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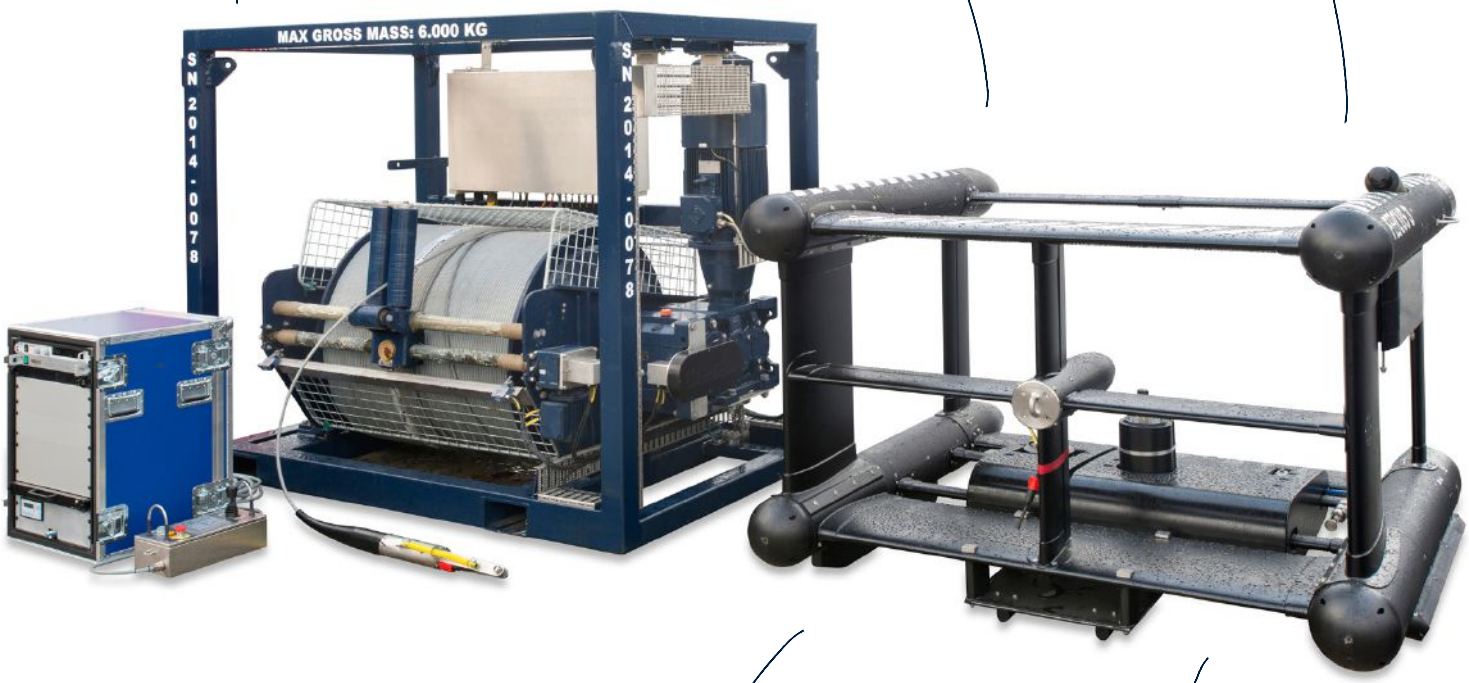

