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APRIL 2022

**OFFSHORE TECHNOLOGY
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FEATURING:

Geodata Engagement Platform

Fiber-Optics in Aquaculture

Electricity from Water



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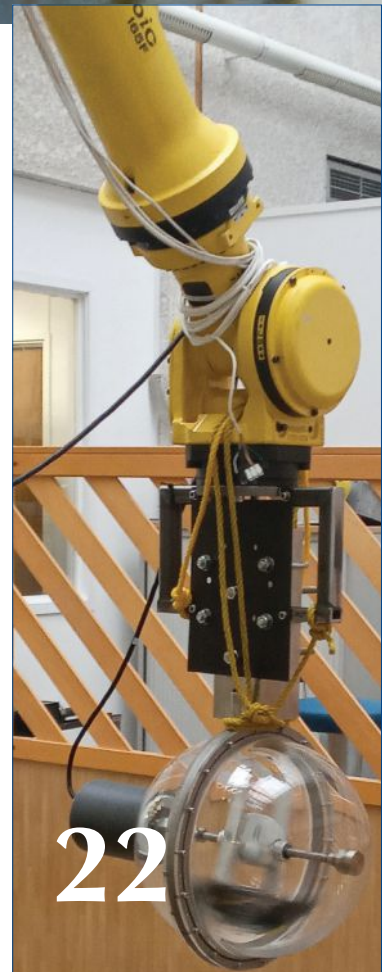
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A bird's-eye view of Ocean Farm 1. See story on p. 14. (Credit: SalMar)

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)) Critical Relationship Between Digitalization and Sustainability, ABB Study Finds. ABB has released the findings of a new study of international business and technology leaders on industrial transformation, looking at the intersection of digitalization and sustainability. The study, “Billions of better decisions: industrial transformation’s new imperative,” examines the current take-up of the Industrial Internet of Things (IoT) and its potential for improving energy efficiency, lowering greenhouse gas emissions and driving change. The goal is to spur discussion within industry on opportunities to leverage the Industrial IoT and empower companies and workers to make better decisions for both sustainability and the bottom line. The study, commissioned by ABB, found that an organization’s “future competitiveness” is the single greatest factor, cited by 46 percent of respondents, in industrial companies’ increased focus on sustainability. Yet while 96 percent of global decision makers view digitalization as “essential to sustainability,” only 35 percent of surveyed firms have implemented Industrial IoT solutions at scale. This gap shows that while many of today’s industrial leaders recognize the important relationship between digitalization and sustainability, the adoption of relevant digital solutions to enable better decisions and achieve sustainability goals needs to accelerate in sectors such as manufacturing, energy, buildings and transport. Among other key findings of the study are: 71 percent of respondents reported greater priority given to sustainability objectives as a result of the pandemic, and perceived cybersecurity vulnerabilities are the number one barrier to improving sustainability through the Industrial IoT.

)) France Extends Marine Protections in Indian Ocean. France has announced that it will expand marine protections by about 1 million sq. km (386,102 sq. mi.) in the southern Indian Ocean. French President Emmanuel Macron declared the new conservation measures at the One Ocean Summit in Brest, France. The move adds protections around Saint-Paul and Amsterdam Islands, the Kerguelen Islands, and the Crozet Islands, which are all part of the French Southern and Antarctic Lands, an overseas territory that is home to a richly diverse wildlife community. The expansion makes the waters around the three archipelagos the largest marine protected area in French waters by far, representing about 15 percent of the country’s global exclusive economic zone (EEZ). The Southern Lands marine reserve will include a new highly protected area surrounding Saint-Paul and Amsterdam Islands and covering about 255,000 sq. km (98,500 mi.), where all extractive activities, such as industrial fishing, will be prohibited. The added area will more than double the percentage of French waters that are highly protected, from 1.6 to 4 percent, but still leaves the country with a challenge of reaching its goal of highly protecting at least 10 percent of its waters by the end of this year. Science shows that highly protected areas provide the most significant ecological benefits.

)) Seafood Risk Tool Supports Sustainable Aquaculture. Scientists have developed a new way to identify and reduce the impact of chemicals and diseases in global aquaculture. Aquaculture already provides about half of all seafood consumed by humans, and by 2050 it is expected to provide as much as 70 percent. In 2020 seafood consumption reached an all-time high, and sustainable aquaculture is playing a vital role in this “blue food” revolution. In a new paper in *Nature Food*, scientists from Cefas (Centre for Environment, Fisheries and Aquaculture Science) in the U.K. and the University of Exeter describe a Seafood Risk Tool to support the development of sustainable aquaculture. Aquaculture, the farming of fish, molluscs, crustaceans, other animals, seaweeds and plants in rivers, lakes, seas and oceans is ranked among the fastest growing and highly traded global food sectors. It is rooted within higher relative efficiencies of production of aquatic protein compared to many land-based alternatives and the potential benefits of eating aquatic protein as part of a healthy and nutritious diet. Inevitably, alongside this expansion has come calls to ensure adequate sustainability is designed into the sector, with due attention paid to protection of health and welfare of organisms on the farm, the environment in which the farm occurs and the consumers of seafood. The “One Health Aquaculture” approach, previously described by the research team, proposes that such a balance must be urgently factored into local and international plans to expand the sector. The Seafood Risk Tool calculates the combined impact of these complex hazards on seafood supply chains and demonstrates how impacts can be minimized by government, industry and even the consumer.

)) Latest IPCC Report Warns of Unavoidable Climate Hazards. Human-induced climate change is causing dangerous and widespread disruption in nature and affecting the lives of billions of people around the world, despite efforts to reduce the risks. People and ecosystems least able to cope are being hardest hit, said scientists in the latest Intergovernmental Panel on Climate Change (IPCC) report. The world faces unavoidable multiple climate hazards over the next two decades with global warming of 1.5° C (2.7° F). Even temporarily exceeding this warming level will result in additional severe impacts, some of which will be irreversible. Risks for society will increase, including to infrastructure and low-lying coastal settlements. The Working Group II report is the second installment of the IPCC’s Sixth Assessment Report (AR6), which will be completed this year. This report provides new insights into nature’s potential not only to reduce climate risks but also to improve people’s lives. Scientists point out that climate change interacts with global trends such as unsustainable use of natural resources, growing urbanization, social inequalities, losses and damages from extreme events, and a pandemic, jeopardizing future development. **ST**

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Accelerating Innovation In the US Pacific Northwest

The maritime industry is ripe for disruption. While the industry tends to be conservative, the ecosystem is starting to take notice of start-up companies that would like to bring efficiency to ports and port operators who are finding themselves overwhelmed, especially during the pandemic. Port activities show that we are not making the most of the latest technologies to move commerce faster.

Maritime Blue aims to facilitate innovators looking to move the U.S. Pacific Northwest region's maritime industry to the next level. Born out of the Washington State Commerce Department, Maritime Blue helps build innovation clusters throughout the state and region in order to connect resources, industry partners and collaborators. These collaborations result in, for example, more efficient ferries through Puget Sound and sustainable platforms to protect our most vulnerable sea-based population.

The Maritime Blue Innovation Accelerator is a mentor-based program to help early-stage innovators grow their businesses, culminating in a showcase that gives ecosystem partners a chance to connect and, in some cases, fund these start-ups. Founders have a path forward as they look at how their businesses can grow at scale.

Since the program began in 2020, the Maritime Blue Innovation Accelerator has helped more than 20 companies connect with new customers, partners and investors. These companies have gone on to raise millions in venture funding and to create hundreds of jobs for the state and region.

The founders from different cohorts of the Maritime Blue Innovation Accelerator have also connected with each other to grow their businesses and create lasting partnerships, such as the one between Pure Watercraft and Silverback Marine. They recently won a grant to help the Port of Lopez build an all-electric pump-out vessel. Delivery is expected by the end of the year.

While this collaboration is an example of how two companies can achieve big things for our region, some partnerships are smaller and take more time to realize big successes. We facilitate this process through platforms such as Slack, which connects all of the companies that have gone through our program past and present. This platform is invaluable to help founders bounce ideas off each other, vent frustrations and talk about their collective journeys.

While COVID-19 did a lot to keep our founders physically apart—last year's program was completely virtual—founders still managed to connect with and help each other. With COVID cases starting to decrease, we are bringing some of the founders from our latest cohort to our offices to further facilitate collaboration and help companies build long-lasting relationships.

As we look to the rest of the year and beyond, one thing is becoming clear: The more we work together as a community to help these founders, the more the state and the region will reap the rewards. We know that early-stage companies can become the next big job creators if we do our part to help connect them with the tools they need to take their businesses to the next level. Through our partnerships with organizations including the Port of Seattle, Washington Department of Commerce, Boatsetter and Ericsson, we are growing a unique cluster organization.

We are excited to look forward while reflecting on the tremendous impact the program has already made for the founders, their partners and the state. With over 300 jobs being created and over \$200 million in venture funding so far, we've only just begun. We are thrilled for this latest cohort, which includes companies providing training to diversify the maritime workforce. We are proudly part of this rising tide of innovation and community. **ST**

SEA TECHNOLOGY® 2022

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JANUARY

Annual Review & Forecast

**OCEANS 2022 Chennai, February 21-24, Chennai, India

FEBRUARY

Instrumentation: Measurement, Processing & Analysis

**Oceanology International, March 15-17, London, Excel, U.K.

MARCH

Electronic Charting/Vessel Management/
Ports & Harbors/Dredging/Homeland Security

**AUVSI XPONENTIAL 2022, April 25-28, Orlando, FL

APRIL

Offshore Technology/Alternative Energy & Ocean Engineering

**Offshore Technology Conference, May 2-5, Houston, TX

MAY

Communications, Telemetry, Data Processing

**Undersea Defence Technology (UDT), June 7-9, Rotterdam, The Netherlands

**EUROMARITIME, June 28-30, Marseille, France

JUNE

Seafloor Mapping/Sonar Systems/Vessels

**Sea Technology supports these shows via media partnerships.

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22

Editorial Calendar

UE DATE

JULY

Deck Gear, Cable, Connectors, Power Systems & Salvage

***CLEAN PACIFIC 2022*, August 23-24, Renton, Washington

AUGUST

Geophysical Exploration/Seafloor Engineering

***IMAGE '22*, August 28-September 2, Houston, TX

SEPTEMBER

Ocean Resources Development & Coastal Zone Management

***OCEANS 2022 Hampton Roads*, October 17-21, Virginia Beach, VA

***EURONAVAL*, October 18-22, Paris, France

OCTOBER

Environmental Monitoring, Remote Sensing & Pollution Control

***CLEAN GULF 2022*, November 8-10, New Orleans, Louisiana

***Offshore Energy 2022*, November 29-30, Amsterdam, The Netherlands

NOVEMBER

Undersea Defense/Antisubmarine Warfare

DECEMBER

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Embracing Digital Transformation

Geodata Engagement Platform Aids Offshore Wind Development

By Kathryn Rovang • Deanne Hargrave • Shannon Earl

The energy transition is in full swing along the Atlantic Outer Continental Shelf. Seventeen projects in various phases of development now dot the U.S. Eastern Seaboard, from Maine to North Carolina. One of these projects, by New Jersey-based Atlantic Shores Offshore Wind LLC (Atlantic Shores), recently met a major development milestone with submission of its construction and operations plan (COP) to the U.S. Bureau of Ocean Energy Management (BOEM), which regulates offshore energy development in federal waters.

In addition to advancing their project with this formal proposal, Atlantic Shores is also helping to advance the offshore wind industry. Its COP is the first one to supplement required static hard-copy maps and reports with live digital deliverables. Made available to BOEM through an innovative web-based geodata platform called Gaia.Hub, this lead-by-example embrace of digitalization supports multiple industry goals, including faster regulatory review, increased transparency and improved public trust.

Big Project, Big Data

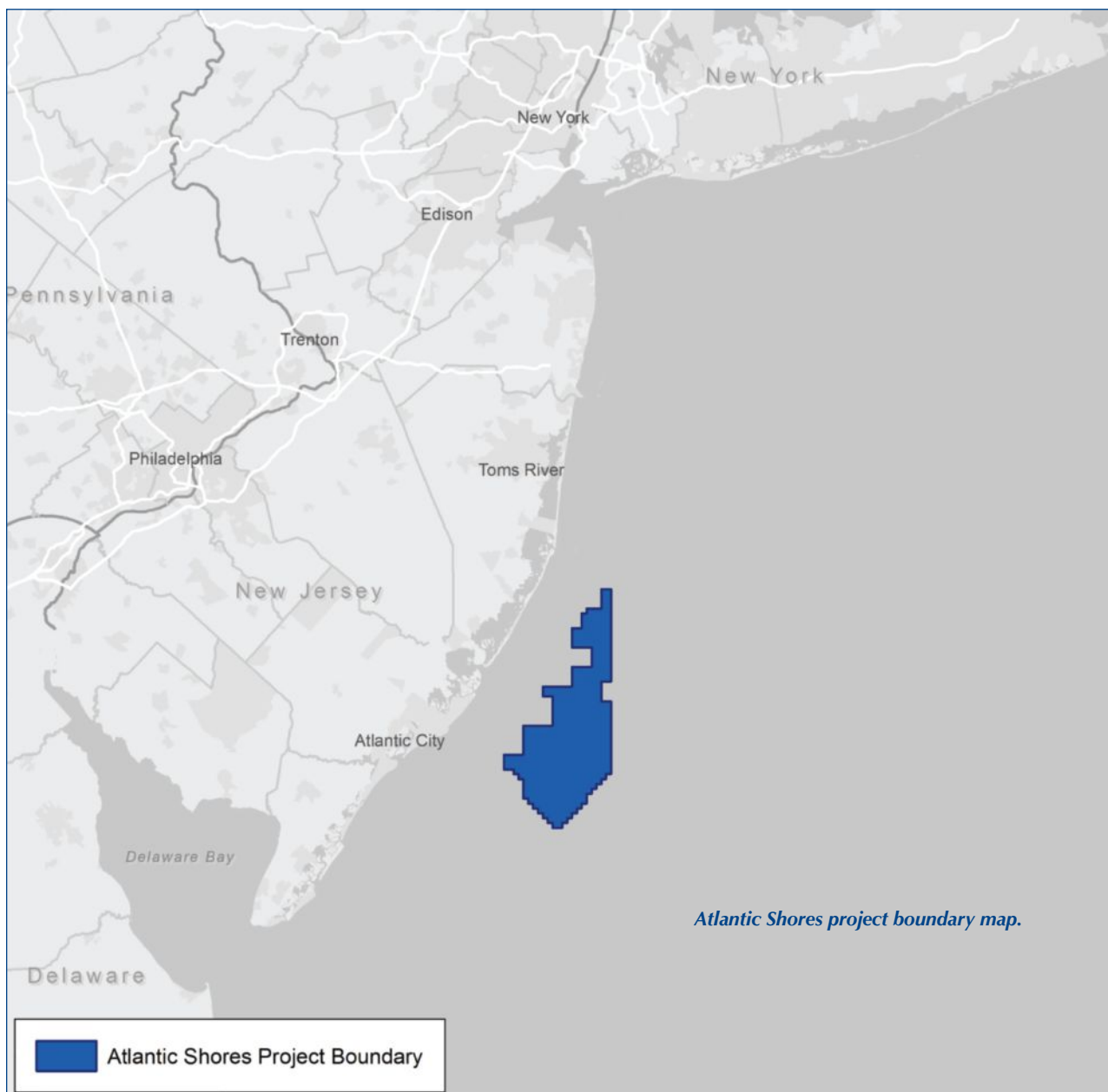
The Atlantic Shores lease area spans 740 sq. km and is located 10 to 20 mi. off the coast of New Jersey between Atlantic City and Barnegat Light. The company's first project is expected to supply 1,510 MW of offshore wind energy to over 700,000 homes. It is the single largest offshore wind project in New Jersey to date, and one of the biggest in the nation. Construction is targeted for

2024, with energy delivery by 2027. In terms of assets, this first project will comprise up to 111 wind turbine generators, two offshore substations, and hundreds of kilometers of export and interarray cables buried 2 m below the seabed.

