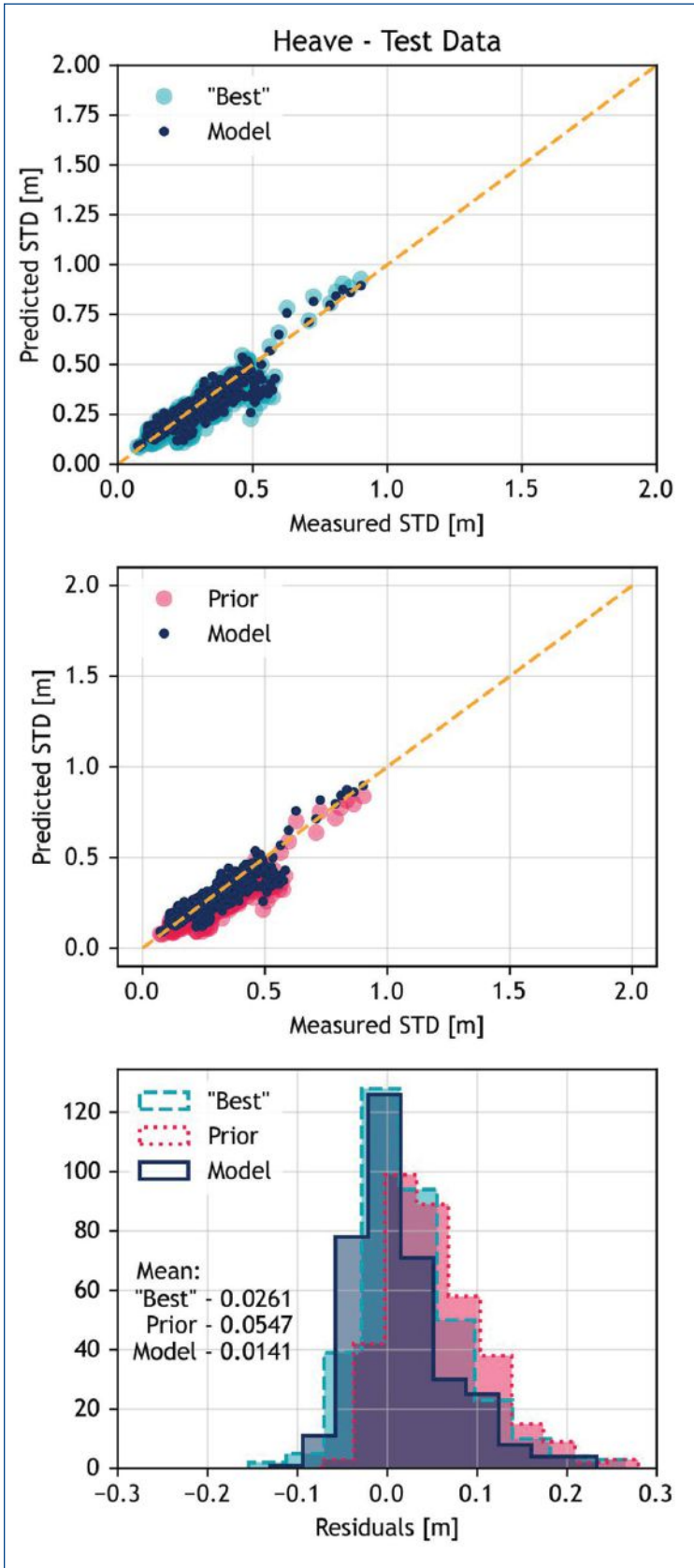
For both heave and pitch predictions, the present model outperforms both the prior and the “best” RAO. While the former outcome is somewhat expected, the latter outcome is remarkable. The scores may be used to quantify the improvement that the present model provides over the “best” RAO. For heave standard deviation predictions, the error/residual standard deviation is re-

duced by about 10 percent, whereas the reduction for pitch is 15 percent.

The difference between the predictions based on the “best” RAO and the present model is subtle, where the latter primarily provides a slight trend correction, but the spread/dispersion is comparable. Therefore, the reduction in prediction errors/residuals is mainly due to this trend correction. Although a bit speculative, the main



Heave response standard deviation predictions using training data.



(Left) Heave response standard deviation predictions using test data. (Middle) Pitch response standard deviation predictions using training data.

source of the spread/dispersion is likely to originate from the wave spectrum forecasts. Moreover, a side effect of the present model is that it estimates RAO amplitudes.

Consistent with the results so far, the RAOs estimated by the model tend to agree more with the “best” RAO, although it is only aware of the prior RAO. A comprehensive investigation is beyond the scope of the present work.

Conclusions

4Subsea has developed an ML model for predicting vessel response which was trialled with a pipe-laying vessel offshore Brazil. This was done by estimating an “effective” RAO and combining it with a 2D wave spectrum. The model makes use of splines and different regularization terms in the cost function to combine flexibility and robustness.

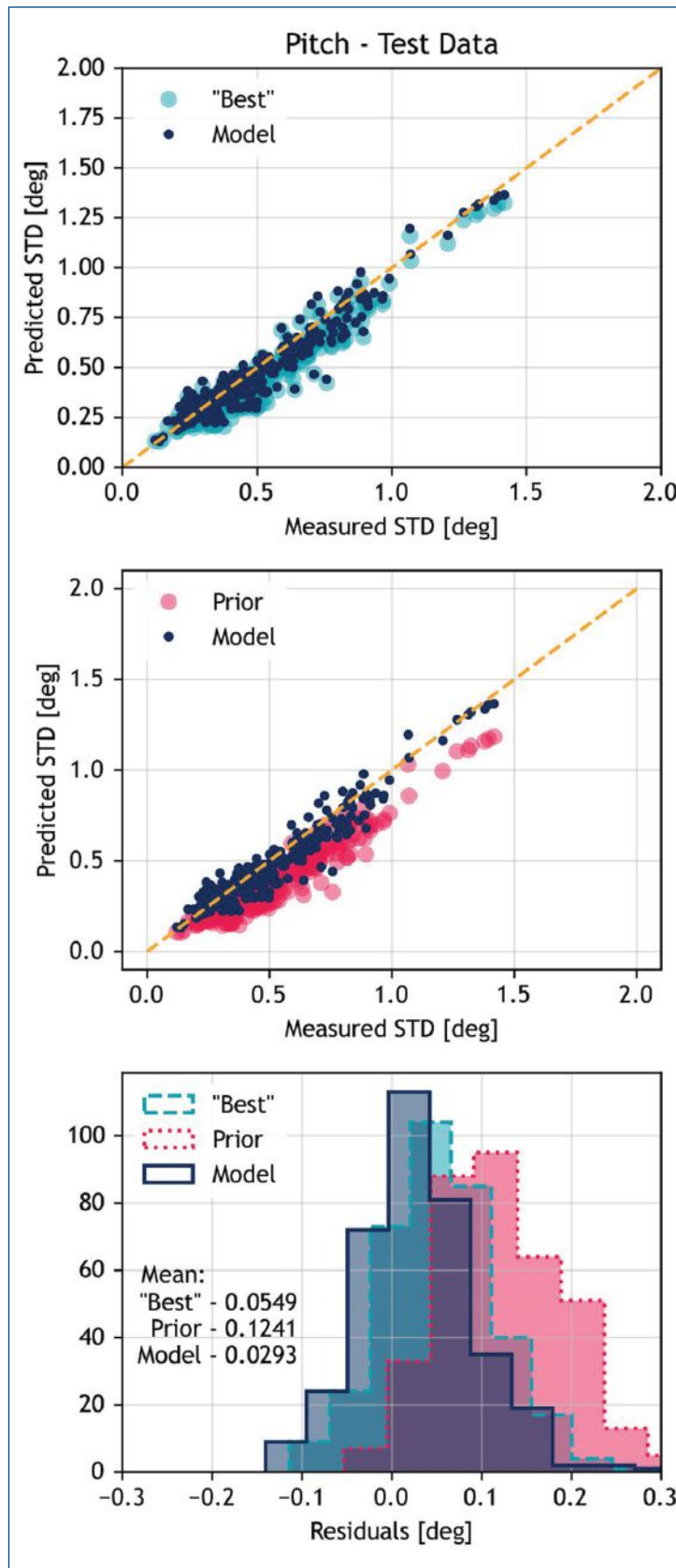
Furthermore, a key feature of the model is that it incorporates an RAO as “prior” knowledge and uses it as a fall-back solution in the absence of sufficient data. In a way, the model “enriches” the prior RAO with data. Therefore, a properly trained and tuned model will always perform at least as good as the RAO used as “prior” knowledge. As the model is only able to estimate the RAO amplitudes and not the phases, it cannot, as yet, fully replace conventional RAOs.