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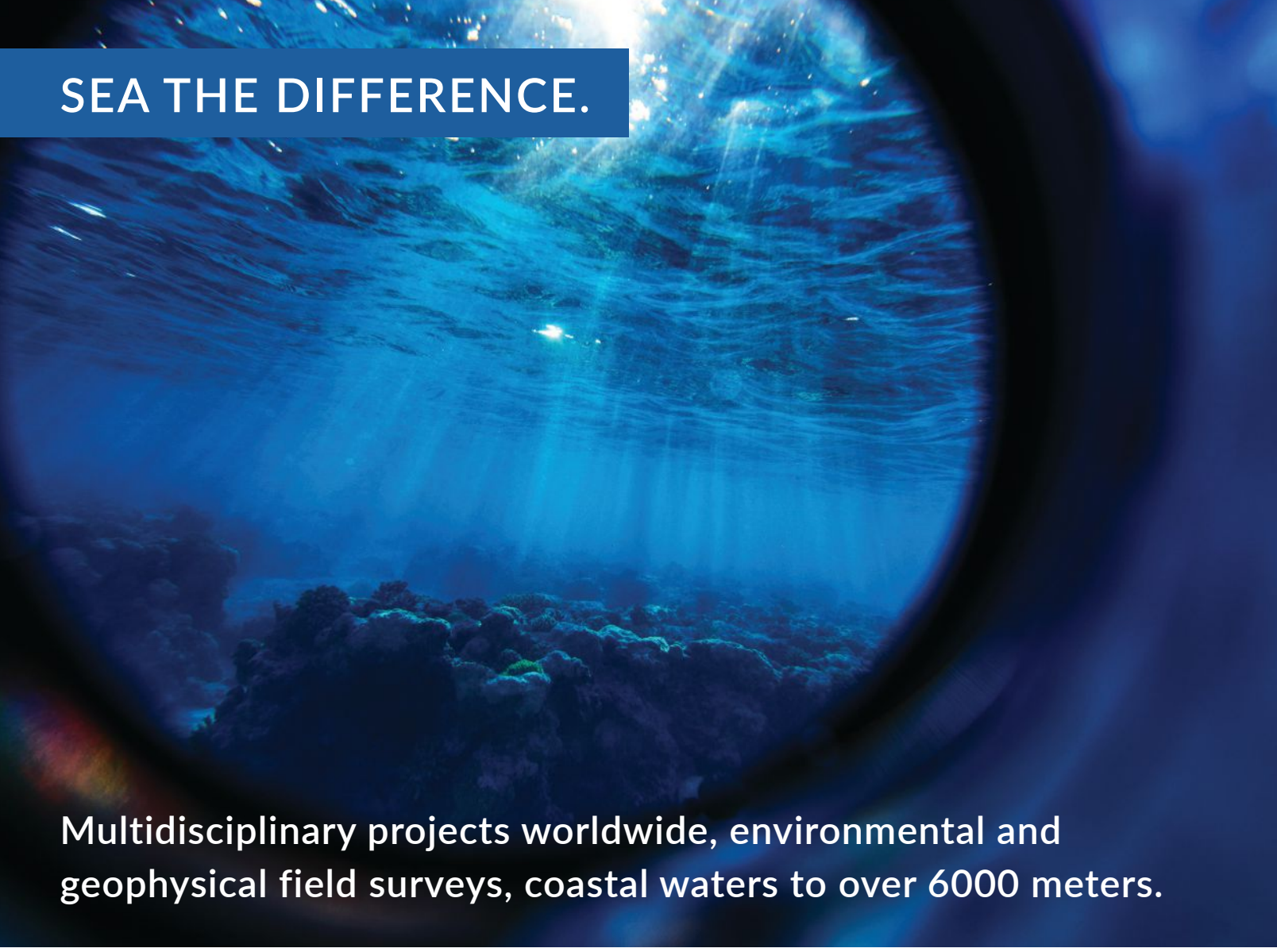