Developing an offshore wind farm project of this size and scope requires a massive amount of geodata that must be integrated and communicated to an ever-growing audience of stakeholders. Operators, contractors and



Fugro collects geodata for Atlantic Shores Offshore Wind off the coast of New Jersey.



regulators alike can quickly become bogged down by the volume and complexity of these information assets—especially when they are locked in multiple, siloed systems that challenge contextual decision making and limit operational insights.

To improve the data delivery and discovery experience, Atlantic Shores worked with Fugro, a global geodata specialist and years-long contractor on the project, to apply its Gaia.Hub solution.

Answering the Geodata Challenge

Gaia.Hub is Fugro's cloud-hosted, web-based geodata engagement platform for accessing geospatial data and documents throughout the project life cycle. Evolving with the project, Gaia.Hub provides a single source of information for the project team and its stakeholders, allowing users to access geodata at any time, from any location in a simple, intuitive website.

Within a singular interface, Gaia.Hub provides a clear overview of the various types of geodata visualized in a spatial context, linked with associated documents. From this platform, users can readily access the project's evolving ground model, latest wind farm layout, site constraints, final geodata locations, processed data sets and interpretive results in one interface.

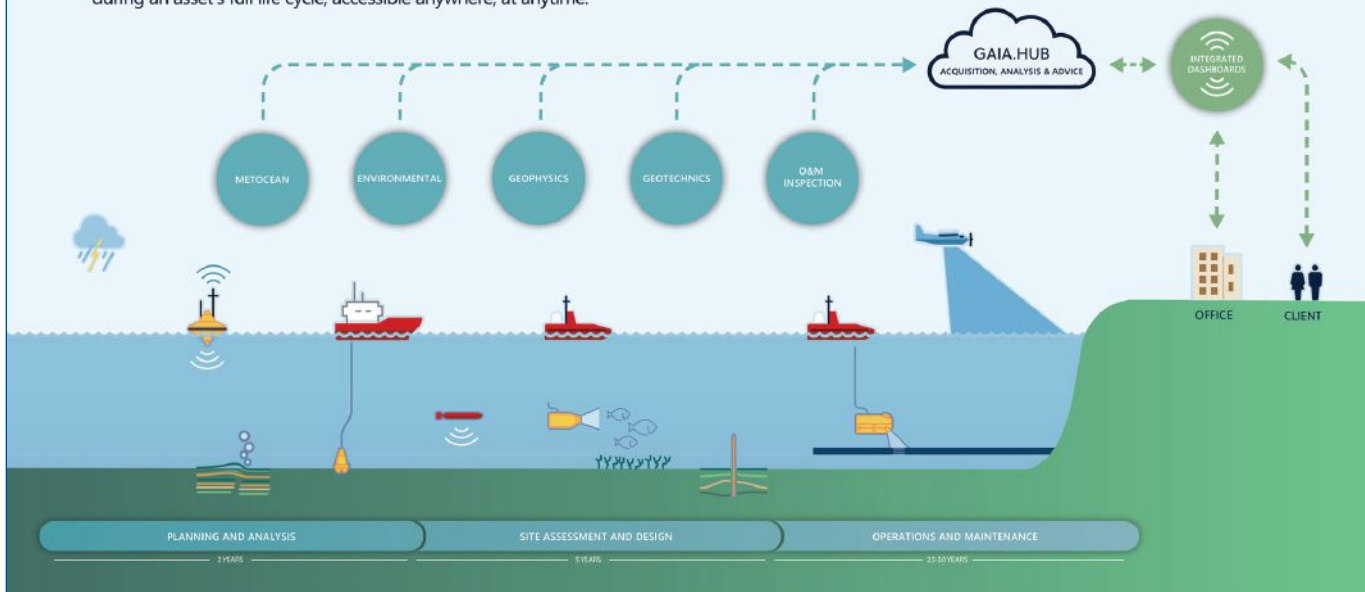
Gaia.Hub for Atlantic Shores

Fugro began building the Atlantic Shores Gaia.Hub solution in April 2021 to support the COP. The system was designed to integrate public data sets and historical project data with new information being developed during ongoing field programs. As such, the platform enables real-time tracking of the site characterization effort, along with an updated digital twin of the project's developing ground model.

Gaia.Hub currently stores an impressive progression

Gaia.Hub

A cloud hosted Geo-data engagement platform that provides insights during an asset's full life cycle, accessible anywhere, at anytime.



Fugro's Gaia.Hub, a life-cycle solution for geodata management.

of geodata development, the highlights of which are summarized in the following timeline of activity:

2019: Reconnaissance surveys in support of seabed clearance of obstructions and buried archaeological resources for the installation of metocean buoys. Prior to this glance at the seabed, Atlantic Shores relied on nautical charts and limited public domain data of low-resolution bathymetry; historical seismic and sampling surveys; regional geomorphology; and charted wrecks, obstructions and submarine cables for preliminary site understanding.

2020: Site characterization of the planned wind turbine corridors and export cable routes, with acquisition of high-resolution geophysical and geotechnical data to: develop a baseline for the soil stratigraphy and unitization for turbine foundations; determine the conductive properties of the shallow soils and understand the chemical effects of the soil-cable interface; identify areas more susceptible to scour or sediment mobility; and understand the native benthic environment at proposed infrastructure sites.

2021: Continued site characterization activities with additional high-resolution geophysical and geotechnical data acquisition and testing, this time with a focus on potential interarray cable lay areas and extension and re-routes of the export cable corridors. The additional geophysical information allowed a more complete mapping of the subsurface data, particularly the extent of buried channels that could have implications on the strengths of the shallow soils as infrastructure is installed. The addi-

tional geotechnical samples and lab tests characterized the soil profiles on the order of weakest to strongest in terms of soil behavior under loading to understand the ground risk and optimal design.

To put this work in perspective, over the span of 2.5 years, these environmental, geophysical and geotechnical surveys and assessments covered over 485 sq. km of seabed, producing 45 terabytes (TB) of raw and processed geophysical data, 9,800 onshore and offshore lab tests, 550 min. of benthic video, and daily wind and wave measurements from two LiDAR buoys. All of this information now resides in and is being managed through Gaia.Hub, with users accessing the data from interactive spatial displays to make informed decisions earlier in the development process.

Concrete examples of how Gaia.Hub supports faster project decision making include: the avoidance of magnetic anomalies, obstructions and geohazards during data acquisition; the rerouting of cables and adjusting of wind turbine locations in a single work season; the reduction of survey operations in unfavorable areas; the optimization of geotechnical investigations to target challenging stratigraphy; and the adjustment of acquisition programs while survey work was ongoing. By employing Gaia.Hub early in the design phase, users benefit from the full picture of information.

High Engagement, Meaningful Returns

The Atlantic Shores Gaia.Hub site has become a well-utilized tool among the project team and its contractors. In fewer than nine months, the site has provided over 200 users access to over 45 TB of geodata and more than 11,000 documents and supporting files. These files, which are linked to discrete seabed locations, include



(Top) Data interaction within Fugro's Gaia.Hub solution. (Bottom) Atlantic Shores provided BOEM access to its Gaia.Hub site to supplement its construction and operations plan submission.

istration issuing a goal to reach 30 GW of installed wind energy by the year 2030.

Meeting this aggressive target will require all parties—operators, contractors and regulators—to operate at maximum efficiency. The Atlantic Shores Gaia.Hub solution is an important step in this direction, accelerating the pace of project development through highly coordinated field programs that can adjust based on real-time geodata and supplementing static, hard-copy reporting deliverables with access to source project geodata to allow faster regulatory review.

By making large data sets available through streaming, and complex data sets accessible through intuitive dashboards and web-based applications, Gaia.Hub allows regulators to view and manipulate the same information as project engineers, which increases transparency, builds public trust and hopefully leads to streamlined review and construction. **ST**

Kathryn Rovang is a senior geoscientist/GIS analyst for Fugro, responsible for the implementation and administration of the enterprise GIS environment, including product engineering and development for client delivery solutions. She is also involved with marine site characterization projects that include the integration of geodata to evaluate engineering constraints and geohazards.

Deanne Hargrave is the geoscience manager for Atlantic Shores Offshore Wind, a joint venture between EDF Renewables and Shell Renewables Energy Solutions. She is a recognized expert in marine shallow hazards and offshore development surveys, with 20-plus years of experience. Hargrave serves on the NOAA Hydrographic Services Review Panel and on several Society for Underwater Technology working groups, and is the Hydrographic Society of America's vice chair for the Mid-Atlantic Chapter.

Shannon Earl is a marketing and public relations manager for Fugro. With 25 years of industry experience, she writes frequently about marine technologies, the energy transition, and Fugro's involvement in two global ocean sciences initiatives, the United Nations Decade of Ocean Science for Sustainable Development and The Nippon Foundation-GEBCO Seabed 2030 Project.

geotechnical logs, prognosis charts, sample photos, sample videos, final reports, seismic images, etc.

The growing user group for the Gaia.Hub site includes project managers, geotechnical engineers, marine archaeologists, geoscientists, biologists, ecologists, foundation engineers, cable engineers and offshore field crew. As of January, BOEM staff have also joined the user community and can now directly access source geodata related to BOEM's hardcopy COP reporting requirements.

Advancing Industry Goals

As one of the world's largest energy markets, the U.S. offers much offshore wind potential, but so far it only has two wind farms in operation, producing less than 50 MW of energy. Current U.S. policy aims to significantly increase these energy resources, with the Biden Admin-

Offshore Aquaculture

Verifying New Fish Farm Designs with Fiber-Optics

By Ernad Sehic

Lack of space for more freshwater and coastal marine sites, new legislation and growing demand for more fish and seafood production globally are driving the creation of innovative fish farm designs for deeper offshore waters. The transition to so-called “exposed aquaculture” is not without difficulty, with the frequency and severity of structural fatigue caused by the impact of inclement weather and high seas firmly at the top of the design criteria for proposed new fish farms, including the world’s first such offshore facility, Ocean Farm 1.

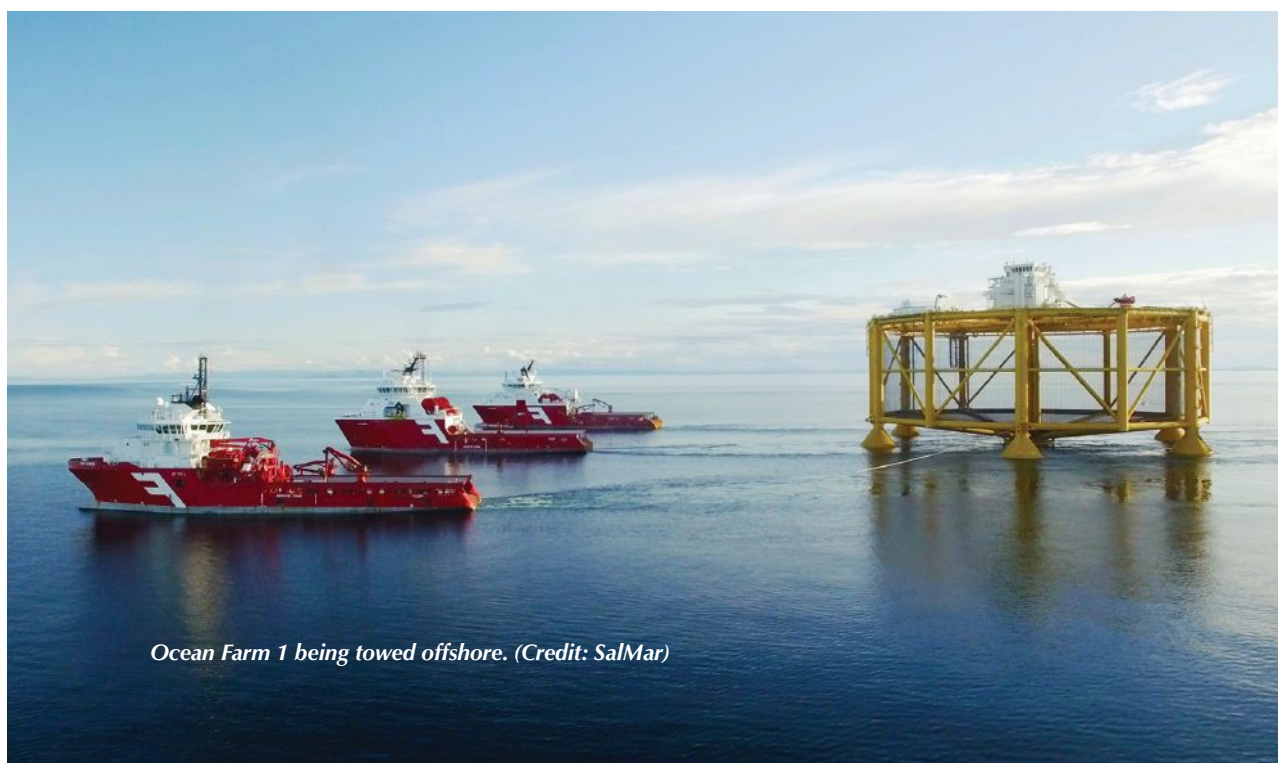
Making its debut as the first-ever offshore fish farm in 2017, at 68 m high with a diameter of 110 m and

250,000 m³ volume, Ocean Farm 1 is a full-scale pilot facility designed to verify the biological and technological aspects of offshore fish farming.

Located in open water near Frohavet on Norway’s west coast, it has already demonstrated that the “exposed fish farm” concept introduces tangible benefits to the aquaculture workflow, not least with the ability to raise healthier fish due to the continuous flow of water an offshore location enables.