An interesting property of the model is that it can be used with zero data, which will revert to the prior RAO. Therefore, the model may, in practice, be deployed at any time and retrained regularly. Accordingly, the model will gradually put less emphasis on “prior” knowledge and more on data, enabling it to become more accurate with an increasing amount of data.

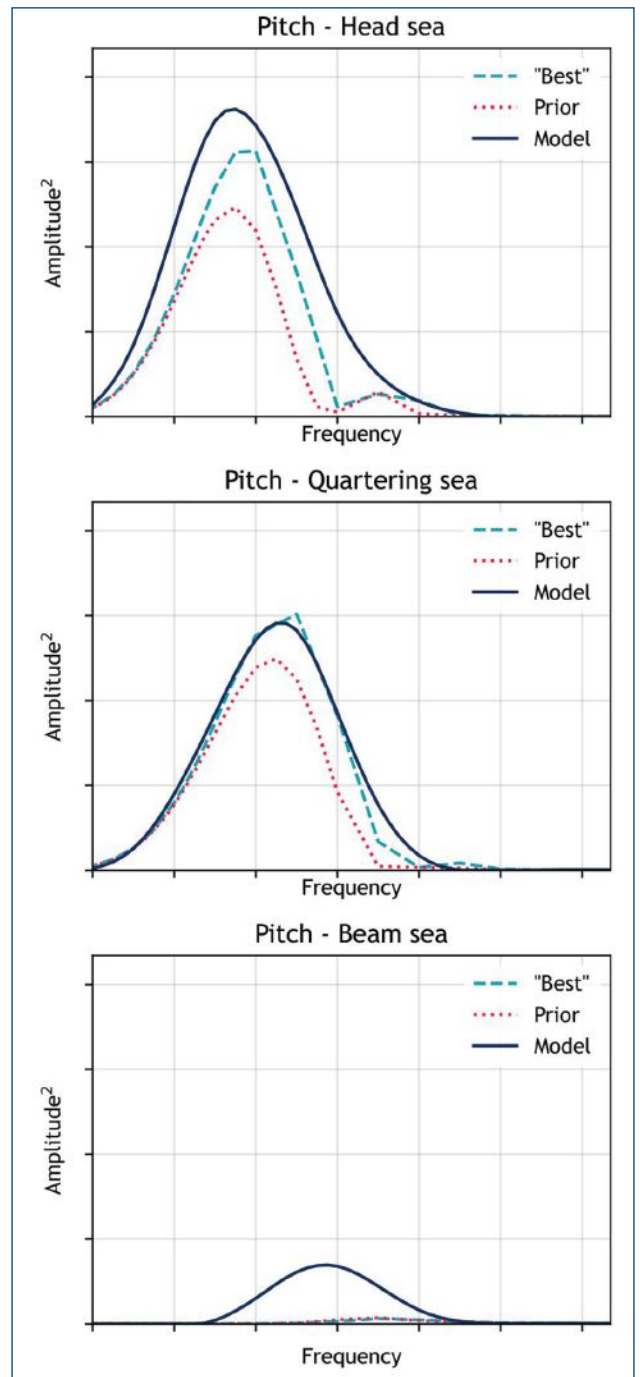
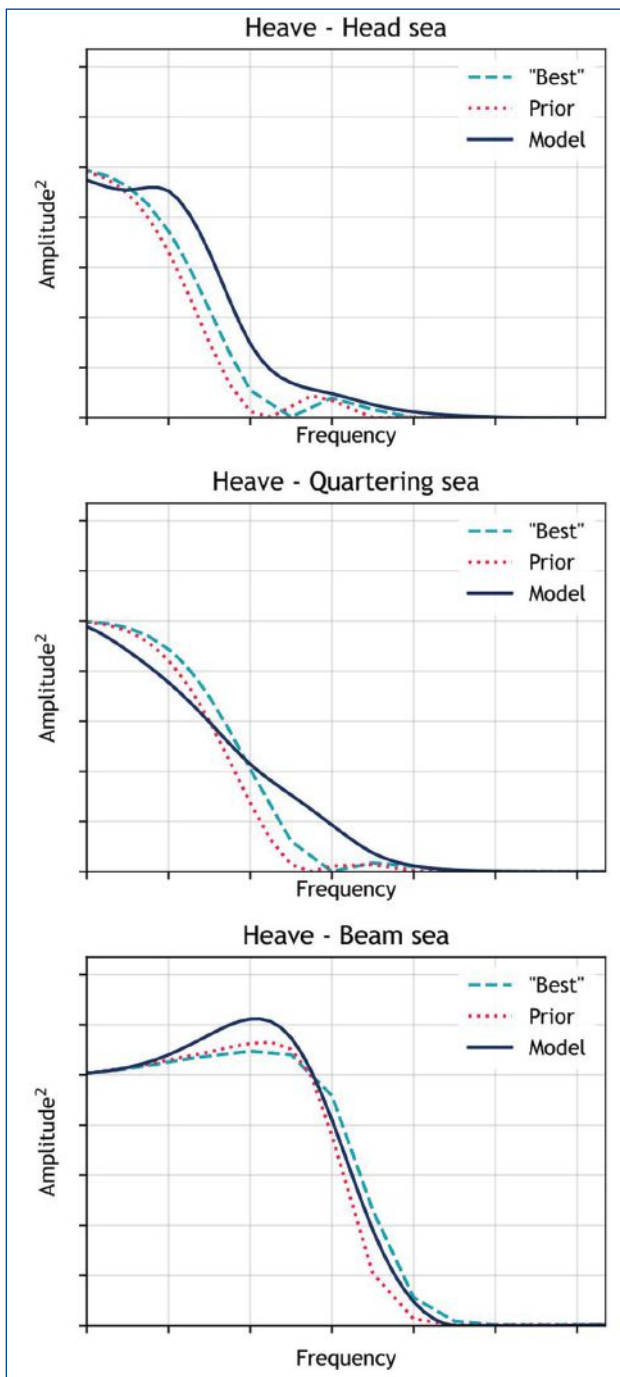
A shortcoming of the model is that it requires stationary RAOs that will typically affect the roll response of a vessel—the most critical response in most practical scenarios—as this changes with payload and is largely dependent on sea state.

There are opportunities to extend the model to properly handle roll response, which may involve including the roll natural frequencies and damping as model parameters.

The field trial clearly demonstrated that the model outperformed the “best” available RAOs obtained by means of conventional methods. This was achieved despite purposefully using an inaccurate RAO as “prior” knowledge. Therefore, it is reasonable to expect that even simple, semi-analytical RAOs may be used as



data. (Right) Pitch response standard deviation predictions using test



(Left) Heave RAO estimated by the present model for select direction. (Right) Pitch RAO estimated by the present model for select direction.

"prior" knowledge, provided there is sufficient data.

In addition to providing predictions, the model may provide additional information/feedback to engineers; for instance, comparing the predictions made by the model and the "best"/prior RAOs to confirm/validate existing RAOs. It could also be used to reveal unexpected response characteristics, which may trigger comprehensive investigations. Ultimately, this approach can be used to better inform operability and weather windows

to allow "waiting on weather" thresholds to be less conservative.

References

For a list of references, reach out to: contact@4subsea.com. **ST**

Dr. Ali Cetin is lead data scientist at 4Subsea and has more than 10 years' experience in the oil and gas industry. He holds a Ph.D. in mechanical engineering from the Norwegian University of Science and Technology (NTNU) and has published several scientific papers.



international

Merger Focuses on Autonomous Systems

ACUA Ocean and HydroSurv, two U.K.-based companies specializing in maritime autonomous systems, will merge to combine their extensive expertise in the development and operation of USVs and associated technologies for marine surveying and surveillance. The new company, Blue Ocean Autonomy, will deliver turnkey solutions across a broad spectrum of capabilities, covering the inland, nearshore and offshore sectors.

Blue Ocean Autonomy's strategy will focus on low- and zero-emission vessel operations for sustainability. It will leverage HydroSurv's electric and battery-hybrid Rapid Environmental Assessment Vessels (REAVs) and ACUA Ocean's hydrogen-powered H-USV, being developed as part of the U.K. Department for Transport's Clean Maritime Demonstration Competition program.

Inmarsat Acquired

Viasat Inc., a global communications company, has completed its acquisition of Inmarsat. This brings together spectrum, satellite and terrestrial assets, including 19 satellites in space spanning Ka-, L- and S- bands. These complementary assets are expected to deliver connectivity and key safety services across maritime, aviation, government and consumer markets with speed and reliability of connection.

Trelleborg Expands in Vietnam

Trelleborg Marine and Infrastructure is set to open a new state-of-the-art manufacturing facility in Vietnam, with the construction scheduled to be completed by the end of 2025 and production to commence in 2026. The location will be in the Phu My 3 Specialized Industrial Park of Ba Ria Vung Tau province, one among eight provinces in the Southern Key Economic Zones of Vietnam. The addition of a new site in Vietnam will reinforce Trelleborg's production capabilities in the marine fender, marine construction, and infrastructure product areas while complementing the existing operations at its Qingdao-based facility for the Chinese market.