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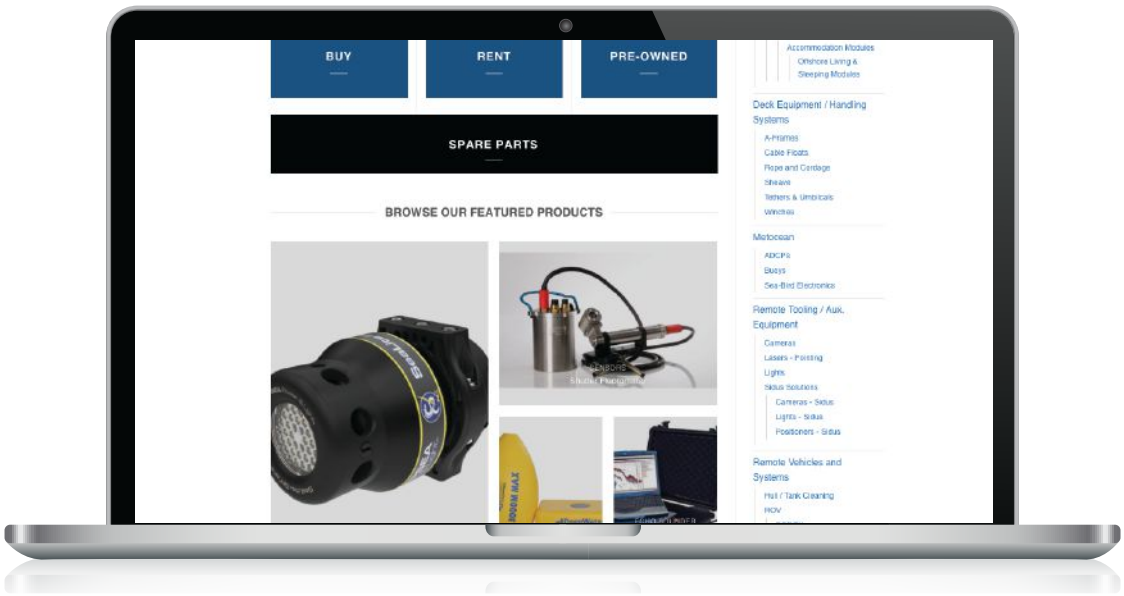

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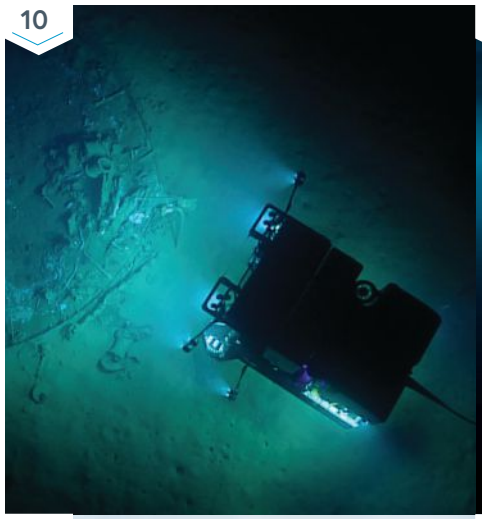