Offshore Pilot Facility

Having partnered with Ocean Farming AS, the operat-



Ocean Farm 1 being towed offshore. (Credit: SalMar)



(Above) Ocean Farm 1 lowered into the water. (Credit: SalMar) (Below) Sensor installation on Ocean Farm 1. Sixteen high-precision fiber-optic sensors from Light Structures' SENSFIB technology range have been installed on site. (Credit: SalMar)

ing company established by Norway-based SalMar ASA, since the very beginning of the Ocean Farm 1 development project, Norwegian maritime classification society DNV has played an integral role within key technology, engineering and regulatory workflows.

The DNV team leveraged expertise in developing systems, solutions and regulatory frameworks for offshore energy production, but a huge amount of applica-

tion-specific innovations and processes were needed to ensure safety and efficiency in the building and operation of Ocean Farm 1.

With the main goal of any fish farm to have a large, safe volume of water where fish can be produced, new structures designed for offshore aquaculture are far removed from their counterparts in the offshore energy sector. As the first structure of its kind, Ocean Farm 1



A bird's-eye view of Ocean Farm 1. (Credit: SalMar)

development was undertaken using limited information and experience on the impact of the increased motion and load caused by the offshore environment. Thus, SalMar designated Ocean Farm 1 as a pilot facility. Its operation to date has returned significant data that have contributed to a greater understanding of how to deal with structural loads that a standard fish farm would never encounter. The data lead to Ocean Farm 1 updates and the development of new exposed fish farm concepts.

But there is still a lot more to learn. In order to provide more precise structural stress and fatigue data for life-cycle research conducted by DNV, SalMar tasked structural measurement specialist Light Structures to deliver a customized monitoring system using its SENSFIB technology in August 2021.

The new system is based on fiber-optic technology that applies the fiber Bragg grating (FBG) methodology to introduce more granularity than traditional electromechanical systems. Sixteen high-precision fiber-optic sensors from Light Structures' SENSFIB technology range have since been installed on Ocean Farm 1.

The decision to use this unique alternative to traditional electromechanical structural monitoring was made based on the better accuracy, dependability and adaptability of FBG, as well as DNV's previous experience of hull stress and fatigue monitoring with Light Structures. Through the use of SENSFIB technology, DNV is now working to improve knowledge of fatigue-sensitive areas and how this contributes to making inspection

plans that reduce the risk of fatigue damage and the cost of inspections.

Fatigue and Overloading

Having already contributed significantly to, e.g., concept evaluations, defining the regulatory framework, verification and certification of the structure and mooring system, and class uptake, DNV is well placed to extract value from the SENSFIB data in a study that is vital not just for the future of Ocean Farm 1 but for the future of offshore fish farming.

DNV's workflows and processes, which are enabled in part by the improvement in structural load data, include a risk-based inspection plan for the steel structure and upgrades to the measured response.

When measuring integrity and reliability, SENSFIB data can help to reveal the conditions of a structure and potential damage sources, fatigue cracking and overloading that could cause yielding, buckling and rupture. The data can also help with supporting aspects, including, for example, operating within safe limits and safe weather windows.

These insights are related to maintenance and safety, but the same data may also be useful to provide input to surveys for inspection planning of scope, extent and focus. For example, a single extreme event may reveal the need for an immediate inspection, while generally low and favorable conditions may justify extended survey intervals.

Securing Dependable Stress Data

Considering that traditional electromechanical measurement systems are more prone to failure in the maritime environment, Light Structures uses FBG to offer a more dependable data stream for its clients. SENSFIB is deployed on more than 300 vessels/platforms globally.

FBG sensors are small and intrinsically safe, so they can be installed practically anywhere, including vessels and hazardous zones covered by ATEX (explosive environment) regulation. They are also immune to electromagnetic interference for reliability, and because FBG systems measure the wavelength of light, they provide the most accurate stress measurements possible.

While each installation is an in-depth custom project led by Light Structures' experts based on the specific monitoring requirements of the customer, SENSFIB's fiber-optic stress monitoring sensors are practically fit and forget. They need no recalibration, and the maintenance burden is much lower than alternative systems because there are no moving parts. Importantly, no welding is needed for installation, which further lowers ownership costs and enables easier expansion to include, e.g., fatigue monitoring in the water line and bow sensors for ice load monitoring.

Integrated Data Challenges

While classification society interest in structural stress monitoring continues, there are currently no regulations

demanding its use on special platforms such as Ocean Farm 1 or on ships of any size or specific structural loading risk. However, there are already rules for inspections based on condition monitoring of structures for offshore units and floating wind turbines, which may be applied to fish farms. They take a quantitative risk-based approach combining sensor data with design models to help define inspection intervals for critical details subject to non-destructive testing. This is mainly related to fatigue cracking but potentially also overloading. Corrosion and other damage modes need to be covered by other approaches.

Reflecting the potential to combine and integrate disparate data sets, DNV's Veracity cloud platform has become an important aspect of Ocean Farm 1's structural monitoring in recent months. SENSFIB data are sent to Veracity once per day, where they are stored safely and can easily be shared with DNV, SalMar engineers or third-party consultants, including Light Structures' experts. Veracity also provides a platform for improving insight based on data trends, and it is possible to add new data streams from other sensors or communications channels (weather, motion, currents, etc.) should they be required going forward.

To deliver added value, there must be complete trust in all data coming through the system; for instance, the data must not be tampered with, and the quality should be according to expectations. These concerns are an issue for all sensor-based systems and also apply to structural

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“Ocean Farm 1 is just the start of a new era of exposed aquaculture: Its inception, development and operation will provide a knowledge platform that will have an impact far and wide.”

load monitoring. The system itself and the data from each sensor network need to be verified against requirements addressing quality and security for class systematics and important decisions; cyber secure is a class notation for this, and D-INF is a class notation for the data collection infrastructure. SENSFIB may then be a part of a larger system, with sensor data coming from many systems.

Increasing Production Capacity

Ocean Farm 1 is just the start of a new era of exposed aquaculture: Its inception, development and operation will provide a knowledge platform that will have an impact far and wide. The United Nations predicts that the world will need 70 percent more food by 2030, at the same time as tackling lowering global emissions and aiming to achieve the UN's Sustainable Development Goals.

SalMar Aker Ocean, the new company formed by SalMar AS and offshore engineering and operations specialist Aker for the operation of Ocean Farm 1 and subsequent new offshore aquaculture concepts, aims to establish sustainable production of approximately 150,000 tonnes of salmon in offshore and semioffshore sites by the end of 2030, securing Norway's position as a key fish and seafood producer.

SalMar is confident that precise structural stress and fatigue measurement by Light Structures will provide a significant contribution to the development of structural modifications and alternative offshore fish farm designs, as well as new processes and workflows that will strengthen the case for taking aquaculture further from shore.

DNV will ensure that SalMar Aker Ocean can leverage the SENSFIB data into actionable insight and decision support through ongoing development of structural monitoring with SENSFIB technology. And the in-depth experience of Light Structures' technology on Ocean Farm 1 is helping to prepare SENSFIB for safety and risk reduction in the day-to-day operations of advanced new fish farms that we are yet to imagine. **ST**

Ernad Sehic is senior international sales manager at Light Structures AS. He is based at the maritime structural stress monitoring company's Oslo headquarters. Sehic joined in 2017 as a project manager after spending 10 years in various hands-on project management and engineering roles at National Oilwell Varco.



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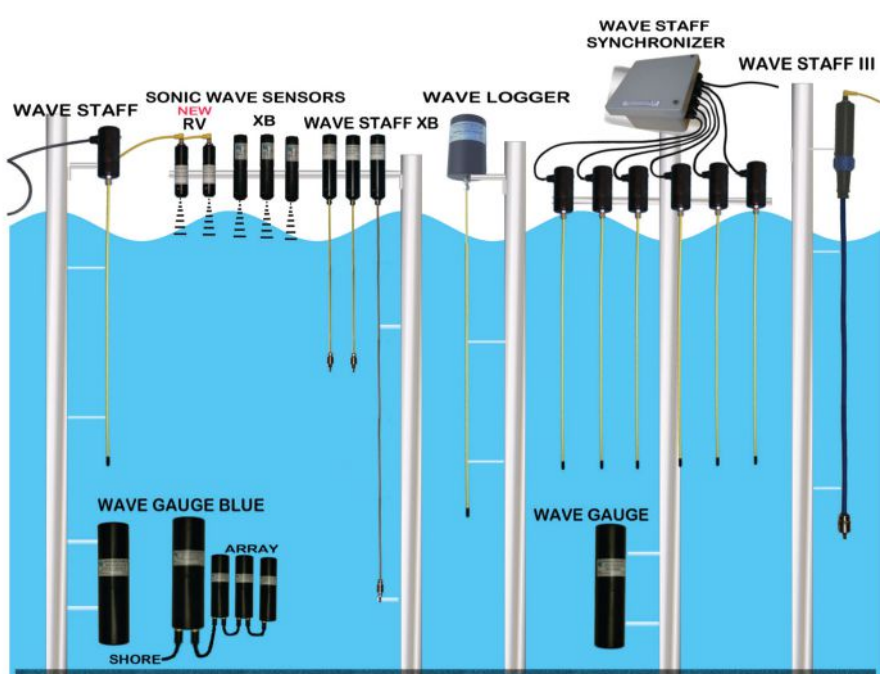
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Direct Drive Electric

A Smoother Transition to Electric Propulsion

By Jonas L. Nyberg

Driven by cost and sustainability imperatives, the maritime industry is increasingly attracted by electric propulsion technology, whose benefits include compatibility with a wider range of fuels, higher levels of integration and more flexible power management.

Yet, while shipping's electrification is clearly underway, not everyone is on board: Many shipowners remain unconvinced that the advantages of conventional electric propulsion warrant a shift away from diesel-mechanical setups.

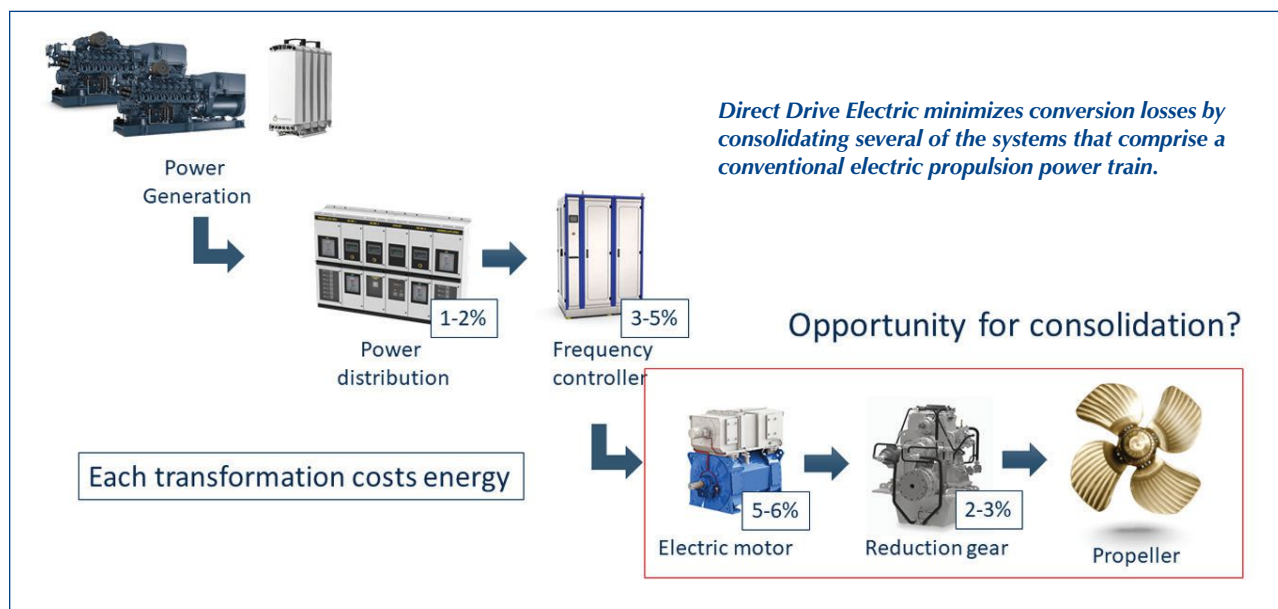
In response to this industry challenge, Berg Propulsion has collaborated with green technology expert The Switch to develop an alternative solution that offers superior electric propulsion efficiency compared with conventional systems, alongside a robust and simplified configuration to appeal to both new and existing user groups.

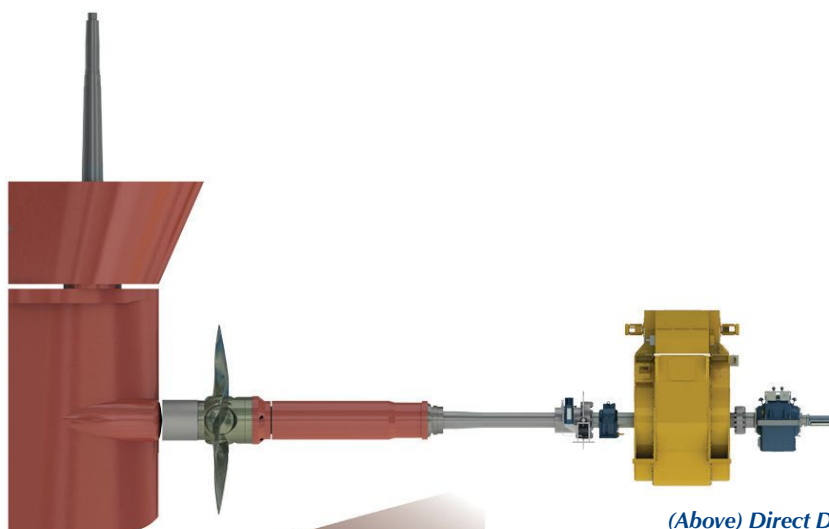
Efficiency Gains Through Consolidation

In the conventional approach to electric propulsion, power is fed from the generators into the power distribution system before moving on to the frequency controller, passing through the electric motor and finally reaching the main propeller shaft via the reduction gear. While this process offers enhanced flexibility to adapt to changing loads, energy is lost at every step.

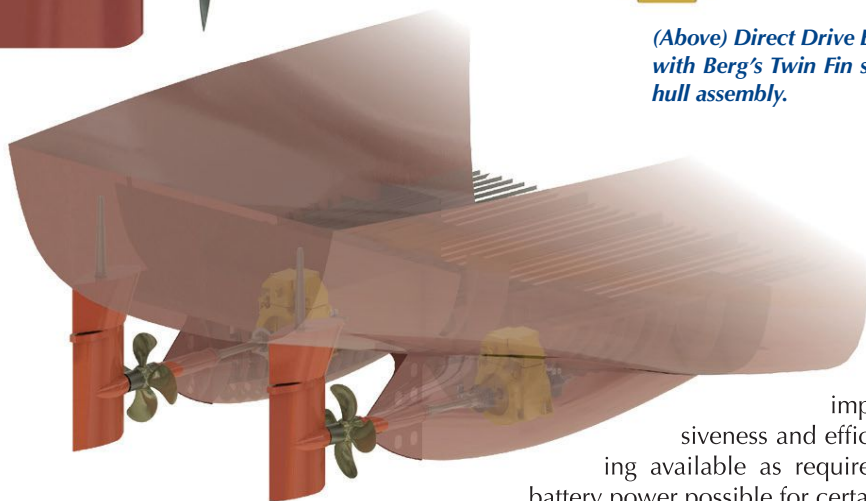
Named "Direct Drive Electric," Berg's new solution minimizes conversion losses by consolidating several of the systems that comprise a conventional electric propulsion power train.