Flagship Founders' Spin-Off

The Berlin-based venture studio Flagship Founders has announced the spin-off of another startup, Arinto, a software solution enabling just-in-time arrival of merchant ships in ports. Shipping companies and ship managers will be able to calculate the ideal arrival time of vessels to make voyages much more efficient. This will lead to drastic reductions in fuel consumption, lower emissions and more sustainable shipping.

Nikkiso Joins SEA-LNG

Nikkiso Clean Energy and Industrial Gases (Nikkiso CEIG) is the latest company to join SEA-LNG, the coalition established to demonstrate the commercial and environmental benefits of LNG and the pathway it provides for maritime decarbonization. Nikkiso supplies equip-

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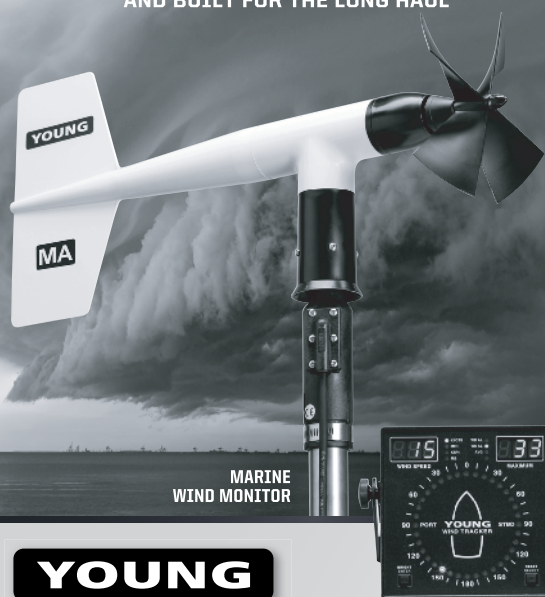


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ment, technologies and engineering services to support the safe operation of LNG as a marine fuel.

SEA-LNG membership will open up networking and collaboration opportunities for Nikkiso to support its work on cryogenic pumps and process systems, as well as broader cryogenic services. The group also works on heat exchanger systems and Nikkiso Turboexpander systems and has experience in boil-off-gas management for LNG-fueled vessels, methane slip mitigation, and integrated LNG fuel gas supply systems.

New Canadian Polar Icebreaker

KNUD E. HANSEN has entered into a partnership agreement with Barrier Marine Services (Canada) Ltd. to design the HVAC system for the Canadian Coast Guard's new polar icebreaker to be built at Seaspan's Vancouver shipyard. KNUD E. HANSEN will provide the design and engineering package for the HVAC system through the functional and production design phases of the project and continue to provide support through long lead item procurement and vessel construction. Barrier Marine Services, a subsidiary of U.K.-based Barrier Architectural Services Ltd., will supply and install the HVAC system based on the design by KNUD E. HANSEN.

As part of the National Shipbuilding Strategy, Seaspan Shipyards is the prime contractor responsible for the design and construction of the polar icebreaker. The vessel will be 158 m long and 28 m wide and can accommodate up to 100 personnel. It will be able to operate in higher latitudes, in more difficult ice conditions and for longer periods than any existing Canadian icebreaker.

Name Change for Smart Buoy Company

The Norwegian ocean-tech company Innomar Ocean Technology has changed its name to Smart Ocean AS. Along with the name change, Smart Ocean has launched the next generation of its smart buoy, SMART OCEAN BUOY Coastal Edition II, featuring advanced tracking and monitoring technology for fishing gear and the digitalization of fishing and aquaculture. The new buoy provides highly precise localization using GPS and is designed to withstand harsh conditions.

Future Ship Joint Innovation Centre

DNV and China State Shipbuilding Corp. (CSSC) have established the Future Ship Joint Innovation Centre in Shanghai to cooperate on ship and offshore field technical innovation; advance decarbonization and digitalization transformation; and provide technical support and solutions to the maritime industry. The center will set up three joint work groups on decarbonization, digital twin/digital ship and smart shipping, focusing on developing future-proofed vessel holistic solutions to advance green and smart shipping innovations.

BlueTech OCEAN Project

The government of Massachusetts has awarded a \$2 million grant to the MITRE Corp. to create BlueTech OCEAN (Open Collaborative Experimentation and Acceleration Network), a two-year project that will boost

the state's global leadership in ocean science, marine robotics, clean energy and other game-changing marine industries.

The grant, funded through MassTech's Technology & Innovation Ecosystem program, will help MITRE fund and outfit a state-of-the-art BlueTech Lab on its campus in Bedford, create a national marine data network, and establish new workforce development programs to promote blue economy career opportunities to students across the state.

FarSounder Adds Patent

FarSounder, a developer of 3D forward-looking navigation sonars (*Sea Technology*, June 2023), has expanded its IP portfolio with an eighth patent, number 11,609,316. This U.S. patent adds to the company's patent portfolio for its unique sonar system and its 3D processing.

The invention provides a sonar system that includes a forward-looking sonar device that operates in an integrated fashion with one or more other sonar devices so that a boater can have a reliable navigation tool. The forward-looking sonar can include a transducer array that takes a 3D acoustic reading of the objects and seafloor ahead. The electronics that process the acoustic data can also process data from down-looking sonar, side-scanning sonar or both, and can integrate the information to present an expansive display in the boat, revealing the contents of the seafloor in front of, around and under the boat. The new patent will secure FarSounder's technology IP as tech development continues.

Trident Acquires US Navy Supplier

Trident Maritime Systems, a maritime systems and solutions provider and portfolio company of investment affiliates of J.F. Lehman & Co., has acquired the assets of Custom Alloy Corp. (CAC) through one of its subsidiaries. CAC is a vertically integrated provider of highly specialized alloyed forgings, fittings, and pipe to defense and industrial end-users. CAC is a critical supplier to the U.S. Navy on key programs, including nuclear submarines and aircraft carriers.

OPENSEA UXO Demo

Greensea Systems Inc. has successfully demonstrated OPENSEA in a mission to locate buried munitions in the surf zone. This UXO survey demonstrated the power and flexibility of OPENSEA to rapidly integrate and deploy a new sensor suite while showcasing the capabilities of the Bayonet 250 AUGV, which was selected as a finalist in the Defense Innovation Unit's Autonomous Amphibious Response Vehicle (A2RV) program's rapid prototyping phase. Operating over eight days and covering 18 sq. km in depths of up to 10 ft., amid wave heights of 4 to 6 ft. in the challenging surf zone, the Bayonet 250 provided a stable, reliable platform for conducting the survey that included a towed sled equipped with White River Technology's marine APEX seamlessly integrated into OPENSEA. Objects were detected and classified, with a buried depth of up to 3 m, based on material composition. **ST**

Prepping for Australia's First Offshore Wind Farm

Fugro has been awarded a contract to perform an offshore geotechnical site investigation for Australia's offshore wind project Star of the South (SOTS), located off the coast of Gippsland, southeast of Australia.

Partly funded by the Victorian government through the Energy Innovation Fund, Star of the South is in the feasibility phase and has the potential to generate up to 2.2 GW of new capacity, supply around 20 percent of Victoria's energy needs, and power about 1.2 million homes.

Partnership to Serve Expanding Offshore Wind Sector

Subsea Europe Services and Rental Technology & Services (RTS) have embarked on a new strategic partnership to expand their mutual subsea equipment rental pools and collaborate to create solutions that will deliver marine survey and underwater inspection efficiencies using new sensors, communication systems, autonomous platforms and digital technologies.

From its facilities in Aberdeen and Åkrehamn on the west coast of Norway, RTS is an international provider of electronic engineering equipment, while the Hamburg-headquartered Subsea Europe Services specializes in hydroacoustic technology rentals and autonomous operations, on and beneath the surface.

The partnership will ensure that customers in the North Sea, Baltic Sea and further afield have access to diverse products and cutting-edge innovations that can optimize offshore and shallow-water surveying, seabed mapping, geohazard identification and underwater inspection workflows.

OE35 Floating WEC Demo

Irish wave energy developer OceanEnergy has signed up to demonstrate its OE35 floating wave energy converter (WEC) at the European Marine Energy Centre (EMEC)

in Orkney, Scotland. OceanEnergy intends to demonstrate the OE35 over two winter periods from 2024 at EMEC's Billia Croo wave energy test site off the west coast of Orkney.

The 1-MW OE35 WEC floats on the ocean's surface, with the lower part of the machine open to the sea. Waves cause a water column within the device to rise and fall, creating pressurized air to rotate a turbine. This generates electricity, which will be fed into the U.K. grid via EMEC's subsea cable and onshore substation.