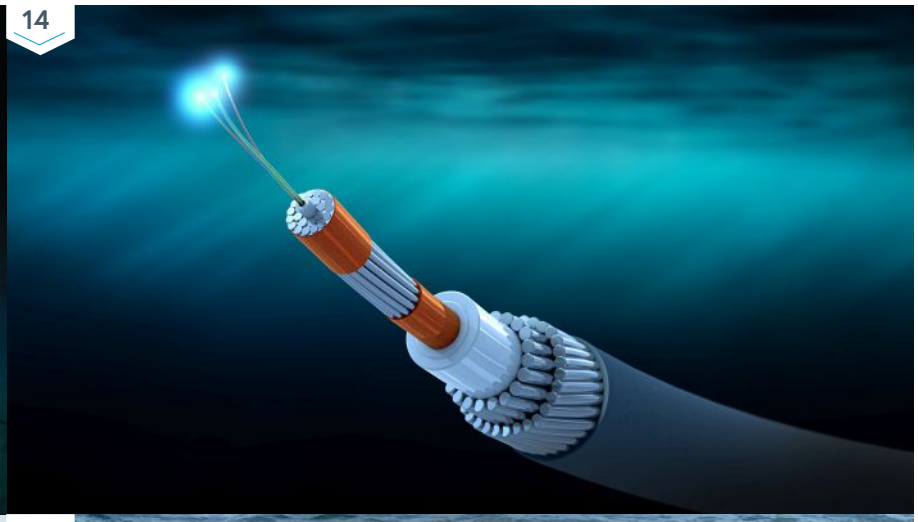

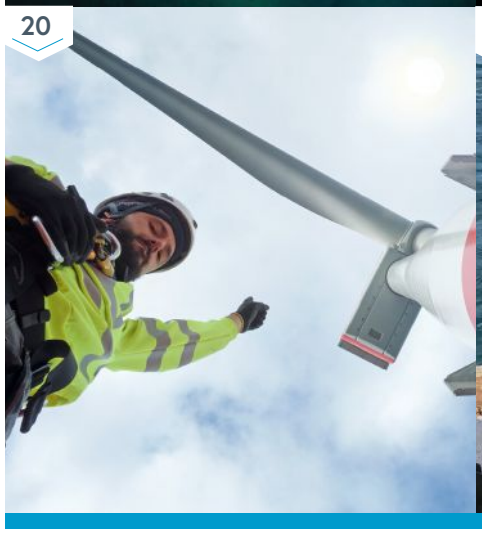

FEATURES

DEPARTMENTS

IN EVERY ISSUE

ON THE COVER:
The ex-USS Kittiwake Submarine Rescue vessel is popular with divers. She sank at the northern end of Seven Mile Beach, on the West side of Grand Cayman.

DISCLAIMER: *Our About the Cover last month contained a typo. The correct caption should read: The NOAA Office of Ocean Exploration and Research (OER)'s remotely operated vehicle, Deep Discoverer, being recovered during the Windows to the Deep 2019 expedition. Image courtesy of NOAA OER, Windows to the Deep 2019.*

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NOIA APPLAUDS SAFETY OVERSIGHT FOR OFFSHORE RENEWABLE ENERGY FACILITIES

ERIK MILITO,
President, National Ocean Industries Association (NOIA)

With $70 billion in capital investments projected by 2030, 160,000 domestic jobs projected by 2050, and $473 million already generated to the U.S. Treasury from lease sales to date, offshore wind is a vital part of America's all-of-the-above energy strategy and provides energy security and economic growth for our nation.

In mid-October 2019, the Department of the Interior (DOI) announced steps to ensure workplace safety on Outer Continental Shelf (OCS) renewable energy facilities. The new policy, publishing in the Federal Register clarifies that DOI will act as the principal Federal agency for the regulation and enforcement of safety and health requirements for OCS renewable energy facilities. The policy does not apply to workplace safety and health requirements for OCS marine energy projects or OCS renewable energy facility support vessels, which fall under different jurisdiction.

The policy requires, for example, that regulated entities must implement a Safety Management System (SMS) for activities conducted on an OCS renewable energy leases. It also promulgates regulations requiring self- and agency-conducted inspections and incident and equipment failure reporting, and providing a range of enforcement tools. DOI's available enforcement actions include issuing noncompliance notices, ordering cessation of activities, cancelling a lease or grant, and assessing civil penalties.

DOI will continue to collaborate with the Occupational Safety and Health Administration (OSHA) and the U.S. Coast Guard to share relevant safety and training information and promote safety on the OCS. To date, DOI has leased approximately 1.7 million acres in the OCS for offshore wind development and currently has 15 active leases on the Atlantic, from Cape Cod to Cape Hatteras.

NOIA applauds the Department of the Interior (DOI) for clarifying its authority as the primary regulator and enforcement agency for worker safety and health on outer continental shelf renewable energy facilities. We encourage DOI to continue to move forward on developing safety regulations for the rapidly emerging U.S. offshore wind industry. With 15 active offshore wind leases and several offshore wind projects in various stages of development, it is crucial that safety regulations be developed and finalized by the time construction begins. Safety remains the offshore energy industry's top priority and we look forward to working with DOI to establish a world-class safety regime for U.S. offshore wind.

ABOUT NOIA

NOIA is a national trade association representing all segments of the offshore industry with an interest in the exploration and production of both traditional and renewable energy resources on the nation's outer continental shelf. For more, visit www.noia.org.