Consolidation Opportunity One. The revised configuration uses proven permanent-magnet motor technology for higher efficiency, reduced electrical losses and optimized flexibility at varying revolutions per minute (rpm), torque and pitch.





(Above) Direct Drive Electric can be combined with Berg's Twin Fin system. (Below) Twin Fin hull assembly.



improves vessel responsiveness and efficiency, with peak loading available as required and zero-emissions battery power possible for certain operations.

In this setup, the electric motor is part of the propeller shaft and drives the propeller directly, with no reduction gear installed, to achieve 2 to 3 percent greater fuel efficiency. The more robust arrangement also simplifies installation, addressing the issues of system complexity and high component numbers, which have been acknowledged as key factors in many shipowners' resistance to electric propulsion.

As well as improving efficiency and simplifying installation, removing the reduction gear decreases wear in ancillary components to cut maintenance requirements, while the addition of a separate bearing unit, located before the electric motor on the shaft, eliminates inherent alignment and integration issues.

Consolidation Opportunity Two. The power distribution and the frequency controller—respectively responsible for 1 to 2 percent and 3 to 5 percent conversion losses in the conventional electric propulsion setup—offer a second opportunity for consolidation.

Direct Drive Electric features a DC hub, or “superdrive,” that draws on the main power generation source, as well as any sources of stored energy, such as batteries and fuel cells. The superdrive outputs interface separately with main propulsion and hotel/other electrical systems, establishing an integrated power source that can be distributed for optimized fuel efficiency at all times.

The capacity to draw on stored energy significantly

Design Advantages

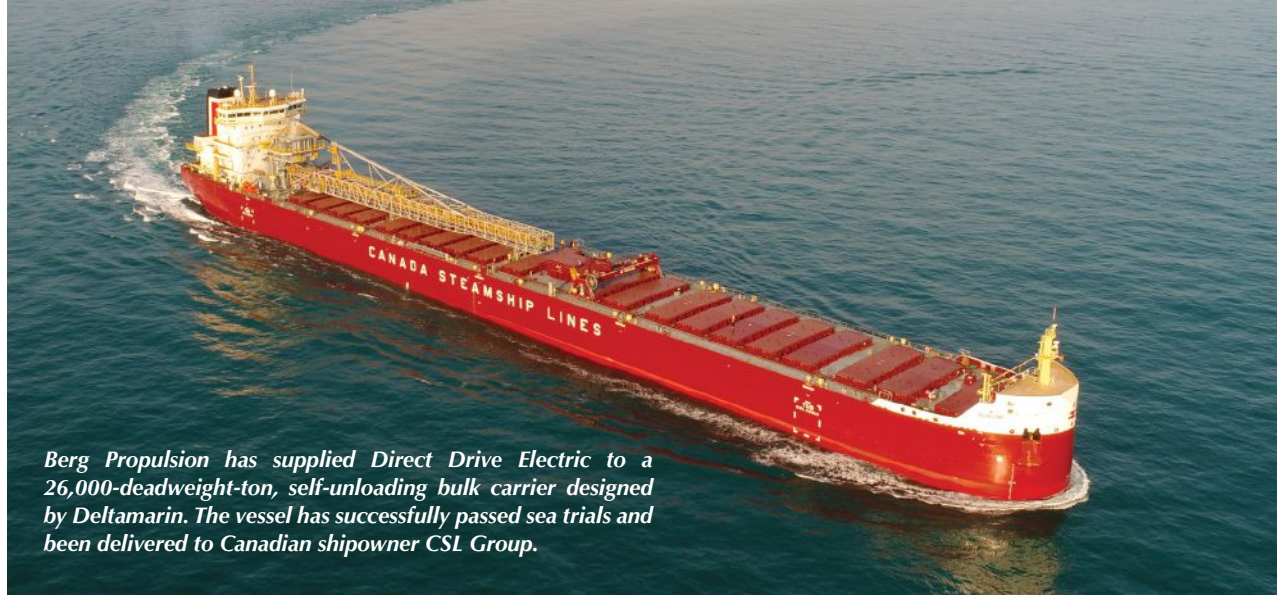
Direct Drive Electric also offers advantages in propulsion system design, with the removal of gears allowing a shorter shaft line, fewer bearings and a smaller engine room footprint. In addition, the solution's extremely high torque capability enables far larger propeller diameters than are usually possible in an electric propulsion installation, further increasing efficiency.

When combined, performance enhancements achieved through the absence of a gearbox, the superior performance of the electric motor and the larger propeller can yield efficiency gains of up to 30 percent as compared with conventional or podded propulsion systems.

Use Cases

Already fully operational, Direct Drive Electric has been included in orders featuring Berg's patented Twin Fin system, where it is installed within compact, hydrodynamically shaped fins custom designed to optimize flow through the propellers and thereby minimizing fuel consumption and noise.

For example, Berg Propulsion has supplied Direct Drive Electric to a 26,000-deadweight-ton, self-unloading bulk carrier designed by Deltamarin and built at CSSC Chengxi Shipyard, China. The vessel, named *Nukumi*, has now successfully passed sea trials and been officially delivered to Canadian shipowner CSL Group.



Berg Propulsion has supplied Direct Drive Electric to a 26,000-deadweight-ton, self-unloading bulk carrier designed by Deltamarin. The vessel has successfully passed sea trials and been delivered to Canadian shipowner CSL Group.

A complete electrical integration package from Berg includes variable-speed, permanent-magnet alternators through DC switchboards, the Direct Drive Electric motors and power management with AC distribution. Furthermore, the vessel's propulsion system has been fully adapted to optimize performance in relation to its hull form.

The CSL newbuild is equipped with two fully feathering controllable-pitch propellers, each directly powered by a 3-MW permanent-magnet electric motor housed in the dual fins attached to the hull. Meanwhile, its four diesel-electric Caterpillar MaK gensets will deliver a combined total power of 9.5 MW, helping the ship to reach a service speed of 12 to 14 kt.

While this is a specialized application for Direct Drive Electric, the solution is also available and generating interest in applications for vessels where the motors are installed inside the hull. Examples include single-screw cargo vessels, RoPax ferries, patrol vessels and other ships whose energy transformation and operational profile are better served by an electrical setup than by a mechanical concept.

Vessel Electrification Made Easy

With the industry-wide transition toward vessel electrification now underway, Direct Drive Electric represents an ideal solution for integrating gas or dual-fuel engines, other fuel alternatives, fuel cells and batteries.

The solution's robust configuration makes it a particularly attractive proposition for owners of offshore vessels, who are, in general, already convinced of the advantages of electric propulsion. At the same time, Direct Drive Electric's ability to facilitate the integration of battery

power could prove appealing to ferry operators. Owners of bunker vessels and single-screw cargo ships might be persuaded by its capacity to incorporate new low-carbon fuels and thereby support regulatory compliance.

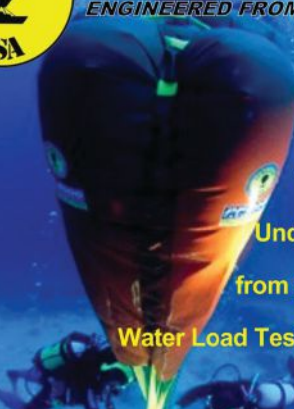
Owners seeking to optimize efficiency, flexibility and sustainability—and whose ships require the high maneuverability or redundancy at which electric propulsion excels—should therefore see Direct Drive Electric as a direct response to a market need for a smoother transition to vessel electrification. **ST**

Jonas L. Nyberg is Berg Propulsion's managing director for the Western Hemisphere.





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Electricity from Water

Transforming the Motion of Water into Subsea Power

By Mairi Wickett

WITT Energy, based in the U.K., has invented novel solutions to harvest electrical power from the naturally occurring motional energy that is all around us: in the water, the sea, rivers, tides and wind. The company has already designed the onshore Dragonfly wind energy harvester that is portable and easy to assemble, and we are continuing to develop WITT technology to generate power for subsea applications.

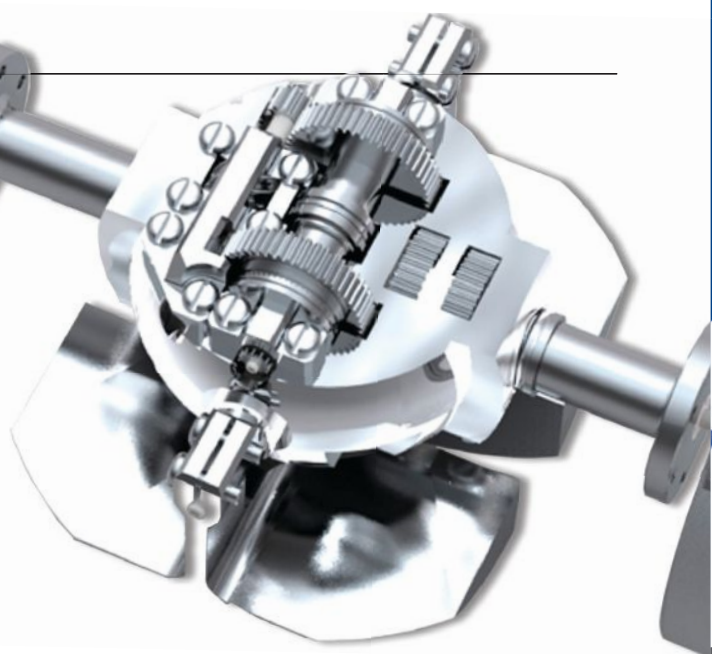
Our technology is patented in the U.S., China and throughout Europe, with the possibility of licensing in other countries, including developing nations, to provide local jobs and enhance daily life. For example, the Dragonfly will be easy to assemble and disassemble with material sails that can be customized to provide power for heating and cooking in developing countries.

Maritime Design

WITT is an acronym for “whatever input to torsion transfer.” The system was designed and built by Martin Wickett, a senior civil engineer whose career was in building roads and bridges. He has always been fascinated with complex engineering problems, and after many years of trial and error, he developed WITT to demonstrate that any motion could be turned into electricity.

The system comprises a sealed energy unit with a transmission that has two pendulums and a flywheel that turns in one direction to harvest chaotic motion. Peak power is used to charge a battery without slowing down or stalling the system.

When fully developed, WITT will harvest underwater motion known as vortex-induced vibration (VIV) to provide clean power at an unprecedented 6° of motion: clockwise, anti-clockwise, up, down, backward and forward. The invention can use all paces of motion—fast, slow and erratic—to turn the two pendulums inside, and this energy turns a flywheel in one direction to create electrical power to recharge batteries. WITT can be de-



ployed as a fit-and-forget solution, greatly reducing operating costs in remote and dangerous locations.

WITT could be built at a scale of centimeters to meters, depending on the application. The system could be joined in arrays communicating with each other and transmitting data for a wide range of applications, including defense, security and combating illegal fishing.

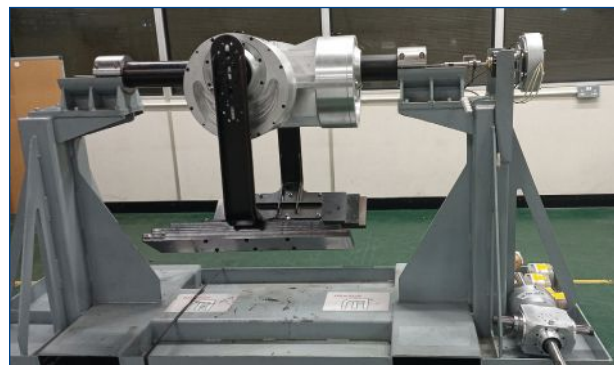
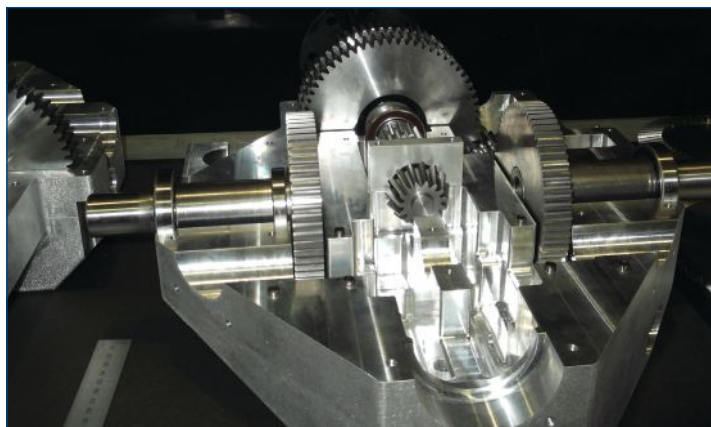
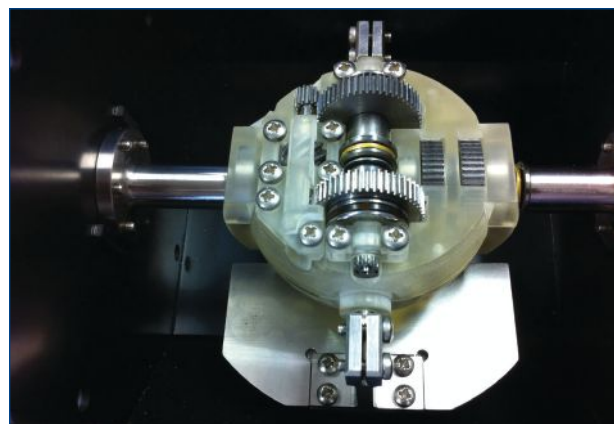
Testing

We conducted a one-year feasibility study of the WITT system from small to large sizes in 2011 with Glasgow University's School of Mechanical Engineering. The work was overseen by Professor Matthew Cartmell, an international expert in sound, vibration and 6° of motion.

From 2021 to 2022, we conducted testing at QinetiQ's Haslar marine technology facility in the U.K. inside a 250-m towing tank. With the VIV water moving at 0.5 m/s up to 1.1 m/s, WITT clearly demonstrated it can harvest energy from the motion of water and transform it into electrical power.



(Far left) The WITT system being tested in our Fanuc in-house robotic arm, demonstrating power from VIV. (Above) Small WITT unit, proving we can harvest 6° of motion. (Top right) WITT larger-scale system. (Bottom right) Large WITT unit being tested at Southampton University.