The OE35 incorporates well-proven ship-building techniques and has only one moving part that is above sea level, increasing survivability, reliability and availability.

EMEC will support OceanEnergy with environmental monitoring. A series of field campaigns will include underwater and airborne acoustics, biophysical assessment of wave dynamics, fish aggregation, and seabird analysis to assess the potential interactions between local species and the operation of the technology.

First French Offshore Wind Research Platform

Determining the effects of commercial wind farms on local and regional coastline scales along the French Channel remains a major research challenge. A measuring mast located at sea off Fécamp and belonging to France Energies Marines is gathering data long term, with innovative monitoring protocols being developed. This research is a public-private endeavor.

The offshore research platform is coupled with a large-scale multidisciplinary R&D program, called DRACCAR, which aims to improve understanding of the interactions between offshore wind energy and the environment, to optimize the design of wind turbines, and to co-construct a permanent observation network for the maritime seafronts. The research topics are: the marine ecosystem as a whole; ma-

rine megafauna; fishery resources, biofouling and benthos species; the wind and its physical parameters; structural behavior; and hydrosedimentary processes.

Wind Propulsion Simulation

NAPA, a maritime software and data services expert, Norsepower, a global provider of auxiliary wind propulsion systems, and Sumitomo Heavy Industries Marine & Engineering Co. Ltd. (SHI-ME), one of the world's leading shipyards, have announced the results of phase one of their joint simulation project looking at the fuel saving and emissions reduction potential of combining Norsepower Rotor Sail and NAPA Voyage Optimization onboard SHI-ME's wind propulsion ship.

Phase one of the simulation project (from December 2022 to March 2023) found that the combination of NAPA Voyage Optimization with the Norsepower Rotor Sail can deliver emissions reductions of 28 percent on average along the Atlantic route between New York and Amsterdam. Of these average CO₂ emissions savings, the contribution of NAPA Voyage Optimization can be estimated at 12 percent.

Phase two of the research project began May 2023. The goal is to enhance the performance of vessels with Norsepower Rotor Sails. Using fleet data, the study will conduct advanced performance analysis to improve operational performance and explore new optimization strategies. The project is part of SHI-ME's plan to develop a new proof of concept for wind-assisted ships, which will be equipped with Norsepower Rotor Sails.

The project and its findings will help strengthen the business case for investing in wind-assist technology at a time when the industry is under increasing pressure to decarbonize. Using NAPA's operational voyage simulation technology alongside the technical expertise of Norsepower and SHI-ME, the collaborative study brings critical insight and assurance to inform commercial and operational decisions as early as the design stage. **ST**

productdevelopment

For more information on any of these products, visit our website at www.sea-technology.com/products

Boat Launch and Recovery System



This three-hook system applies to naval architects when designing the layout of workboats up to 12 tonnes. With two of the lifting hooks at opposite corners of the boat's stern and the third in the bow, the after-deck can remain completely clear of obstructions. Tools and equipment such as AUVs and towed sonars can then be deployed over the stern without being obstructed by a hook in the center of the after-deck. H Henriksen AS.

Plastic Management

Oceanworks Plastic Action Dashboard gives organizations tools to measure, reduce, track and communicate their plastic action initiatives. The dashboard offers complete access to orders, metrics, marketing and compliance information in one place. Oceanworks.

Sea Ice Propulsion

The SeaJet range of electric podded propulsion solutions brings high efficiency and maneuverability to ship operations in harsh sea ice conditions, improved efficiency in transit and high bollard pull. Power ranges from 1.5 to 4 MW, using low voltage (<1,000 V), ideal for smaller ships. GE Power Conversion.

High-Speed Broadband

Fleet Reach coastal LTE service for maritime connectivity provides uninterrupted high-speed broadband to merchant, offshore, energy and fishing customers, even when they are sailing near the coast or docked

in port. Optimized by Fleet Xpress and added terrestrial mobile connectivity, the service enables faster speeds, increased signal strength, lower latency and more reliable connectivity. Inmarsat Maritime.

Ammonia Release Mitigation

The WARMS system has received approval in principle from DNV to cover its use on ships fueled by ammonia. This innovative system mitigates the risks associated with future fuels, such as ammonia, which can be hazardous to both health and the environment unless handled and stored with great care. With WARMS, typical emissions comprise nitrogen and water, with ammonia emissions less than 30 ppm (in most cases, close to 0 ppm). Wärtsilä Marine Systems.

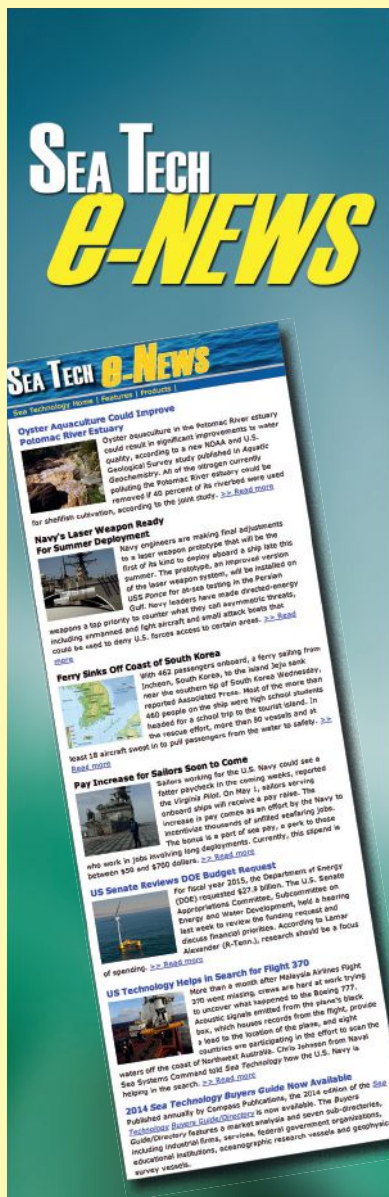
Protective Suit



VIKING YouSafe Twist is a compliance-led, constant-wear immersion suit offering high-performance protection. Designed using waterproof, highly durable and breathable materials, the suit can be worn constantly across multiple tasks in difficult conditions. It provides insulation for up to 1-hr. immersion in 5° C water, with the comfort of conventional marine work gear. VIKING Life-Saving Equipment A/S.

AI Bathymetric Data Processing

GS4 software v1.0.25 for GeoSwath bathymetric sonars adds several upgrades, including an artificial intelligence data processing system. The software update is available free of

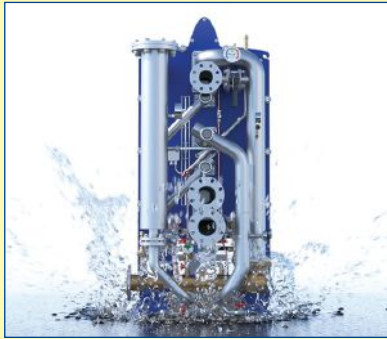


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charge for customers already operating GS4 software v1.0.24. The new AI processing augments the existing automated filtering in the GS4 software by removing surplus and undesired data autonomously; during acquisition, the system is designed to log clean data, without any user intervention in the cleaning process. The processing happens in real time. GeoAcoustics Ltd.

Freshwater Generator



AQUA Blue E2 uses a single-plate pack for the desalination process of evaporation, separation and condensation. By applying Alfa Laval's 3-in-1 AQUA plate technology in two stages, it reduces seawater flow needs, energy use and related CO₂ emissions. Providing up to 100 m³ of freshwater per day, it consumes 50 percent less electrical power than conventional single- and two-stage freshwater generators. Alfa Laval AB.

Alternative Energy Ships

These new anchor handler (AHT) and platform supply vessels (PSV) have the option to include alternative fuels and energy sources, such as methanol, ammonia and hybrid-battery power. They will help shipowners address current and future challenges of efficiency, emissions reduction and developing market requirements. Kongsberg Maritime.

Fuel Cell System

Pelican Fuel Cell System (FCS) is the result of the H2NOR research project that started in 2021. H2NOR was initiated by Corvus Energy, Toyota and other partners to fast-track the development and production of

sustainable and scalable maritime hydrogen FCS. The modular and flexible system is inherently gas safe and can be installed anywhere on a vessel. Corvus Energy.

Water Quality Instrument

Aqua TROLL 700 and 800 multi-parameter sondes are seven-port water monitoring instruments for a variety of surface water, coastal, groundwater and aquaculture applications. They hold six Aqua TROLL sensors and an automatic antifouling wiper. Both instruments are ideal for long-term continuous monitoring and spot checking in freshwater, brackish water and salt-water environments. In-Situ Inc.