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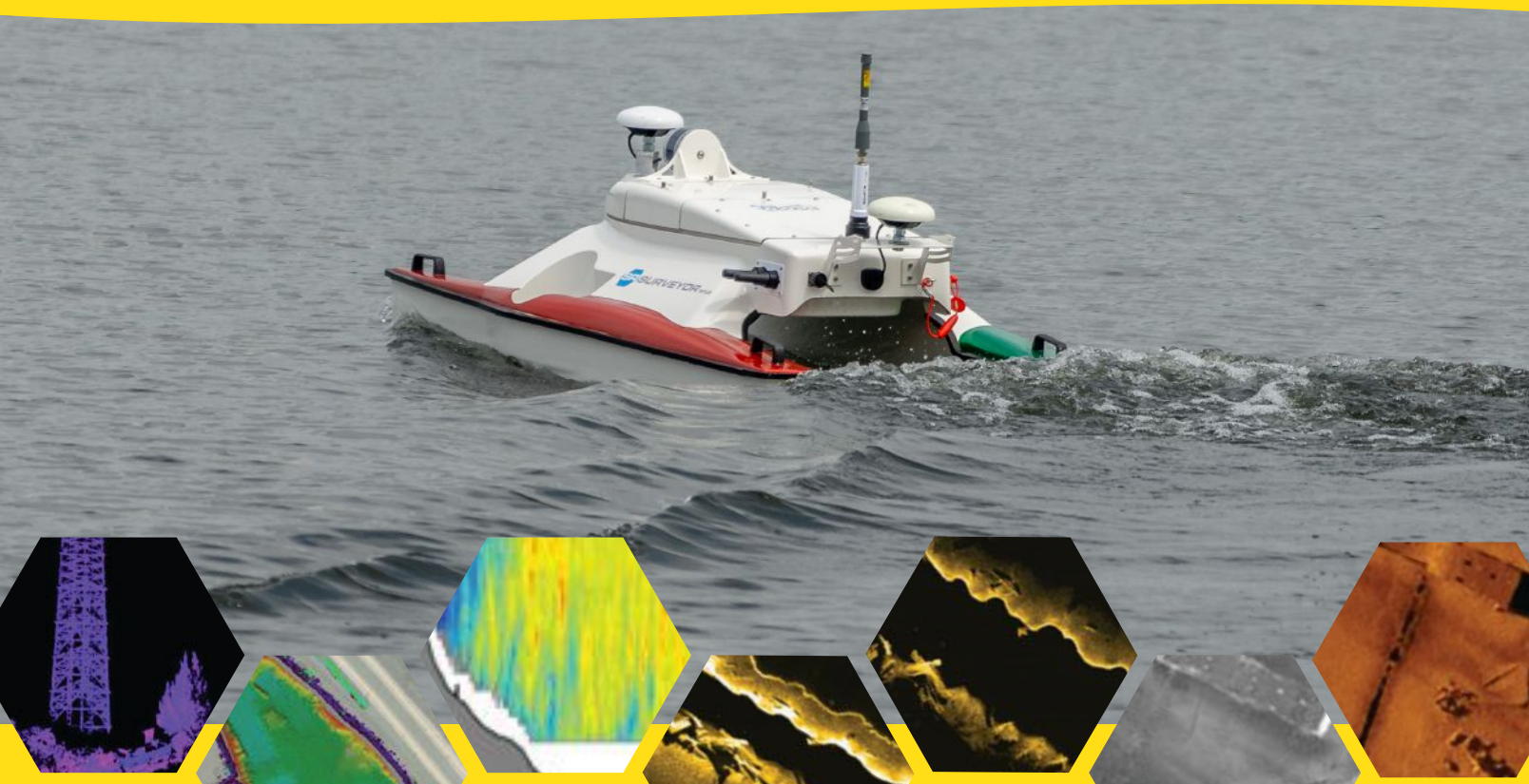