Further tests will be conducted at Langstone Harbour, Portsmouth, this spring, as well as several other locations in the near future. In addition, we will deploy a full system with the U.S. Department of Energy in Seattle. WITT will continue building and testing larger systems and engaging with interested parties.

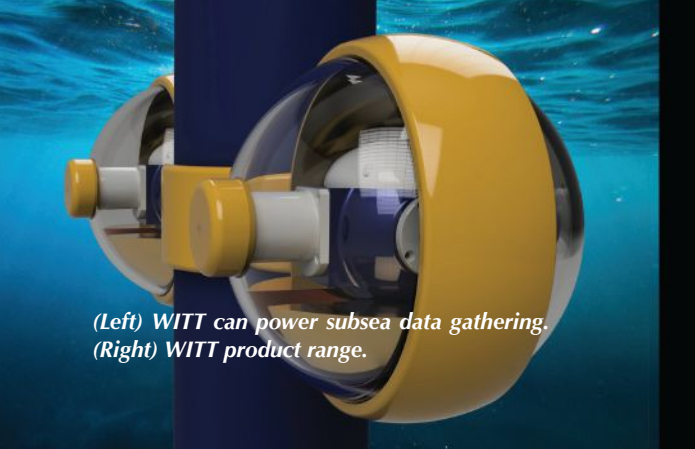
Applications

Our first order, which is from the U.K. Ministry of Defence/Defence & Security Accelerator (MOD/DASA), is to provide approximately 4 W of constant power in remote sea locations to charge batteries for data gathering

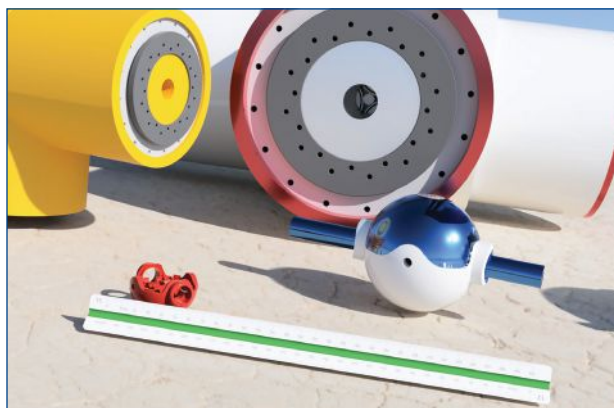
and sensors at 100-m depth. Deployment is scheduled for late spring. This will reduce maintenance costs and has great advantages at high latitude, where solar panels struggle to gather energy because there is little to no sunlight for nearly six months.

In addition to defense applications, we are very interested in helping provide green power and supporting the restoration of coral reefs. For example, we are investigating coral reef projects for which we supply the power to play reef noises (an array of clicks and clacks) continuously in order to influence marine life to travel to a new reef location to spur the symbiosis between marine life and corals.

We can also supply power for marine mammal studies. We will deploy a complete system in Seattle in April 2022 for the U.S. Department of Energy's Pacific Northwest National Laboratory (PNNL) to conduct temperature and marine mammal studies. Seattle has been the home of orcas for many years, but it was discovered that



(Left) WITT can power subsea data gathering.
(Right) WITT product range.



the orcas are going further north due to global warming. The WITT system will support marine mammal research by being fitted onto an HDPE pipe secured to the seabed with Teledyne's Sea Spider anchor system. Water flow at 0.8 m/s will vibrate the pipe, causing the two pendulums inside WITT to oscillate, turning a flywheel in one direction, providing constant power to charge a battery at 4 W; that amount of power in this environment equates to 52 heavy-duty car batteries per year. WITT was chosen for its quiet operation; other systems that harvest power would make a whooshing noise as turbine blades rotate, which could disrupt data collection.

In addition to the PNNL project, we will also work with the Department of Energy on a solution in the Arctic for data gathering and security.

What's Next?

At present, our focus is on providing power in the subsea environment to reduce carbon emissions, bring power to remote locations and examine the many opportunities to join systems in arrays for various applications.

In the future, we would like to build larger units for testing, and we are looking to partner with others for this purpose. WITT can be built in a wide range of sizes, and we are talking with investors to build larger WITT systems and conduct testing in different locations, from seas to rivers to tidal areas. **ST**

Mairi Wickett is the business development director and co-founder of WITT Energy Ltd.

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Unmanned Maritime Systems

Creating a New Paradigm for Ocean Observation

By George Galdorisi

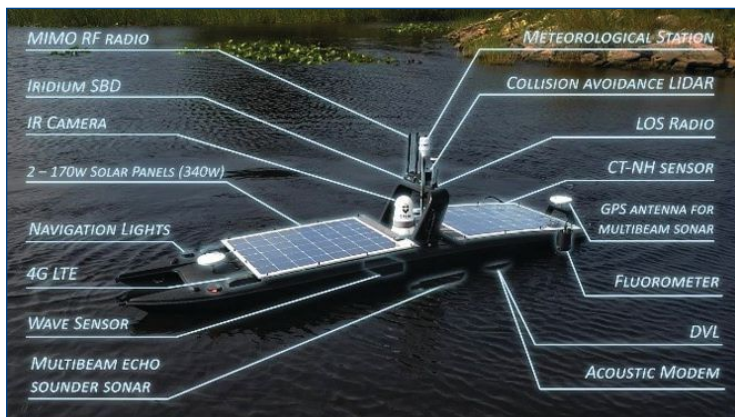
For two weeks in November 2021, the UN COP26 Glasgow summit highlighted the disastrous impact of climate change. By dominating national and international headlines, the event increased awareness that the oceans sustain the planet and that efforts to combat climate change must focus on the seven seas—seas that are increasingly under stress.

The U.S. sees climate change not just as an environmental problem but also as a national security threat that involves the Navy. For decades, the Navy gained its knowledge of the ocean environment by conducting ocean sampling from Navy vessels. This worked to a point, but, today, with a ship count of less than 300, the Navy seeks viable alternatives for sampling.

A new pact between the U. S. Navy and NOAA has examined the potential of unmanned surface vehicles equipped with a variety of sensors to conduct ocean sampling. This initiative serves two purposes: to provide NOAA with the information needed to make data-driven deci-

sions to help combat climate change and to provide the Navy with timely information for tactical and operational situations.

This partnership provides a best practices example that nations and navies can leverage to provide an effective and efficient way to gain a comprehensive knowledge of



(Above) MARTAC T12 USV. (Credit: Jack Rowley) (Below) The MARTAC T12 USV was equipped with an environmental package for CNMOC ANTX in the Gulf of Mexico. (Credit: Jack Rowley)



MARTAC USV performs nearshore scanning. (Credit: Jack Rowley)

the ocean environment via new commercial-off-the-shelf (COTS) technology.

Knowledge Imperative

An important aspect of dealing with climate change has been—and will continue to be—ocean observation. This is one of the reasons that the U.S. Navy and NOAA have moved forward to conduct detailed experimentation to determine whether USVs can provide an effective and efficient means to carry out ocean observation.

This U.S. Navy-NOAA initiative includes the plan to jointly expand the development, acquisition, fielding and operation of unmanned maritime systems. This opportunity has only become possible because of the rapid development of these systems, which can be fitted with a package of sensors to comprehensively measure ocean phenomena and transmit data to shore.

These trends portend a new era in ocean observation that will lead to comprehensive data collection to support naval operations around the world. This effort will also enable a wide range of stakeholders to compile crucial data to address the national security threat of climate change by enabling scientists to make data-driven decisions to protect the health of the oceans and the atmosphere.

Leveraging USVs to Collect Data

In order to address climate change at the national level, federal, state and local officials must make data-driven decisions that depend on collecting the right data at the right place at the right time. In a budget-constrained environment, having various agencies collect—but fail to share—oceanic data, is a recipe for failure. These gaps lead to an incomplete picture of the ocean's health, along with suboptimal solutions for long-term ocean sustainability.

The U.S. Navy-NOAA partnership is a natural outgrowth of the fact that both organizations must collect and utilize much of the same oceanic data. By working together, NOAA will be able to leverage the Navy's expertise, infrastructure, best practices and training to accelerate its stewardship mission, especially its efforts to address climate change.

The Navy's executive agent and key stakeholder in

this effort is the Naval Meteorology and Oceanography Command, whose mission is to define the physical environment from the bottom of the ocean to the stars to ensure the U.S. Navy has freedom of action on the oceans. Naval Oceanography has been a global pioneer in the development and use of unmanned systems.

NOAA conducts research and gathers data about the global ocean and atmosphere to forecast weather, protect the ocean and manage marine resources. These missions rely on a continuous process of testing and evaluation of new technologies, such as unmanned systems, to improve data gathering.

Experimenting with Sampling Methodology

For both the Navy and NOAA, a major appeal of unmanned systems is their ability to provide a persistent sensor picture for areas of interest. One important factor that is driving this move to unmanned maritime systems is the high cost of using manned air or sea craft to conduct observations; add to this the dangers of using these vessels in bad weather, in turbulent waters, or at night.

Thus, the Navy and NOAA agreed to experiment rapidly with ways to enhance their ability to conduct comprehensive ocean observation. In order to organize an experiment in the near term, a decision was made to use COTS technology that was mature and met the exercise objectives.

Based on these criteria, a U.S. corporation, Maritime Tactical Systems Inc. (MARTAC, *Sea Technology* February 2022), was invited to demonstrate its USVs by conducting a comprehensive environmental monitoring evaluation. This month-long endeavor was done under the auspices of the Naval Meteorology and Oceanography Command (CNMOC). Under CNMOC's stewardship, an Advanced Naval Training Exercise (ANTX) was conducted in the Gulf of Mexico in July 2019.

CNMOC scientists outfitted a COTS 12-ft. MANTAS USV with a CNMOC Environmental Monitoring System to provide a one-vehicle solution for missions that were previously conducted by multiple platforms.

CNMOC equipped the MANTAS T12 USV with sensors that included: Teledyne Benthos ATM-900 underwater modem; Teledyne FLIR M232 camera; Teledyne RD Instruments Citadel CTD-NH; Teledyne DVL with ADCP;

NORBIT Subsea iWBMSH STX echosounder; Turner Designs C3 fluorometer; Quanergy M8-1 Plus LiDAR; AIR-MAR 220WX WeatherStation; and SeaView SVS-603 wave-height sensor.

A second MANTAS USV with its own ocean monitoring system was employed to conduct an additional round of testing. Sensors on this USV included a NORBIT Subsea iWBMSH STX echosounder and Klein UUV 3500 side scan sonar.

Ocean observations during the demonstration included: wave height, wave frequency, current speed and direction, wind speed and direction, air temperature, barometric pressure, fresh and saltwater concentration, and bottom bathymetry/contour. All of these measurements are essential components that feed environmental models for the Navy and NOAA.

Unlike previous technology, the MANTAS USVs were able to conduct surveys in higher sea states. The catamaran-hulled MANTAS operated in sea state five conditions. It has a number of compartments that protect sensor components in heavy weather.

Persistent Ocean Observation

Finding a cost-effective means to collect oceanic information autonomously while having humans in the loop is crucial, given the ongoing importance of collecting the right environmental information at the right time at the right place to support the U.S. Navy, as well as help NOAA and other agencies make data-driven decisions on the national security implications of climate change.

The successful use of COTS USVs during this demonstration can be readily scaled-up in USV platform size and, thus, accommodate added oceanographic sensors. This will enhance data collection, transmission and evaluation of water conditions and the ocean environment.

U.S. Navy officials have encouraged MARTAC Inc. to scale-up the MANTAS T12 used for this CNMOC ANTX effort and produce larger vehicles to conduct more comprehensive ocean observation. To this end, MARTAC's 38-ft. Devil Ray T38 USV was deployed during U.S. Navy exercises Trident Warrior in October 2020 and Integrated Battle Problem in April 2021. This larger USV could be ideal to conduct extended and more detailed ocean observation, with more sensors and longer deployment periods.

Given the capabilities of USVs to conduct comprehensive oceanic observation, there will likely be an increased demand for unmanned systems prototyping and experimentation to support comprehensive ocean sampling. The vast array of technologies emerging in today's unmanned maritime systems provides a viable opportunity to move forward with an effective and affordable oceanic observation taxonomy for defense and environmental stewardship. **ST**

Captain George Galdorisi (U.S. Navy, retired) spent 30 years as a career naval aviator. His active-duty service included four command tours and five years as a carrier strike group chief of staff. He has a graduate degree in oceanography, and he worked with unmanned systems throughout his Navy career.

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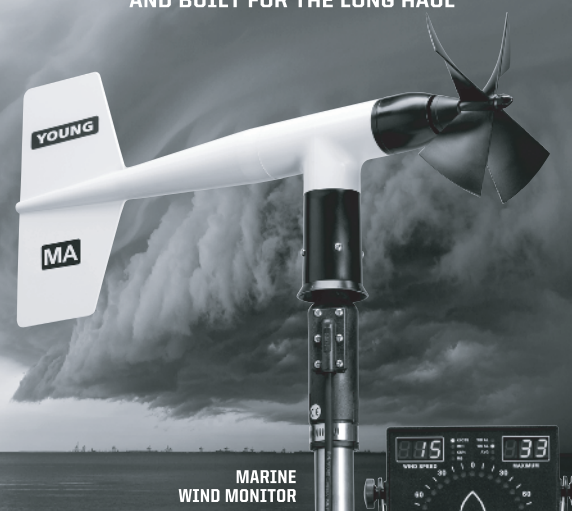
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Ammonia Bunkering Safety Study

DNV has been selected to lead an ammonia bunkering safety study by the Global Centre for Maritime Decarbonisation in Singapore. The pioneering study will define a robust set of safety guidelines and operational envelopes to establish the basis of a regulatory sandbox for ammonia bunkering trials at two local sites.

DNV will team up with Singapore's leading infrastructure developer Surbana Jurong and the Singapore Maritime Academy. DNV's work scope will comprise ammonia demand forecasting, bunkering site recommendations, the development of conceptual designs of bunkering modes, HAZID/HAZOP/QRA studies, and drafting of technical and operational guidelines.

IWSA Now Official IMO Consultant

The International Maritime Organization (IMO) has formally confirmed that the International Windship Association (IWSA) has been granted full consultative status at the regulatory body. This will help bring wind-assist and primary-wind-propulsion issues to the fore as the wind technology segment continues to grow and the industry looks to this abundant, emission-free energy source to help propel the commercial fleet into an uncertain, tightly carbon-constrained future.

It is a critical period for the industry with the Energy Efficiency Existing Ship Index (EEXI) and Carbon Intensity Indicator (CII) regulations coming into force next year and the challenging discussions over carbon levies and raising the decarbonization ambition for 2050.

Maritime Mechanical Services Firm Expands

In response to increasing demand for critical machinery alignment and troubleshooting services from the maritime industry, On Site Alignment has expanded its global network with two new offices in the U.S. and United Arab Emirates.