Intelligent Y Adapter

YQ230 enables full use of a boat's onboard systems by safely powering a 50-A, 125/250-V vessel from two 30-A dockside receptacles. Designed for long life, the adapter has a rugged, high-impact and UV-resistant housing that is environmen-

tally sealed against humidity, fog and rain. Hubbell Marine Electrical Products.

Acoustic Animal Tracking

NexTrak is an acoustic telemetry system that uses digital technology and advanced coding schemes to improve coverage, extend range and provide researchers with deeper, more accurate data. Preliminary testing shows NexTrak receivers have a range that's 39 percent greater than the current VR2 receivers, which will lead to a vast increase in the number of valid detections in the field. InnovaSea Systems Inc.

Ultrasound Inspection

P-Scan 5 is now even easier to configure for a wider range of geometries and asset integrity applications, including regular inspection of submerged pipelines, flowlines, subsea templates, manifolds and offshore wind turbine subsea structures. It can be deployed by divers or ROVs. FORCE Technology. **ST**

A promotional graphic for the Twitter account @SeaTechnology. It features a blue cartoon penguin character holding a magazine titled 'SEA TECHNOLOGY SERVICES THE WORLD'. The magazine cover shows an offshore oil rig. The background is a dark blue gradient with the Twitter logo and the text 'FOLLOW SEA TECHNOLOGY ON...' in large yellow letters. At the bottom, the URL 'twitter.com/SeaTechnology' is displayed in large yellow letters.

Decarbonization Toolkit

Inmarsat Maritime, a Viasat business, and a world leader in global, mobile satellite communications, has published its Decarbonisation Toolkit, which outlines a practical blueprint for decarbonization in the maritime industry: www.inmarsat.com/en/insights/maritime/2023/decarbonisation-toolkit.html. Compiled by maritime innovation consultancy Thetius, the report uses real-life examples to set out a framework across three domains of energy transition: “operation,” “ship” and “human element.”

At the operational level, voyage optimization is a particularly effective means of decarbonization. In September 2022, Scandinavian shipping company Wallenius Wilhelmsen announced its intention to adopt an AI-based voyage optimization system across its 120-vessel fleet. The announcement followed

the company’s 18-month trial of a performance-routing solution that yielded a 6.9 percent increase in vessel efficiency, equating to a projected 170,000-tonne carbon dioxide equivalent (CO₂e) reduction in emissions with a fleet-wide rollout.

Alongside voyage optimization, collaboration and data sharing could play a key role in lowering emissions. In February 2023, KCC Chartering and integrated energy company Raizen signed a three-year contract of affreightment for more energy-efficient operations through improved charterer-cargo owner communications and data exchange. By minimizing legs in ballast and improving the efficiency of loading and discharge processes, the partnership is expected to result in a 40 percent reduction in the carbon intensity of its agreement.

Under “ship,” other methods include port-call optimization and

green corridor schemes, while tools available for decarbonizing the vessel itself include carbon capture and storage, optimized hull design, energy-saving coatings and devices, wind propulsion, future fuels, and connectivity and data-exchange infrastructure. For example, in the first quarter of 2023, ship management company Eastern Pacific announced the successful installation of carbon capture and filtering technology on board the chemical tanker *Pacific Cobalt*. Installed in the ship’s stack, the system will capture up to 40 percent of the vessel’s carbon dioxide emissions, filtering out sulphur and particulate matter from the exhaust gases.

The “human element,” meanwhile, relies on behavioral economics and change management in addition to skilled decarbonization teams. According to the report, crews should be trained in the new technology and processes that enable greener shipping operations, and they must be willing to em-



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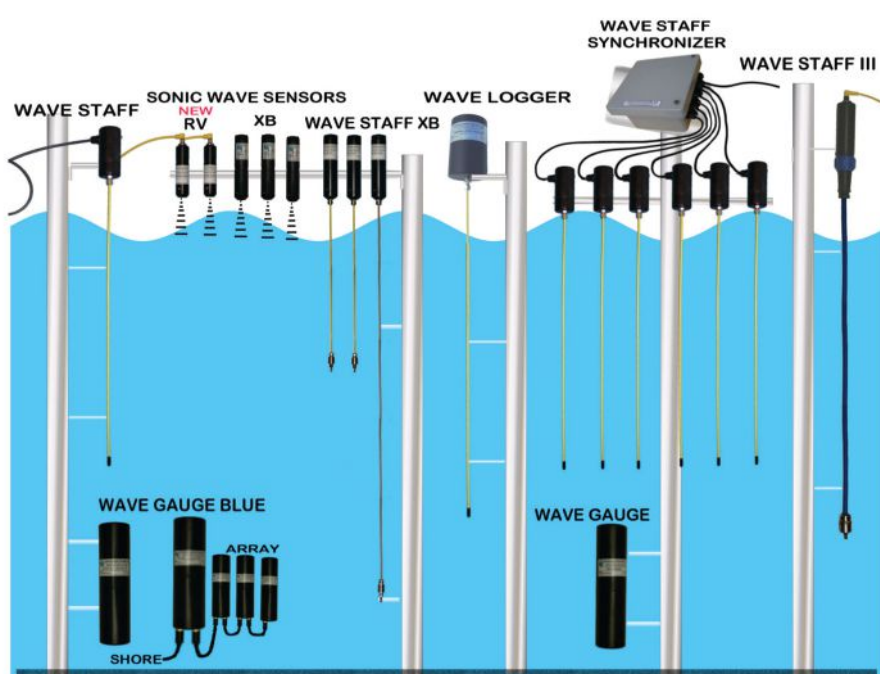
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brace the changes that the maritime energy transition entails.

eDNA to Measure Biodiversity

The BeWild project, aimed at measuring biodiversity at offshore wind farms, has been launched at Fugro's TechCenter in Nootdorp. Fugro, together with project partners, will focus on developing innovative methodologies and technologies for remotely collecting environmental DNA (eDNA) samples in the North Sea. The collected data will assess the impact of offshore wind farms on biodiversity and explore ways to adapt existing infrastructure to enhance marine habitats.

Fugro will develop remote marine eDNA collection, analysis and interpretation capabilities as part of its remote inspection solutions. By also integrating the eDNA sampling into its USVs and ROVs, Fugro aims to inspect subsea assets while also inspecting the broader subsea environment.

Great Barrier Reef Protection

UNESCO has recommended urgent new protection measures to safeguard the Great Barrier Reef, and Australia has decided to implement them. The Australian government formalized its commitments in a letter addressed to UNESCO Director General Audrey Azoulay, including: the creation of no-fishing zones in a third of the World Heritage site by the end of 2024 and banning gillnet fishing altogether by 2027; reaching water quality improvement targets by 2025 by significantly reducing pollutant discharges from farmers and industrialists and restoring flora and fauna in drainage basins; and setting successively more ambitious CO₂ emissions reduction targets, in alignment with efforts to limit global temperature increase to 1.5° C.

UNESCO will closely monitor the effective implementation of these measures.