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SUBMERGED SECRETS

As ongoing discoveries rock the underwater archaeology world, ON&T asks how private corporations, charitable foundations, and governments can fund the high-res mapping of our coastlines

» *Figure 1: The NOAA Office of Ocean Exploration and Research's remotely operated vehicle Deep Discoverer images "Wreck 15377." First identified from an oil and gas industry survey back in 2002, the wreck, which lies in the Gulf of Mexico at more than 700 meters depth, had never been visually surveyed until NOAA imaged it in 2017. Image courtesy of the NOAA Office of Ocean Exploration and Research, Gulf of Mexico 2017.*

For thousands of years, the majority of submerged sites were protected by their inherent inaccessibility, but advances in technology are having a profound impact on the world's submerged cultural resources and rewriting the way archaeologists view prehistoric peoples.

It hints at a vast potential, but predicting the next discovery can be hard, because before any archaeologist can study artifacts from a submerged site, that site must first be discovered (and protected).

As one paper published in the journal *Conservation and Management of Archaeological* sites put it, "Developmental pressures on the sea are growing rapidly from, for example, aggregate, oil and gas extraction; wind farm construction; port development, and dredging for shipping channels. Knowledge to inform responses to such developments is unevenly spread, and of inconsistent coverage and quality. Records map the few known historic wreck sites yet research in some areas has confirmed extensive survivals of submerged prehistoric landscape with archaeological remains and paleoenvironmental preservation."[i]

From the shallow waters of southeastern Scandinavia to the former shorelines of the Hudson River estuary, as well as sites as far flung as Helnæs Bay, the Baltic Sea, the Solent, and even coastal Australia, the end of the last Ice Age also meant the demise of many prehistoric coastal settlements. In 2014, divers exploring six submerged Neolithic villages on the Mediterranean coast, found a preserved water well beneath the sea near Haifa, Israel that some believe may be the oldest wooden structure ever found. Archaeologists theorize that the 7,700-year-old village was submerged as the sea level rose as a result of melting icecaps and glaciers. More recently, the University of Southampton's Black Sea MAP (Maritime Archaeological Project) began surveying the Bulgarian waters of the Black Sea where large areas of land were inundated as the water level rose after the last Ice Age.

According to geologists, most of northern Europe was covered in ice during the last Ice Age. About 18,000 years ago, however, a slow warming allowed a vast area between Britain and mainland Europe to grow grasses, which attracted game animals and humans. Eventually, this place we now call Doggerland warmed into a land of rivers, lagoons, wetlands and marshes that supported a substantial human settlement.

In May 2019, a team from Belgium and the UK led by Dr. Tine Missiaen from the Flanders Marine Institute (VLIZ) used the Belgian research vessel *Belgica* to explore three sites of archaeological interest in the southern North Sea (all contained in an area called Brown Bank, roughly 100 km due east from Great Yarmouth).

To plan their expedition, the team employed a model of the drowned landscape built by conducting geophysical surveys and combing the results with data provided by oil and gas companies, windfarm developers, and the UK's National Coal

Board. The resulting uninterrupted model of the sub-bottom helped identify areas of the landscape with a higher likelihood of past human activity.

Dr. Missiaen's team recovered two stone artifacts that could be over 10,000 years old. One was a small piece of flint that was possibly the waste product of stone tool making. The second was a larger piece, broken from the edge of a stone hammer used to make other flint tools. (Figure 2) The team also collected sediment samples and video footage from the seafloor. When combined with samples acquired in the area for Europe's complimentary Lost Frontiers project, the case for Neolithic human activity in land now submerged beneath the North Sea is strong.

As fantastic as these discoveries are, there remains just as much promise on other continents. For example, on 30 August 2019, a research team led by Professor Loren G. Davis of Oregon State University published a paper in the journal *Science* suggesting that the first people in the Americas arrived over 16,000 years ago via the sea, not across an ice corridor as previously believed. [ii]

Excavating at the Cooper's Ferry site in western Idaho, Davis' team uncovered almost two hundred stone artifacts upon which they used radiocarbon dating and Bayesian analysis to provide solid evidence that humans arrived in the Americas before an inland ice-free corridor had opened.