On Site Alignment's network expansion activities are set to continue later this year with the establishment of an office in Shanghai.

Selektape Shows More Anti-Fouling Results

Swedish biotechnology company I-Tech AB, developers of the anti-fouling agent Selektape (*Sea Technology*, March 2022), has announced outstanding five-year performance results achieved on a container vessel using a copper-free, Selektape-containing, anti-fouling coating. The hull of the 8,900-TEU containership was coated in March 2016 with SEAFLO NEO CF PREMIUM, supplied by Chugoku Marine Paints (CMP).

After 60 months of operation in waters with a high biofouling risk and with no hull cleaning undertaken, the ship entered drydock with the vertical sides, flat bottom and niche areas of the hull completely free of any barnacle growth. The container ship moved at an average speed of 17 kt. in warm waters, with an average operation level of 78 percent. Analysis of the performance

data confirms that the ship had an impressive zero speed loss over 60 months. Compared to the market average for anti-fouling products, over a 60-month period the ship achieved 16.5 percent fuel savings, and its CO₂ emissions were reduced by 85,500 tons.

Funding for Hydrogen Production in Europe

Lhyfe, a pioneer in renewable hydrogen production, has raised funds for a third time, for a sum of €17 million. Most of the funds came from Andera Partners via its new green infrastructure investment fund, Andera Infra. Ovive (part of Les Saules group) and the risk capital company SFLD (Société Financière Lorient Développement) also backed Lhyfe in this fundraising.

The purpose of this third fundraising is to support Lhyfe's strategy for the deployment of renewable hydrogen production sites in Europe.

Bigger Shipyard for Strategic Marine

Strategic Marine (S) Pte Ltd. has completed the acquisition of a significantly larger shipbuilding facility in Singapore in a move that will significantly boost its shipbuilding capacity and product range. The larger facility will allow Strategic Marine to scale up shipbuilding capabilities and expand its product offering to deliver larger vessels and execute vessel repair/maintenance services. Its shipbuilding, repair and maintenance capacity will also be greatly increased with a 105-m-long drydock facility and a slipway.

Blueprint for Private Equity Net-Zero Investments

The new private equity component published by the Institutional Investors Group on Climate Change is a new component for the Paris Aligned Investment Initiative's Net Zero Investment Framework (NZIF), UN Climate Action reported. The component provides a blueprint for general partners (GPs) to make and implement net-zero commitments and allows limited partnerships (LPs) to incorporate private equity into net-zero strategies for multi-asset class portfolios.

The addition of this new component is part of a strategy of continued expansion of the NZIF, following its initial launch in March 2021. The component brings the asset classes covered to five: listed equity, corporate fixed income, sovereign bonds, real estate and private equity.

The NZIF outlines a common set of recommended actions to maximize efforts to achieve net-zero emissions globally by 2050 or sooner, including guidance for the scope of portfolio companies to be considered for measurement and management.

NLA Joins Seabed 2030

The Nippon Foundation-GEBCO Seabed 2030 Project has announced a partnership with NLA International. The two parties signed a memorandum of understanding to strengthen the collaborative work being undertaken to further understanding of ocean bathymetry and contribute to the global effort to produce the definitive map of the ocean floor. Seabed 2030 is a collaborative project between The Nippon Foundation and the General Bathy-

metric Chart of the Oceans (GEBCO) to inspire the complete mapping of the world's ocean by 2030 and to compile all bathymetric data into the freely available GEBCO Ocean Map.

Three Ocean Tech Companies Merge

Nortek AS (Norway), Strategic Robotic Systems (U.S.) and Blueprint Lab (Australia) have merged to form the common holding company General Oceans AS. Together, the three companies have almost 200 employees and operate across all major segments of the ocean technology market. Revenues in 2022 are expected to reach \$63 million, with a focus on vehicles, actuators and sensors.

Each company will retain its brand and maintain its own production, engineering and sales. General Oceans will provide management services from a base in London. The group will be led by Nortek founder and General Oceans president, Atle Lohrmann, along with executive management from each company.

IMTRA Now Owned by Employees

IMTRA, a manufacturer and importer of products for the marine, energy and transportation markets, has sold 100 percent ownership rights of the company to its employees through an employee stock ownership plan (ESOP). As a compelling alternative to other sale events such as private equity or strategic sale, an ESOP allows the leadership team to stay in place while providing a competitive return for the shareholders without the potential challenges that often come with a change in control of a closely held business.

Record Sales for Raymarine

Less than a year after its acquisition by Teledyne, Raymarine sales are at record levels, with sustained increases since the second quarter of 2020. Raymarine's workforce continues to evolve by promoting from within the company.

Fugro Adds Remote Operations Center

Fugro is building a remote operations center (ROC) in the company's St. John's office, located in the province of Newfoundland and Labrador in eastern Canada. The ultramodern communications hub is scheduled for completion in the fourth quarter of 2022 and will complement Fugro's global network of ROCs, which make it possible to complete offshore operations onshore via remote and autonomous technologies.

exactEarth Joins Spire Maritime

exactEarth's merger with Spire Global is now complete, meaning that exactEarth is part of Spire Maritime.

Benefits of the merger include: a more extensive portfolio of services for advanced analytics; increased detection capability to drive better data quality and more accurate tracking and analytics; and more investment and development resources for building the innovative future of maritime AIS. Spire's satellite constellation has increased from 69 to 165+ satellites, with real-time vessel tracking ability, as a result of this merger. **ST**

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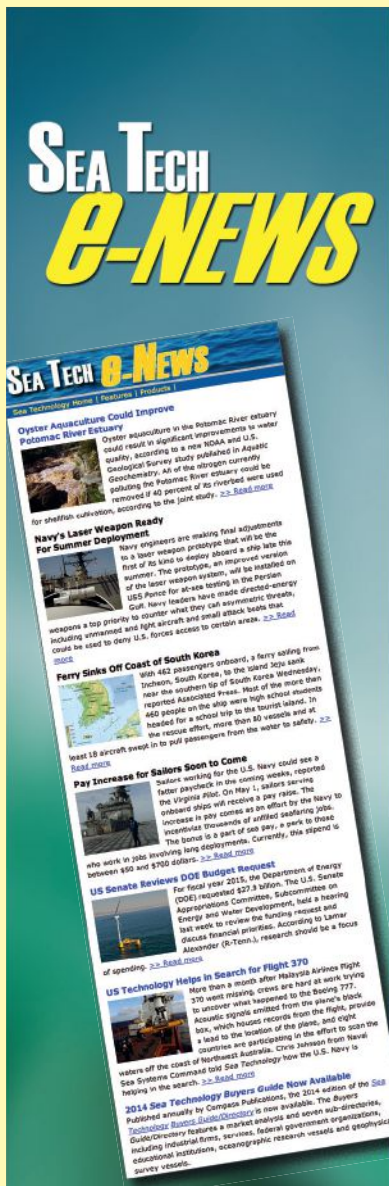


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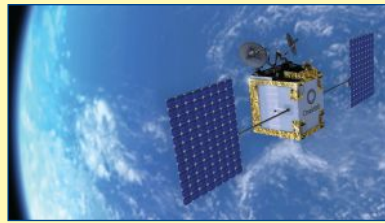
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Satellite Communications



OneWeb's high-speed, low-latency connectivity is combining with Marlink's VSAT network. Marlink's network provides remote communications across the maritime, offshore and onshore energy, enterprise, and humanitarian sectors. Flexible, reliable and secure connectivity solutions can be optimized for every application. OneWeb and Marlink.

Digital Condition Monitoring

IKM Instrutek's sensors and services can be connected to Vessel Insight, a cloud-based platform that collects data on board a vessel and transfers the data securely to the cloud. The combined solution is available on the Kognifai Marketplace. Kongsberg Digital and IKM Instrutek AS.

Commercial Diving Gloves

Designed to provide thermal and abrasion protection while diving, these gloves also protect your hands from harmful substances. The range of gloves includes Kevlar Superstretch gloves that combine the comfort and dexterity of super-stretch neoprene with the extra protection of Kevlar palms and fingertips. Northern Diver International Ltd.

Emissions Assessment

AI-enabled Carbon Baseline delivers a detailed and verified baseline assessment of historical vessel and fleet emissions. The patent-pending AI Digital Chemist uses historical operational data to calculate prior-year GHG emissions profiles for a vessel or fleet. This provides commercial and ESG compliance advantage. FuelTrust.

Web Antenna

weBBoat Link IT1304/US antenna enables 4G Wi-Fi web access up to 10 mi. from shore. WeBBoat Link is a single SIM system. Beyond the powerful 42 Mbps download Wi-Fi signal it provides, it has two Ethernet ports to connect onboard systems and PCs to the internet. Glomex.

Aquaculture Oxygenation

PCI VSA oxygen generators are part of the aquaControl automated environmental monitoring and control system that helps farm operators protect fish stocks from low-oxygen events and maximize growth rates. aquaControl features a digital valve system that can be run autonomously or remotely via computer or mobile device. Innovasea and PCI Gases.

Subsea Integrity Management



KINEKtron Subsea Strain Monitoring Clamp is a retrofit subsea strain monitoring system capable of measuring strain on structural tubular members. It comes in an ROV-installable package. The Temperature Monitoring System is a clamp that provides long-term monitoring of pipeline skin temperature. The magnetically attached retrofit clamp can be installed by divers in shallow water and in all water depths with ROV assistance. Aquatec Group Ltd.

ASW Sonar Performance Check

SIERA is an autonomous system towed at variable speed from a dedicated boat. It characterizes and calibrates underwater acoustic systems, such as hull-mounted sonars,

dipping sonars, variable depth sonars and buoys. SIERA also allows radiated noise measurements in the far field. RTsys.

Ultralow-Light Camera



Nightwave is built around the SiOnyx patented Black Silicon CMS sensor to allow for easy spotting of obstacles and debris in moonless starlight. Operating without the need for white light or an expensive thermal camera, Nightwave mounts and sets up easily to stream video to a mobile device via Wi-Fi or connects directly to other hardware via analog output, displaying clear color or digital night vision. SiOnyx.

Holographic Training

The digital eLearning training provider will offer live courses run by holographic tutors. The solution has portals, each with built-in speakers, through which the speaker's voice can be heard. Cameras and microphones allow the person appearing as a hologram to see the audience. OneLearn Global.

Mooring for Floating Wind

Honeymooring connects floating wind turbines in a honeycomb layout using shared buoys, synthetic fiber lines and anchors. It is estimated to reduce hardware costs up to 50 percent compared to traditional mooring solutions based on steel chains. Semar AS.

Wireless Mine Detonation

Initiation Transponder 6 (IT 6) is designed to be connected directly to a remotely deployed, nonelectric mine neutralization device, such as a Cobra MDS from ECS Special Projects. This allows EOD teams to send a wireless, acoustic command from their vessel, safely initiating a

shock tube detonator over distances in excess of 1,000 m. Sonardyne International Ltd.

SAS for AUVs

Ranger SAS (synthetic aperture sonar) is designed for man-portable AUVs and larger. It offers low power consumption while providing a 300-m search range (150 m per side) at a 3-cm resolution. The standard sonar has a 300-m depth rating. There is also a 1,000-m-depth-rated version. Marine Sonic Technology.

Microplastics Filtration

This patented system filters out microplastics from open-loop scrubber washwater. It is efficient in capturing particles smaller than 10 μm , and the captured concentration by volume is about 76 particles/ m^3 . Wärtsilä Marine Systems and Grimaldi Group.

2-kW/3-kW CHIRP Fish Finder

DFF3-UHD High-Power TruEcho for NavNet TZtouch3 provides fish-

ermen the ability to see fish and bottom structure deeper and clearer than ever before. Digital signal processing interprets the echoes from fish and underwater structures at depths down to 15,000 ft. Furuno USA Inc.

Rope Health Management

ICARIA 2.0 is a full suite of digital services dedicated to mooring line management. It includes: the new Samson Inspection App, Samson CONNECT online portal and Samson CLASSROOM. Samson Rope Technologies.

Embedded Vision System

IDS NXT ocean has new features, including: multi-region-of-interest (ROI) for AI-based object detection; the possibility to use different neural networks for different ROIs in one image via Vision App; and binning, line scan mode and performance and configuration improvements. IDS Imaging Development Systems GmbH. **ST**

A promotional graphic for Sea Technology on Twitter. It features a blue cartoon penguin holding a magazine titled 'SEA TECHNOLOGY SERVICES THE WORLD'. The magazine cover shows a large offshore oil rig. The background is a dark blue gradient with the Twitter logo and the text 'twitter.com/SeaTechnology' repeated in a lighter blue font. At the top, the text 'FOLLOW SEA TECHNOLOGY ON...' is written in large, bold, yellow letters. At the bottom, the Twitter logo and the URL 'twitter.com/SeaTechnology' are displayed in large, bold, yellow letters.

marinerenewables

Triple Offshore Substation O&M Contract

James Fisher Renewables (JF Renewables), a part of James Fisher and Sons plc, has won three contracts supplying specialist operations and maintenance (O&M) services to support informed decision making for offshore transmission asset owners at Thanet, Gwynt-y-Môr and Humber wind farms.

Contract work will be performed by JF Renewables' high-voltage business EDS HV Group for Balfour Beatty Equitix Consortium.

Wave Energy Collaboration

Eco Wave Power Global AB and Ocean Power Technologies Inc. (OPT), two publicly traded wave energy companies, will work together on several fronts, including knowledge sharing, joint grant submissions and collaborative assistance in entry to new markets.

In addition, joint solutions can be developed utilizing each company's respective offshore and onshore technologies and leveraging OPT's offshore engineering and newly acquired robotics capabilities in Eco Wave Power's applicable projects.

Equinor, bp New York Wind PSAs Finalized

The purchase and sale agreements (PSAs) with the New York State Energy Research and Development Authority for Empire Wind 2 and Beacon Wind 1 offshore wind farms have been finalized. The PSAs set the terms under which these projects will supply homegrown, renewable power to New York and inject significant economic investments into the state's economy.

The finalization of the PSAs concludes the contracts awarded in January 2021, when Equinor and bp were selected to provide New York

State with offshore wind power in one of the largest renewable energy procurements in the U.S. to date.

Once completed, Equinor and bp's portfolio of active offshore wind projects (Empire Wind 1, Empire Wind 2 and Beacon Wind 1) will produce enough electricity to power about 2 million New York homes and will help generate more than \$1 billion in economic output to New York state. This includes investments in ports and infrastructure that will reinforce New York's position as the regional offshore wind industry hub and a leading example of economic activity driven by the energy transition.

Large-Scale Floating Wind Farms in Scotland

Shell and ScottishPower have secured joint offers for seabed rights to develop large-scale floating wind farms as part of Crown Estate Scotland's ScotWind leasing. The partners have won two sites representing a total of 5 GW off the east

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and northeast coast of Scotland. The new wind farms will be delivered through two joint ventures called MarramWind and CampionWind. The development, construction and operation of ScotWind projects is set to bring new skilled jobs and manufacturing opportunities and boost local supply chains.