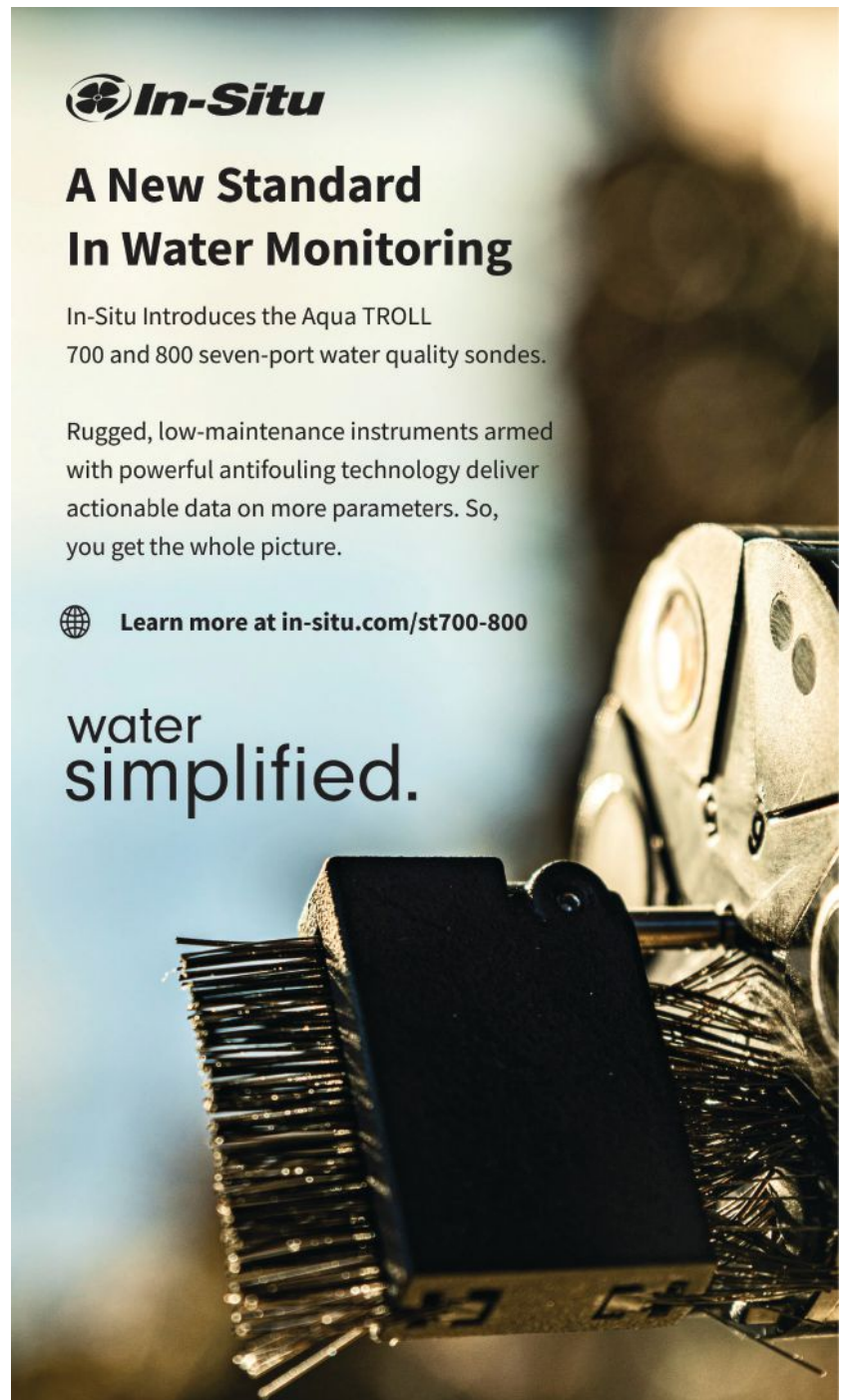
Autonomy in Survey

A group of companies came together to conduct a recent offshore survey of the anchorage near the entrance to Boston Harbor using an autonomous vessel, which traveled

8 line mi. to cover over 5.5 million sq. ft. and operated over 5 nautical mi. from the control room. The survey was conducted in just over 2 hr., including data processing.

Sea Machines provided the vessel, controlled by the SM300 autonomous control system. The vessel was commanded and monitored from the Sea Machines control room in Boston. 4G internet connectivity was used for the survey.

Survey Equipment Services provided the survey sensors. A Teledyne T20 MBES and Applanix POS MV were used for the survey. HYPACK software was configured to create a new file every 15 min. of survey, while, in the office, the HYPACK 64-bit multibeam editor (MBMAX64) automatically applied filters and saved the processed data. This process increased personnel safety and decreased survey time. **ST**

A close-up photograph of an In-Situ Aqua TROLL water quality sonde. The device is metallic and cylindrical, with a large, dark, rectangular sensor array at the front. The background is a blurred blue sky.

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Electric Demo Workboat

Shift Clean Energy has a new partnership with NYK Trading and Keihin Dock to develop a fully electric in-house demonstration workboat. This 9-m boat will showcase Shift's leading-edge energy storage system (ESS) technology, utilizing 123 kWh to power the fully zero-emission boat, which is a crucial step toward maritime decarbonization goals. Keihin Dock will use the electric demonstration boat to transport customers to new vessels being built, assist tugboats as they dock, and supply small equipment to a tugboat under operation. The ESS will significantly reduce fuel and maintenance costs while improving the responsiveness, reliability and safety of operations.

Overall, this project represents a significant step toward the wider adoption of electric propulsion systems in the maritime industry and

paves the way for a greener and more sustainable future.

YUCO Micro-AUV Crosses English Channel

SEABER's YUCO micro-AUV has successfully crossed the English Channel, paving the way for new ways of exploring and monitoring marine environments. The YUCO covered the 39 km between Folkestone, U.K., and Wissant, France, in less than 8 hr. Over the course of its journey, the YUCO followed a pre-programmed mission on the SEAPLAN software. During its crossing, the drone resurfaced three times, specifically for legal reasons. This mission shows the reliability and high battery capacity of the YUCO, which finished its journey with 35 percent of its power left.

The crossing was a complex challenge because the maritime route between France and England

is regarded as one of the busiest in the world, with more than 400 commercial ships a day and highly variable weather conditions. Furthermore, nearly 4 million passengers, 27 million tonnes of goods and 400 ships pass through every day.

YUCO measures just less than 1 m and weighs only 10 kg. It has applications for researchers, coast guards, search and rescue, police and sailors.

DNV Approval For Data System

Samsung Heavy Industries (SHI) has become the world's first shipyard to receive DNV's D-INF(S) type approval for the SVESSEL BIG data collection system.

SVESSEL BIG is set to become a crucial component of SHI's digitally enabled vessels. With D-INF(S) type approval, shipowners can be confident that the onboard critical data infrastructure is verified to meet international standards (ISO 19847/19848) for reliable, safe and efficient information sharing.

Two New ROS Innovations

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- Depth rated to 6000 meters

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Partnership for Vessel Performance Data

Kongsberg Digital and StormGeo are collaborating to transform how performance data are gathered, analyzed and utilized. As the first step, StormGeo's Performance Application will be available to maritime customers together with Kongsberg Digital's Vessel Insight Vessel to Cloud data infrastructure.

A significant development within this partnership is the augmentation of StormGeo's s-Insight performance application. High-frequency sensor data will be supplied through Kongsberg Digital's Vessel Insight via their cloud infrastructure.

The combined offering is already operational on numerous vessels and has been contracted for deployment on over 100 vessels in 2023.

Electric Boat, Ship Market Grows with Decarbonization

Across the land-based electric vehicle sectors tracked by IDTechEx, there is mostly a transition to battery-electric propulsion systems over the next two decades. The case is not so simple for the marine sector: Due to the sheer scale of the power, energy and distance requirements for merchant vessels, reducing maritime emissions will require solutions ranging from giant Li-ion battery systems to green hydrogen fuel cells and other alternative fuels.

The new IDTechEx report "Electric Boats & Ships 2024-2044" provides granular 20-year forecasts in unit sales, battery demand (GWh) and battery market value for electric ferry, electric cargo/container, electric Ro-Ro, electric cruise, electric OSV, electric tugboat and electric recreational boats by power class (<1 kW, <12 kW, >25 kW). Based on primary supplier interviews, it further shares technology analysis and price information on marine Li-ion battery systems and electric propulsion systems.

Today, marine electric and hybrid propulsion systems have mostly emerged in recreational boating, ferries and short-sea or inland vessels, where they have enjoyed steady uptake due to small vessel sizes or well-defined operational

profiles that allow for opportunity charging. The IDTechEx report finds that cumulative battery deliveries since 2013 are set to surpass the milestone of 1 GWh in 2023.

While growth has been strong in inland and coastal marine sectors, uptake in larger deep-sea vessels is less rapid but gaining momentum as unprecedented global emissions regulations upcoming from the International Maritime Organization

and EU, which focus on carbon and greenhouse gas emissions.

Pure battery-electric ships are often the best solution where possible to reduce emissions and lifetime ROI costs. Technological advancements in electric powertrain technology, driven by the automotive sector, are enabling multi-megawatt-hour systems to be installed on vessels, such as the 70-MWh Ro-Pax ferry proposed by Stena Line. **ST**

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New RV for Denmark

Dansk Dana Konsortium (DDK), set up by Naval Architects KNUD E. HANSEN and Odense Maritime Technology, will design the 68-m multidisciplinary research vessel, RV *Dana V*. This vessel will replace the aging workhorse RV *Dana IV* that has been serving the Danish marine sciences since 1981. The new RV *Dana V* will enter service for DTU Aqua in 2027.

Like the RV *Dana IV*, the new RV *Dana V* will be designed for operations in icy waters in the Baltic and Arctic Seas. The vessel will be classed to Polar Code B, PC 6 and comply with high standards for low-level underwater noise during scientific operations. RV *Dana V* will be designed with the operational efficiency of a modern trawler combined with state-of-the-art multidisciplinary science operations capabilities for marine research. This includes efficient fishing gear configuration and several laboratories. Also, the vessel will be designed for drop keel installation with a large hydroacoustic sensor suite.

On the multi-flex aft deck, a large hydraulic A-frame will be designed for handling various equipment and fishing gear. Smaller cranes will operate from the side of the vessel to handle smaller nets and sampling equipment.

The RV *Dana V* will also have teaching, training and testing facilities. Shipyard tender will be released early 2024, with delivery expected by the end of 2026.

Rising Cost of Invasive Species

Over the past 40 years, the financial losses caused by biological invasions have been equivalent to those caused by natural disasters, such as earthquakes, floods and storms, according to new research published in *Perspectives in Ecology and Conservation*, and these losses are increasing at a faster pace.