OMSi Moves into Taiwan

U.K. subsea services company OMSi International (OMSi), a subsidiary of Offshore Marine Management Holdings Group, has entered the Taiwanese offshore wind market by signing a memorandum of understanding with Alliance Energy Co. Ltd.

The Taiwanese government's ambitious policy for developing a capacity of 9 GW of offshore wind from 2026 to 2031 has prompted OMSi to test the waters in the booming Asia-Pacific region.

OMSi Taiwan's investment strategy is to combine Taiwanese local resources with offshore experience, capability and assets from the European side of the OMSi business.

New WEC Installed at EMEC

A new wave energy converter (WEC) developed by AWS Ocean Energy, the 16-kW Archimedes Waveswing, has been deployed at the European Marine Energy Centre's (EMEC) Scapa Flow test site. The Archimedes Waveswing is a 7-m-high, 4-m-diameter device moored to the seabed, reacting to changes in pressure caused by passing waves. It is moored on a single-tension tether. The subsea location and ability to winch low in the water column enables avoidance of extreme storm loadings so the device can continue to operate in rough sea conditions. The Waveswing is designed to react to long ocean swell waves and short, wind-driven seas for high energy capture.

The £3.4 million prototype project has been funded by Wave Energy Scotland as part of the Novel Wave Energy Converter development program. The demonstration at EMEC is also supported by the Interreg North-West Europe's Ocean DEMO project.

iXblue Positioning Tech Facilitates Wind Installation

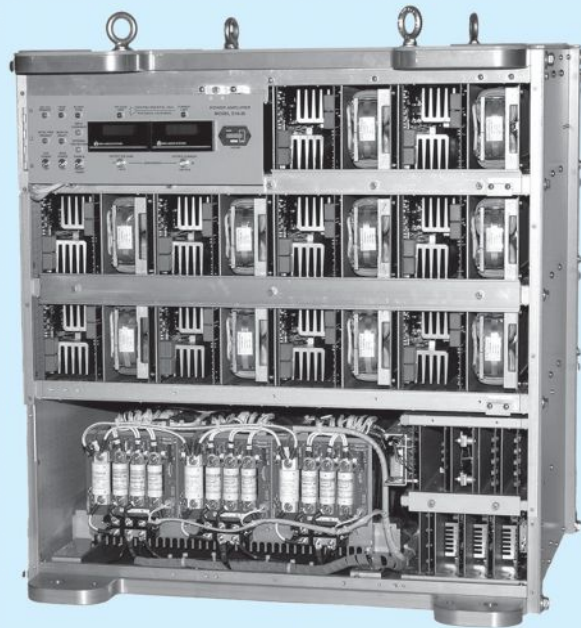
Van Oord has deployed iXblue's new LBL subsea positioning solution to install 190 offshore wind farm piles in the Bay of Saint-Brieuc, France. Pile positioning verification was achieved by Canopus LBL transponders transmitting data to a Ramses LBL transceiver, then to Delph software that generated reports from all received baselines.

River, Tidal Hydrokinetic Power

Our Katahdin and ORPC Inc. will create a testing center at One North, the former Great Northern Paper Mill site, to support new design and development of ORPC's river hydrokinetic power system that generates electricity from river and tidal currents without dams or impoundments. The Modular River-Gen device will be deployed there for grid-connected markets. **ST**

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Terradepth Adds Gavia AUVs

Terradepth has greatly expanded its survey operations capabilities by acquiring three Teledyne Gavia AUVs to support the rollout of its ocean data as a service and Absolute Ocean data platform. The Gavia AUVs are highly configurable and carry a depth rating of up to 1,000 m, making them ideal components to meet the growing demand for Terradepth's survey services in shallow and medium depths.

The three Gavia AUVs are each equipped with an EdgeTech 2205 600/1,600-kHz module that retrieves both side scan sonar and bathymetric sonar data; Teledyne RD Instruments DVL-aided iXblue Phins C3 INS for accurate navigation; and field-replaceable battery modules from Teledyne Energy Systems for longer endurance.

Future updates include Teledyne T20 multibeam sonar and sub-bot-

tom profilers. The Gavia AUVs were also delivered with a science bay module in anticipation of installing scientific sensors based on operational need.

Terradepth's Absolute Ocean (AO) is part of Terradepth's survey-as-a-service offering. AO is a cloud-backed, browser-based, geospatial data platform that enables storage, search, visualization and analysis of ocean data, whether collected by Terradepth or a third party. This unique capability allows users to leverage geospatial ocean data on a petabyte scale to view, search and query from any web browser.

Angel Investor Funds Subsea Europe Services

New six-figure funding from an angel investor has strengthened hydroacoustic technology specialist Subsea Europe Services GmbH's commitment to taking autonomous

technologies to the next level for marine survey applications.

The investment boosts the company's focus on the integration of new-generation smart, AI- and machine learning-enabled hydroacoustic systems with diverse survey platforms, including AUVs, USVs and crewed vessels as survey motherships.

Subsea Europe Services (Sea Technology, February 2022) is working with several autonomy-focused partners globally, and the first fruits of these collaborations will be shown as early as April 2022 during demonstrations of a new solution created with MARTAC Inc., based on the high-performance Mantas T12 USV with a tightly integrated hydrographic survey payload.

The solution is expected to be ready for operation in May, with short, on-demand surveys at offshore wind farms projected to drive demand for the combination of a high-speed USV and increased autonomous payload functionality.

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Series A Funding for Port Digitalization Start-Up

Port digitization expert Innovez One has successfully completed a pre-Series A funding round. The round was led by Innoport, the corporate venture capital arm of the Schulte Group. The company also welcomed Haymon Sinapius, investment manager at Innoport, to the board of Innovez One Group.

Founded in 2004, Innovez One provides port management solutions for the world's busiest ports and towage operators, using its AI-powered MarineM software to optimize complex maritime port operations and services.

Innovez One's maritime digital solutions have transformed and supported ports around the world, including Singapore, Tanjung Priok (Indonesia) and Portsmouth (U.K.), by optimizing tug, pilot and launch boat operations in the "last mile" of the journey at sea. The company has recently won contracts to deploy its MarineM solution in Malaysia and in the Indonesian ports of Balikpapan and Belawan.

This digitalization is instrumental in unlocking new efficiencies, reducing waiting times, freeing up berths, and improving the management of tug and pilot orders and dispatch. The transition from the traditional use of manual processes to a digitized system helps address problems such as inefficient scheduling and personnel deployment, inaccurate job entries, delays in service response and wasteful fuel burn.

In ports where the solution has been deployed, the annual mileage of boats involved in towage and pilotage has been cut by up to 20 percent, leading to savings in fuel consumption and fleet maintenance costs, as well as a better utilization of resources. Wait times for incoming ships have also been significantly reduced.

Shell Acquires Powershop

Shell Energy Operations Pty Ltd., a wholly owned subsidiary of Shell plc, has completed the acquisition of Powershop Australia, an online energy retailer serving more than 185,000 customers. Powershop will

operate as a wholly owned subsidiary of Shell under the Powershop brand within the Shell Energy business in Australia, which is part of Shell's global Renewables and Energy Solutions business.

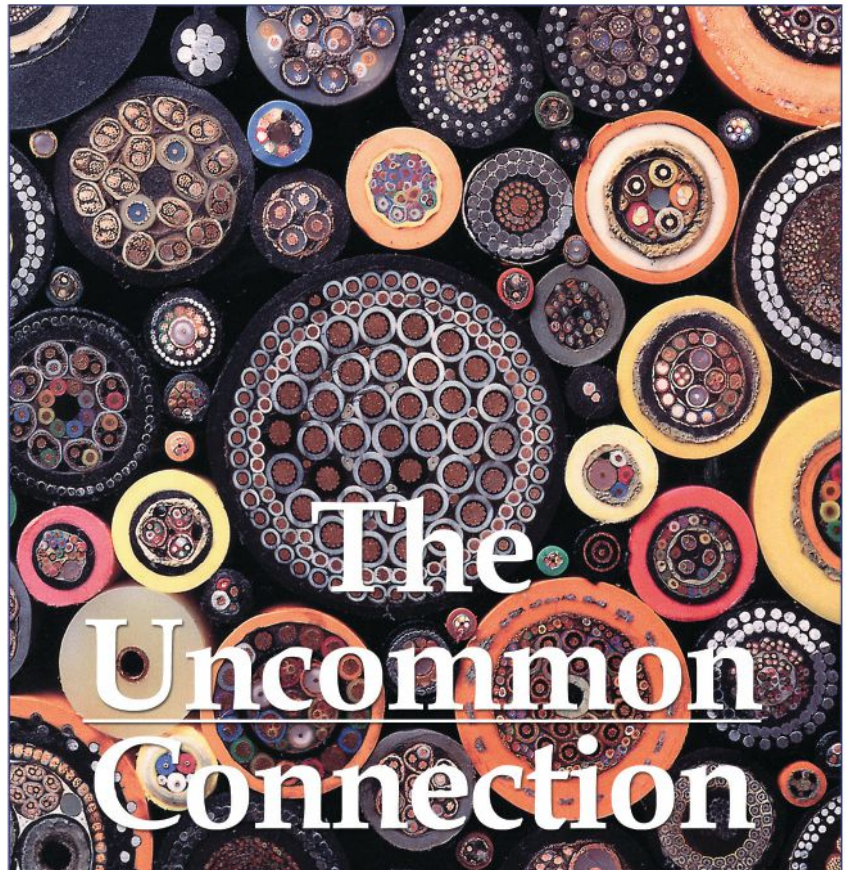
EEL Celebrates 40 Years

In the 1980s, the North Sea oil and gas industry was expanding rapidly. It was into this environment that Bruce Allen launched Explora-

tion Electronics (EEL) in May 1982, renting, servicing and maintaining seismic equipment to support oil and gas exploration.

Over the last 40 years, EEL has grown to support the offshore energy (oil and gas and renewables), engineering and survey industries worldwide.

The business specializes in renting geotechnical, geophysical and seismic equipment. **ST**



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JW Fishers Side Scan Sonar Aids Search and Recovery

According to the U.S. Centers for Disease Control and Prevention, 3,960 fatal unintentional drownings, including boating-related drownings, occurred in 2020. To locate the missing persons and provide closure to families, it takes dive teams time to assemble, gather equipment and begin searching, sometimes vast bodies of water.

Searching via divers is a long process that adds a considerable level of risk to an already dangerous assignment. One way to avoid that elevated risk is to use modern technology to help aid in the search. Side scan sonar technology enables a search and recovery team to scan local waterways quickly and produce a detailed image of the bottom, regardless of water clarity. JW Fishers produces both a single-frequency and dual-frequency side scan, as well as a new compressed high-intensity radiated pulse (CHIRP) system.

An example of the JW Fishers side scan sonar system in use is the Berkshire County Sheriff's Office assisting local and state authorities with the sonar in the search and recovery of a man gone missing in Pontoosuc Lake in Pittsfield, Massachusetts.

Other teams that use JW Fishers side scan sonars are: Columbia County Sheriff's Department in New York, the Union Fire Company in Pennsylvania, Webster Rescue Squad in Massachusetts, Livingston Parish Office of Homeland Security in Louisiana, Midland County Sheriff's Department in Michigan, Wheeling Police Department in West Virginia, Chautauqua County Emergency Services in New York, Miami-Dade Police Recovery Unit in Florida and the U.S. Navy's EOD Technology Division.

AIP for Onboard Carbon Capture and Storage System

The Korean Register (KR) has awarded approval in principle (AIP) to Samsung Heavy Industries (SHI)

and Panasia for their "Onboard Carbon Capture and Storage System (OCCS)," an eco-friendly technology that captures the CO₂ emitted in the exhaust gases generated from the internal combustion engines of ships.

The optimized wet-absorption type carbon dioxide capture device developed by SHI and Panasia is the result of three years of joint R&D and seeks to address the need for additional carbon reduction technology to realize carbon neutrality in the mid- to long-term. The system is the very first of its kind to be developed in Korea.

DNV Certifies Carbon Fiber for Thermoplastic Composite Pipe

Strohm and Evonik have been awarded the full certification from DNV, attesting that the unidirectional carbon fiber PA12 tape "VESTAPE PA12-CF" (PA12) used for Strohm's thermoplastic composite pipe (TCP) is fit to use for dynamic sweet and sour hydrocarbons, water and gas injection applications according to DNV-ST-F119.

The two companies, in partnership with the Netherlands Aerospace Centre (NLR), have led the way in the development, qualification and supply of PA12 for TCP applications following an intensive investment and testing program over the past five years.

The novel knowledge-based approach introduced in DNV-ST-F119 and fully utilized by Strohm and Evonik has been trailblazing in seeking a fundamental understanding of the material to demonstrate the lifetime performance of a product operating in a challenging chemical, thermal and mechanical environment. It has established a relationship between the functional requirements of a pipe and the performance characteristics of its materials.

PA12 is a fully nonmetallic, corrosion-resistant solution. Carbon fibers make it exceptionally resistant to fatigue-based failures, making it suitable for any dynamic applica-

tion, from jumpers to flowlines and risers. The high stiffness of carbon fibers paired with the load transfer capability of PA12 as matrix also enables it for deepwater service and operating pressures up to 700 bar and temperatures up to 80° C. The material has been qualified for a lifetime of up to 30 years.

Further expansion of the scope will include hydrogen and carbon capture, utilization and storage.

TCP is a strong, noncorrosive, spoolable, lightweight technology that is delivered in long lengths, resulting in a significant reduction of transportation and installation costs. TCP is installed using small vessels or subsea pallets, significantly reducing CO₂ emissions. It is also 100 percent recyclable.

3-MW Hydrogen Fuel Cell

ABB and Ballard are progressing with their partnership to decarbonize marine transport with an approval in principle (AIP) from DNV for their high-power fuel cell concept, the development of which was launched in 2018. The solution can now be completed within the next couple of years.

The high-power fuel cell unit will support the energy needs of a diverse range of vessels requiring multiple 3-MW blocks of power. For example, a cruise vessel operating in coastal areas could either run entirely on fuel cell power or switch to it when operating in environmentally sensitive areas or emission control zones, while a ferry with a regular schedule and frequent bunkering opportunities could operate solely on fuel cell power. For ocean-going vessels, fuel cell power could support auxiliary needs. The solution could also integrate with an energy storage system.

Fuel cells turn the chemical energy from hydrogen into electricity through an electrochemical reaction. When renewables are used to produce the hydrogen, the entire energy chain can be clean. Having a larger, megawatt-scale power unit makes it feasible to combine units to reach much higher total power than is practically possible with smaller power units. **ST**

iXblue SAS for Ifremer

Ifremer, the French Research Institute for Ocean Science, has received its new synthetic aperture sonar (SAS) from iXblue for the institute's 6,000-m-rated AUV dedicated to deep-sea exploration.

The Sams-150 SAS has a swath width of 500 m for a constant resolution of 6 cm. With its interferometric processing, a high-resolution bathymetric model can be generated simultaneously with the production of the imaging data. The Sams-150, coupled with an inertial navigation system and an acoustic positioning system, ensures precise georeferencing of each pixel, thus enabling the creation of homogeneous maps over large areas. The SAS was designed by seeking the best compromise between mapping coverage and energy consumption.

New Member of Ocean Visions

The Ocean Frontier Institute (OFI) has joined Ocean Visions as a research consortium member to contribute ocean science expertise and ocean assets toward solving some of the largest challenges in oceans and climate. The OFI, a transnational Canadian organization housed at Dalhousie University and Memorial University, Canada, leads at the frontier of ocean research to inform ocean policy and industry to develop a sustainable blue economy. The OFI joins Ocean Visions together with leading academic institutions such as Georgia Tech, MIT and Woods Hole Oceanographic Institution, and impact partners such as Creative Destruction Lab and AGU.

Ocean Visions connects research institutions, governments, investors and industry so that they can collaborate on the development, testing and deployment of scalable and equitable solutions at the ocean-climate nexus, with a specific focus on three grand challenges: reversing the climate crisis in the ocean, building resilient coastal systems and communities, and building a climate-resilient aquatic food system.

Sequoia Receives NSF Grant For Bio-Optical Sensor R&D

Sequoia Scientific Inc. has been awarded a U.S. National Science Foundation (NSF) Small Business Technology Transfer (STTR) Phase I grant for \$254,110 to conduct research and development for a bio-optical sensor for direct detection of sinking marine particles.

Sequoia's Vice President of Science and Technology Dr. Wayne Slade will lead the development as principal investigator, collaborating with Dr. Meg Estapa at the University of Maine (UMaine), School of Marine Sciences.

Almost 4,000 ocean-profiling floats are in operation globally. Hundreds of new floats are deployed each year, measuring a wide range of ocean science and climate change parameters. Scientists and policy makers are increasingly interested in measuring biogeochemical parameters that provide key data on biological ocean carbon uptake, which helps the ocean store carbon dioxide but could be impacted by climate change.

Within the scientific community, there is significant interest in development of new technology to measure the flux of carbon by particles settling out of the ocean's surface.

With the new NSF grant, Sequoia and UMaine will work on developing an "optical sediment trap" sensor that can directly measure the settling particles that carry the greatest amount of biological carbon into the deep ocean. The sensor will be small and power efficient to address the challenges of multi-year deployments from autonomous profiling floats and scaling to a global float array.

Once a small business is awarded a Phase I SBIR/STTR grant (up to \$275,000), it becomes eligible to apply for a Phase II grant (up to \$1,000,000).

Small businesses with Phase II funding are eligible to receive up to \$500,000 in additional matching funds with qualifying third-party investment or sales.

During Phase I, Sequoia and UMaine will focus on sensor optical, power and fluid dynamics modeling. The results will guide a series of laboratory tests and prototype concept development.

An actual prototype and in-situ test on deployed floats would be part of an eventual Phase II award (24 months duration), and a commercial instrument would be ready immediately after Phase II.

Arctic Climate Expedition

Geoquip Marine's Integrated Geotechnical Survey Vessel (IGSV) *Dina Polaris* has been selected to undertake a vital scientific research expedition to recover core samples in the Arctic.

The expedition, known as ArCoP, is part of the International Ocean Discovery Program (IODP), a joint venture between the European Consortium for Ocean Research Drilling (ECORD), the Swedish Polar Research Secretariat (SPRS) and Arctic Marine Solutions (AMS). Its purpose is to gain more understanding of the effects of global climate change in this key location. It is IODP Expedition 377.

ArCoP will explore a critical time interval spanning the period when prominent changes in global climate took place, during the transition from the early Cenozoic Greenhouse world to the late Cenozoic Icehouse world.

An international team of scientists will collect about 900 m of sediment cores at two sites along the Lomonosov Ridge. The expedition will last for about seven weeks offshore, followed by intensive investigation and sampling of the cores onshore.

The expedition will demand a bore depth of 900 m in about 800 to 900 m of water, which is the deepest of any project previously undertaken by Geoquip Marine, in addition to the extreme harsh operating environment that it will encounter. *Dina Polaris* will be accompanied by two ice breaker vessels on the expedition.

The expedition will depart in August, and work is scheduled to last for a month. **ST**

contracts

BMT, London, U.K., has been awarded a design contract for three new crew transfer vessels (CTVs) to be operated at wind farms in the U.S. East Coast. The design features a lightweight Z-bow hull form to improve seakeeping characteristics, and high efficiency reduces emissions. Undisclosed.

The UK Hydrographic Office (UKHO), Taunton, U.K., has signed a new three-to-five-year framework contract for satellite-derived bathymetry. The first survey will cover the waters of Belize. This will be the first complete survey of some of these waters, including where uncharted coral pinnacles are currently noted on the chart. EOMAP.

Miros, Asker, Norway, RangeFinder will support a river management system developed as part of the large-scale European River Information Services Enabled Corridor Management Execution project that enables the authorities and logistics sector to manage traffic and transport; improve the safety, efficiency and reliability of inland navigation; and increase environmental protections. Hungarian National Association of Radio Distress-Signalling and Infocommunications.

GE Power Conversion, Rugby, U.K., will be project lead on transformative design and novel manufacturing techniques to significantly increase power density of high-power electrification systems. This project will help to enable industrial decarbonization. UK Research and Innovation.

ioCurrents, Seattle, Washington, has chosen a company to help promote its digitization services to ship operators servicing the Indian seafaring sector. Vin Marine Services.

applied acoustics, Great Yarmouth, U.K., has partnered to implement the Nexus 2 USBL systems with 2780 directional transceivers on survey vessels. GEOxyz.

Wärtsilä Corp., Helsinki, Finland, will identify, evaluate and implement solutions to increase fuel efficiency and significantly reduce greenhouse gas emissions from offshore vessels. Solstad Offshore.

The Nippon Foundation-GEBCO Seabed 2030 Project, London, U.K., has a new partner to further understanding of ocean bathymetry and contribute to the global effort to produce the definitive map of the ocean floor by 2030. The International SeaKeepers Society. **ST**

meetings

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

MAY

May 2-5—Offshore Technology Conference, Houston, Texas. www.otcnet.org.

May 5-6—Maritime Reconnaissance and Surveillance Technology USA, Arlington, Virginia. www.maritime-recon-usa.com.

May 17-19—AAPA Smart Ports Seminar & Expo, San Pedro, California. rgross@aapa-ports.org or <https://tinyurl.com/mrx5c97p>.

May 24-26—International Mine Technology Symposium, Monterey, California. <https://minwara.org/symposium>.

May 31-June 1—International Marine Contractors Association Dynamic Positioning Conference, Amsterdam, Netherlands. events@imca-int.com or www.imca-int.com/calendar/imca-dp-conference.

JUNE

June 1-2—Navigate, Turku, Finland. info@navigate.fi or www.navigate.fi.

June 1-3—MegaRust, San Diego, California. 703-836-6727, asnehq@navalengineers.org or www.navalengineers.org/Symposia/FMMS2022.

navalengineers.org/Symposia/MR2022.

June 6-9—Canadian Hydrographic Conference (CHC), Gatineau, Canada. chc2022.org.

June 7-9—Undersea Defence Technology (UDT), Rotterdam, Netherlands. www.udt-global.com.

June 19-24—Frontiers in Hydrology Meeting, San Juan, Puerto Rico, and Virtual. www.agu.org/FIHM.

June 21-23—Interspill, Amsterdam, Netherlands. +0333 444 1890, info@interspill.org or www.interspill.org.

June 27-July 1—UN Ocean Conference, Lisbon, Portugal. <https://www.un.org/en/conferences/ocean2022>.

June 28-30—Euromaritime, Marseille, France. www.euromaritime.fr.

JULY

July 3-8—International Coral Reef Symposium, Bremen, Germany. www.icrs2022.de.

AUGUST

August 23-24—CLEAN PACIFIC, Renton, Washington. www.cleanpacific.org.

SEPTEMBER

September 18-23—International Marine Debris Conference, Busan, South Korea. www.7imdc.org.

September 19-22—Moored Systems for the Future Buoy Workshop, Wilmington, North Carolina. <https://mtsociety.memberclicks.net/buoy-workshop>.

September 20-22—Fleet Maintenance & Modernization Symposium, Virginia Beach, Virginia. 703-836-6727 or www.navalengineers.org/Symposia/FMMS2022.

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

people

James Fisher Renewables (JF Renewables), a part of James Fisher and Sons, has appointed **Maida Zahirovic** as APAC regional vice president to strengthen operations within Asia Pacific, including driving long-term, sustainable and profitable growth in the region. With more than 11 years in the wind industry, she joins JF Renewables from her previous role as business director, Taiwan at Vestas. Her previous posts include sales and bid management leadership roles at MHI Vestas Offshore and project management and consultant roles with Siemens Wind Power and MAKE Consulting.



Marcus Jadotte has joined Crowley as senior vice president of government relations, leading the company's advocacy activities across all its businesses. Jadotte will spearhead the company's continuing advocacy for laws and regulations that support the domestic maritime industry while expanding awareness of Crowley's

defense and civilian government services among federal, state and local officials. He will be based in Washington, D.C. Jadotte was previously vice president of federal government relations at Raytheon Technologies.

PMI Industries Inc. has appointed **Robert (Bob) J. Centa**, M.B.A., as president. Centa succeeds Bob Schauer, who is retiring after 17 years of service to PMI. Centa has over 25 years of experience in leadership, strategy, operations and finance in manufacturing and distribution in a wide range of industries and companies.

Phoenix International Holdings Inc.'s Area Manager for Bayou Vista, Louisiana, **Troy Turner** has been elected to the executive board of the U.S. Gulf of Mexico Diving Safety Workgroup (DSWG), a noncompetitive and non-commercial industry group. Turner has 30+ years of experience in the oil and gas industry.

Pioneer Consulting, a full-service submarine fiber-optic telecommunications consulting and project management company, has hired **Austin Shields** as director of client solutions. He brings eight years of submarine cable experience in mechanical and electrical engineering.

MacDermid Offshore Solutions has appointed **Ken McKenzie** as global director of drilling products and **Daniel L. Gaspard** as global director of subsea products. Both are based in Houston. McKenzie will grow the offshore drilling segment and identify new opportunities to serve customers. Gaspard will drive innovation and the international growth of MacDermid's new eco-friendly subsea product lines. **ST**

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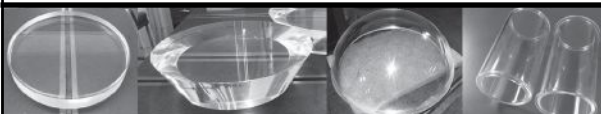
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Maritime 4.0: Opportunities and Challenges—Fabian Fussek

Fabian Fussek is the co-founder and CEO of Kaiko Systems, a fast-growing maritime safety tech company, www.kaikosystems.com. Previously,



Fussek worked on building digital products and businesses in various industries, working with Deloitte Digital, Zenhomes (acquired by Scout24) and others. He studied economics, sociology and politics at Zeppelin University in Friedrichshafen.

Data transmission in real time has become commonplace, from which Industry 4.0 benefits greatly. This development is also reflected in the maritime economy, an essential part of global supply chains. The term for this new, digitally enabled industry is “Maritime 4.0.”

Maritime 4.0 is intended to extend the life cycles of ships, improve performance, reduce operating costs and increase safety and reliability. Thus, Maritime 4.0 has four essential elements: automated data integration for decision making, networked technologies for operations, sustainable methods throughout a ship’s lifetime and cost-effective processes.

In the context of Industry 4.0, we speak of four maturity levels through which a company progresses: visibility, transparency, predictability and adaptability. None of these stages can be skipped in the development process if potential is to be maximized.

Relating these stages to the maritime industry, there are two primary concerns. First, the visibility of historical and real-time information is still far from comprehensive. Second, the data specifications and formats used must be standardized.

Hence, there are two phases of maturity that the maritime industry needs to tackle to develop smart capabilities. Phase one entails gaining quick wins by data standardization

and visualization and streamlining processes. Phase two entails achieving smart capabilities by leveraging a single platform of information.

Digitization in shipping is progressing rapidly, and the COVID pandemic has accelerated this development by three years (<https://thetius.com/changed-world>). The global market for digital products and services in the maritime sector will grow to \$159 billion in 2022. Investment in digital technologies is also growing, with 85 percent year-over-year growth in 2021.

This digital acceleration is an urgently needed development for the industry. At the same time, challenges that come with this development must be addressed.

One of these challenges is security: Maritime safety remains a high priority, with unresolved issues. Predictive maintenance is a trending topic, but unlike in the manufacturing industry, it is still far from being implemented comprehensively in maritime. This is due to expensive sensor installation that many shipping companies shy away from for various reasons.

However, companies can benefit now from digital possibilities without an upfront investment in sensors. The principle applies of thinking big but starting small and acting quickly. For example, companies can start digitizing inspection processes without sensors, giving the people on board tools that make it fast and easy to collect reliable data. The data can then be evaluated in the context of clear standards and show trends immediately that normally would only be identified by digging through piles of paper reports after an incident has already happened.

Another challenge is data management: The maritime industry has a history of having inaccurate and/or delayed information among different stakeholders. There are currently no satisfactory solutions to

standardization, as the information gap brings short-term gains, but it is in the best interest of the industry to unlock long-term benefits by sharing required information quickly and efficiently, using collectively agreed-on standards.

Sustainability is yet another challenge. The most discussed topic in 2022 was how shipping must become sustainable, and quickly, in order to meet the growing demands of environmental regulations around the world. The International Maritime Organization (IMO) is calling on the industry to reduce carbon intensity by 40 percent by 2030 and by 50 percent by 2050 (compared to 2008 levels) through energy efficiency improvements, new technologies and low- or zero-carbon fuels. Solutions need to be found on a broad scale, as time is short to meet the goals and the necessary changes are large.

In consideration of digital potential for the maritime industry, one angle is vastly underestimated: the human factor. Seafarers have suffered greatly from the pandemic, with resignation rates rising significantly since its start: from 2 to over 15 percent in some companies, according to *TradeWinds*. Today, it is more urgent than ever to always consider the well-being of the crew when planning and changing processes. Increasing their job satisfaction on the high seas means increasing the quality of operations and reducing downtime.

The vision of Maritime 4.0 is to have a higher level of automation, enable predictive maintenance, create self-optimizing processes and, above all, increase efficiency in all areas without disregarding human well-being. To achieve this, data standardization is a must. The COVID pandemic has accelerated the digital transformation in maritime, and the trend is irreversible. The industry should embrace the change and make good use of it. **ST**

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