Invasive species are a growing problem worldwide. They have caused disastrous consequences for local species and ecosystems, as

well as for human activities: damage to infrastructure, crops, forest plantations, fishing yields, health and tourism. The research showed that from 1980 to 2019, financial losses due to invasive species amounted to \$1208 billion, compared to nearly \$1914 billion in losses caused by storms, \$1139 billion attributed to earthquakes and \$1120 billion due to floods.

These results were obtained using the InvaCost database, which currently lists over 13,500 costs due to biological invasions worldwide. The costs of natural disasters at the global level were compiled using the International Disaster Database and data from NOAA.

To date, investments in preventing and managing biological invasions are ten times lower than the financial losses caused by them. The study's findings imply that action plans and international agreements should be deployed to limit the advance of invasive species, similar to those implemented for natural disasters, the researchers said.

Bottom Pressure Recorders For AMOC Climate Study

The Atlantic Meridional Overturning Circulation (AMOC) is a large system of ocean currents that transports warm surface waters from the tropics northward toward the subpolar and Arctic regions. There, the waters cool, become denser and sink before returning southward at depth. In doing so, this vast "conveyor belt" movement of water is a major factor in controlling global heat distribution, regional sea level changes, the ocean's absorption of carbon and Europe's weather.

To measure the AMOC's impact on our changing climate, scientists from the Scottish Association for Marine Science (SAMS) in Oban have deployed two Sonardyne deep-sea bottom pressure recorders (BPRs), one in the northeast Atlantic and one in the Labrador Sea, to record regular changes in sea surface height. The two Fetch AZA BPRs have been placed thousands

of meters below the sea surface, where they will record sea surface height to the nearest centimeter, giving the researchers a detailed comparison between the two locations. Deployed for up to 10 years, this will allow them to measure changes in the speed and strength of the AMOC, which will provide crucial data to inform climate predictions.

The east side of the Atlantic Ocean is typically around 20 cm higher than the west side, but the flow of the water does not go east to west, as the opposing force of the Coriolis effect from the rotating Earth causes a circular flow in a general south to north movement.

The BPRs will remain on the seabed for up to 10 years, and the data they gather can be transmitted wirelessly through the water to a ship or an uncrewed platform, without the need to recover them.

Gulf of Alaska Ecosystem

The AUVs Gretel and Shackleton transited in the Gulf of Alaska in April, gathering data on ocean conditions: temperature, light, salinity, chlorophyll, fluorescence, and acoustically determined densities of fish and zooplankton. Seth Danielson, a University of Alaska Fairbanks oceanographer, expects this deployment to become a spring ritual.

Shackleton and Gretel made their first transects in the gulf in 2021 and 2022, respectively, repeating the process again this year. With each new data set, Danielson's team expects to better understand how weather and climate affect crucial components of the gulf's ecosystem. The project, funded by the Alaska Ocean Observing System, focuses on conditions that trigger the spring phytoplankton bloom, which itself triggers a feast for the ocean food web. A better understanding of phytoplankton will help fishery managers. Both the timing and species composition of the bloom are linked to the health and size of fish populations. The data could eventually serve as an early-warning system to indicate when fish populations are subject to unfavorable ocean conditions. **ST**

people

Dr. Leila Hamdan, associate vice president of research for coast operations and professor in the School of Ocean Science and Engineering at the University of Southern Mississippi, has been selected to contribute her expertise to the National Academies' 2025 to 2035 Decadal Survey of Ocean Sciences. This survey will advise the National Science Foundation's Division of Ocean Sciences' strategy toward investments in research, oceanographic infrastructure and development of the future ocean science workforce.



West Virginia University graduate **Daniel Price** was chosen as a 2023 Science Communication Fellow sailing aboard Ocean Exploration Trust's (OET) EV *Nautilus* in May and June to explore deep-sea habitats near Kingman Reef and Palmyra Atoll. He engaged with the public via Nautilus Live, a 24-hr. livestreaming web portal bringing expeditions from the field to explorers on shore via telepresence technology at NautilusLive.org and via social media.

The National Ocean Industries Association (NOIA) Board of Directors has reelected **Paul Danos**, owner and CEO of Danos LLC, as NOIA chair for the 2023 to 2024 term. **Jonathan Landes**, president of TechnipFMC's Subsea business, was elected as vice chair for the term.

Steve Feng has joined BIRNS Inc. as financial controller, where he will lead the accounting team and oversee the firm's finances and operational accounting. He will be responsible for developing the annual budget and financial forecasts and for ensuring the fiscal welfare of the company.

The University of Strathclyde's Department of Naval Architecture, Ocean and Marine Engineering Emeritus Professor **Chengi Kuo** has received the Royal Institution of Naval Architects' William Froude Medal for his significant contribution to the field in a career spanning more than 50 years. His areas of expertise include ship safety and stability, the use of computer technology in shipping, and ship support for subsea operations in the oil and gas sector.

Carmine Dulisse has joined PCCI Inc. as president. He most recently served as the president and CEO of the Marine Spill Response Corp., representing one of the largest oil spill response portfolios in the world. Dulisse brings extensive experience in ocean fleet management, including ship chartering, marine safety and marine casualty response management.

The International Marine Contractors Association (IMCA) has chosen **Iain Grainger** to succeed **Allen Leatt** as CEO. Leatt retired in May 2023. Grainger has over three decades of experience in offshore marine construction and was previously an IMCA Board member. He has been leading IMCA's energy transition initiatives.

The American Association of Port Authorities (AAPA) Board of Directors has unanimously elected **Paul Anderson**, president and CEO of Port Tampa Bay, as chairman of the 111-year-old association. Anderson is a former presidential appointee to the Federal Maritime Commission.

Unique Group has appointed **Sahil Gandhi** as CEO, succeeding **Himanshu (Harry) Gandhi**, who is now chairman. Sahil has been Unique Group's COO since 2017, leading its rapid growth, diversifying its portfolio with unmanned survey technology and initiating digitization for operational excellence.

Hill's Newport News Shipbuilding division has promoted three leaders to the senior leadership team. **Rob Check** will become vice president of in-service aircraft carrier programs; **Thomasina Wright** will become vice president of fleet support programs; and **Les Smith** will become vice president of *Enterprise* (CVN-80) and *Doris Miller* (CVN-81) aircraft carrier programs. **ST**

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ABB, Fornebu, Norway, will deliver integrated bridge-to-propeller technology for Havfram Wind's two new NG20000X-HF wind turbine installation vessels. They will be able to install offshore wind turbines with a rotor diameter exceeding 300 m and XXL monopiles weighing up to 3,000 tons at up to 70-m depth. Yantai CIMC Raffles Offshore Ltd.

WinGD, Winterthur, Switzerland, has signed a memorandum of understanding to enter into a partnership for ammonia-fueled vessels. WinGD will apply its X-DF-A ammonia-fueled engines to a range of vessel designs, with Mitsubishi designing the vessels and completing the fuel chain with its ammonia fuel supply system. Mitsubishi Shipbuilding Co. Ltd.

Shift Clean Energy, Vancouver, Canada, has a new channel partner agreement to expand the distribution of Shift's energy storage systems to help decarbonize the marine industry in South Korea. S&SYS.

Northland Power, Toronto, Canada, will use the Autonomous Surveyor USV and A.IKANBILIS hovering AUV (HAUV) for offshore wind foundation survey and inspection. The USV will conduct multibeam echosounder surveys to monitor the interarray cable routes and potential scouring at the foundations. The HAUV will conduct general visual inspections of the foundations, from water level to the seabed. Subsea Europe Services.

DNV, Oslo, Norway, will collaborate to assess the safety, compliance and sustainability aspects of current and future fuels and technologies, from both a technical and operational standpoint, for jack-up barges and offshore support vessels. Zakher Marine International.

The UK Hydrographic Office (UKHO), Taunton, U.K., has signed new memorandums of understanding to improve the supply, manage-

ment, and sharing of hydrographic and marine data. Port of London Authority and Peel Ports Group. **ST**

meetings

Note: The coronavirus (COVID-19) pandemic could affect event dates. Check event websites for the latest updates.

SEPTEMBER

September 6-8—Fleet Maintenance & Modernization Symposium, San Diego, California. www.navalengineers.org/Symposia/FMMS2023.

September 11-15—London International Shipping Week, London, U.K. <https://londoninternationalshippingweek.com>.

September 12-13—International Antifouling Conference, Gothenburg, Sweden. <https://antifouling-conference-2023.confetti.events>.

September 18-20—FWS – South America Offshore Wind, Rio de Janeiro, Brazil. andrew.chadder@questfwe.com or <https://fws.southamerica.com>.

September 18-22—National Marine Electronics Association (NMEA) Conference & Expo, Orlando, Florida. 410-975-9425, mreedenaer@nmea.org or www.nmea.org.

September 25-28—OCEANS 2023 Gulf Coast, Biloxi, Mississippi. <https://gulfcoast23.oceansconference.org>.

September 27-28—Unmanned Maritime Systems Technology USA Conference, Arlington, Virginia. www.smgconferences.com/default/northamerica/umst-usa.

OCTOBER

October 3-5—International Boat-Builders' Exhibition and Conference, Tampa, Florida. www.ibexshow.com.

October 18-20—NOIA 2023 Fall Meeting, Amelia Island, Florida. www.noia.org/event/noia-2023-fall-meeting.

October 22-25—AAPA Annual Convention & Expo, Aurora, Colorado. <https://aapa.getregistered.net/2023-annual-convention-and-expo>.

October 24-27—WISTA International AGM and Conference, Montevideo, Uruguay. <https://wistainternational.com/event/2023-wista-international-agm-conference>.

NOVEMBER

November 7-9, CLEAN GULF—San Antonio, Texas. www.clean.gulf.org.

November 13-16—BlueTech Week, San Diego, California. info@tmablue-tech.org or <https://tmablue-tech.org/bluetech-week>.

DECEMBER

December 3—Naval Power Egypt, Cairo, Egypt. www.navalpower.egypt.com.

December 4-6—AAPA LATAM Convention of Ports, Barranquilla, Colombia. <https://aapa.getregistered.net/latam-convention-of-ports>.

December 4-6—Marine Renewables Canada Conference, Ottawa, Canada. <https://marinerenewables.ca/event/marine-renewables-canada-2023-conference-december-4-6-in-ottawa>.

2024

FEBRUARY

February 26-29—Blue Innovation Symposium, Middletown, Rhode Island. <https://blueinnovationsymposium.com>.

NOVEMBER

November 4-7—EURONAVAL, Paris-Nord Villepinte, France. www.euronaval.fr.

For more industry meetings, visit sea-technology.com/meetings. **ST**

Let's Create a Global High Seas Marine Preserve—Danny Quintana

Danny Quintana is the founder and president of the Global High Seas Marine Preserve (www.savingoceans.org), a nonprofit created using research from his book *"Space and Ocean Exploration: The Alternative to the Military Industrial Complex."* He is an attorney, a member of the Mars Society, a wheelchair tennis player, father and grandfather. He has delivered wheelchairs internationally for the Mobility Project.



Prior to 1950, the oceans were full of wildlife, coral reefs were healthy, and sharks were not in danger of being hunted to extinction for their fins. There was somewhat of a balance between man and nature.

That has all changed as mass advertising has shifted consumer food habits, government subsidies support industrial commercial fishing, and industrial trawlers move through the ocean. Seafood has become a popular food choice in the developed world, at great expense to the ocean's wildlife.

The scientific data are grim, and those of us who care about the environment are aware of the bleak outlook. At least 90 percent of the large predators, such as blue fin tuna, marlin and sailfish, has been slaughtered, and over 50 percent of the ocean's wildlife has been killed off since 1950. Coral reefs are being destroyed by unsustainable human activities, such as overfishing and using dynamite to fish. Human activities are also influencing climate change, which impacts the ocean. In addition, pollution is an ongoing disaster as garbage continues to be dumped into the ocean.

Despite the magnitude of the problems, there are solutions. One partial solution is for consumers in rich countries to give the ocean a break by becoming more conscious of the source of our food. If seafood is not caught in a country's exclu-

sive economic zone, don't buy it. By eating locally, sustainably and more plant based, we can improve our health and maritime sustainability through diet.

From a policy angle, concerned nonprofits and government officials have achieved something remarkable with the 30 x 30 initiative that could soon become international law. This initiative calls for protection of 30 percent of the ocean by 2030. This is a much needed start in the right direction. But it is not enough to solve our massive global environmental problems. The 30 x 30 initiative to protect the ocean is 70 percent short of the goal. We need to protect 100 percent of the ocean, and we need to do so immediately.

The ultimate solution for saving the ocean from more harm is to swiftly amend the UN Law of the Sea Treaty to create a global high seas marine preserve. The United States has been a leader in responsible ocean conservation, and the country's efforts can serve as a guiding light for international marine protection. For example, the bipartisan Magnuson-Stevens Fishery Conservation and Management Act of 1976 that has been renewed and updated over the years is a shining example of stewardship that works to protect marine resources. Extending protection like this to the entire ocean with a global high seas marine preserve is the next major step to solve pressing environmental problems.

Overfishing, shark finning and dumping garbage into the ocean would be banned globally under a global high seas marine preserve. Think of it as the creation of a global wildlife park. The scientific data are clear that marine preserves work. Fisheries can recover when overfishing and dumping garbage are prohibited. Currently, less than 8 percent of the ocean is protected. By protecting the whole ocean, we

can turn this global environmental crisis around. We are running out of time. By 2050 the global fisheries will collapse given the current rate of extraction based on our food choices.

If we shop and eat responsibly, we can protect the ocean, and our children and grandchildren can experience incredible wildlife and still be able to eat seafood. You can help stop the destruction by being conscious of what you buy and what constitutes your diet.

I founded the Global High Seas Marine Preserve nonprofit to help educate people about ocean wildlife issues. The idea of a global high seas marine preserve originated from the research for one of my books, called *"Space and Ocean Exploration: The Alternative to the Military Industrial Complex."* The book provides an economic blueprint for demilitarizing the global economy in the service of exploration to benefit humankind. As I was doing this research, I learned about the massive problems facing the ocean. I discovered that half of the wildlife in the oceans has been slaughtered. We are killing approximately 200,000 sharks each day for shark fin soup. Coral reefs are in major trouble with excessive resource extraction and a warming climate. Furthermore, we dump approximately 15 million tons of garbage into the oceans every year.

Saving Oceans is trying to educate the public about ocean conservation by funding internships for college students. You can help the efforts to protect the entire ocean by spreading the idea of a global high seas marine preserve.

The 30 x 30 initiative is a great start, and congratulations are owed to the High Seas Alliance and the numerous others that helped achieve this important accomplishment, but it's not enough. Let's build on it and go the other 70 percent of the way to protect 100 percent of the ocean. **ST**

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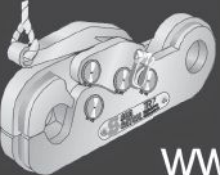
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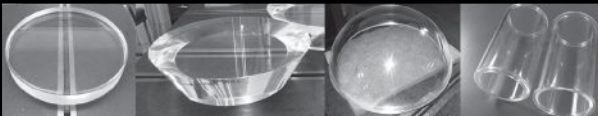
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Remote Ocean Systems (ROS)..... www.rosys.com	38
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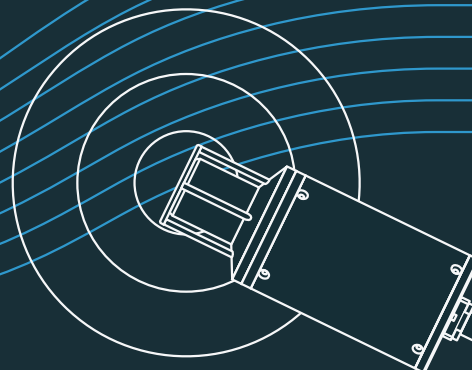


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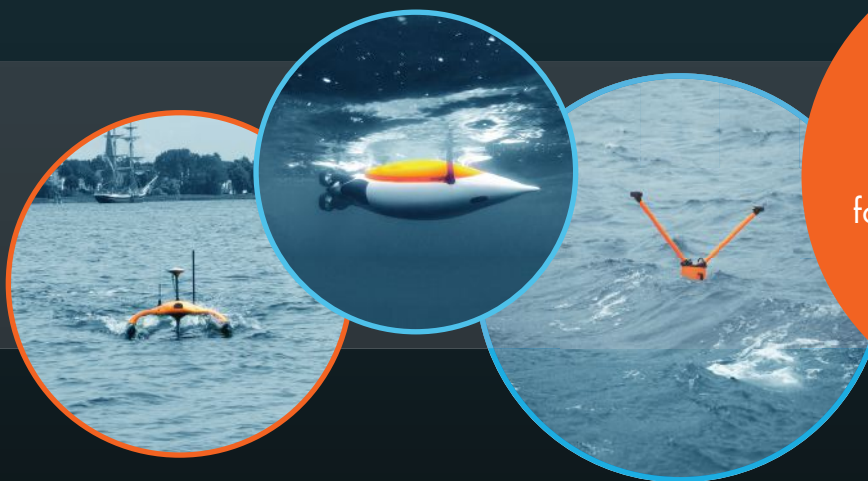
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