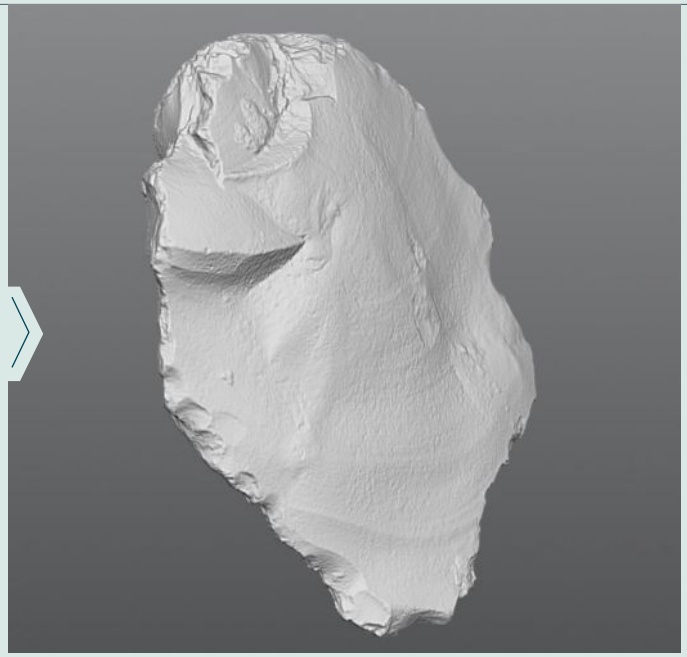
"Early peoples moving south along the Pacific coast would have encountered the Columbia River as the first place below the glaciers where they could easily walk and paddle into North America," explained Dr. Davis.

Davis has been mapping probable archaeological sites off the northwest coast of America for over a decade. He says that due to sea level rise, more than half of Oregon's archaeology sites are now located offshore, out to 30 miles or so. He believes that merging local data on sea level and site survival with modelling procedures could advance underwater research for archeological sites along the Northwest coast of the Americas.

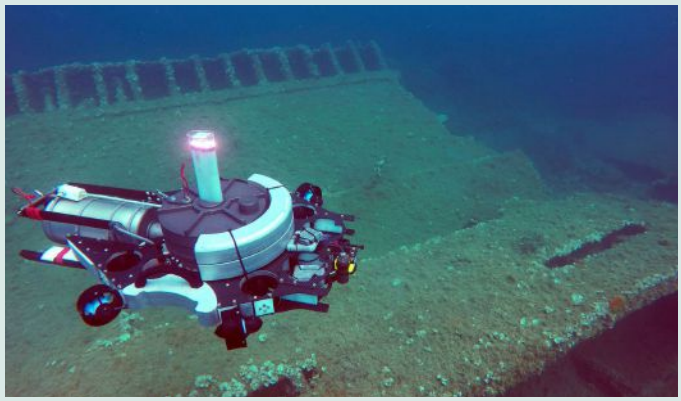
In 2014, for example, another Oregon State study challenged the theory that prehistoric sea level rise happened uniformly. Jorie Clark, a courtesy professor at OSU and lead author of the 2014 study, explained that during the last deglaciation, land which had been depressed under the weight of large ice sheets began to rise while, conversely, ocean basins were depressed by the weight of melt water returning to the oceans.

> *"This exchange of mass between ice sheets and oceans led to significant differences in sea level at any given location from the assumption of a uniform change," Clark says.*

The researchers ran models of what the sea level may have looked like over the last 20,000 years and concluded that parts of the West Coast looked radically different than previous reconstructions. For example, the central Oregon shelf some 14,000 years ago was previously thought to be characterized by a series of small islands. However, the models suggest that much of the continental shelf was exposed as a solid land mass, creating an extensive coastline. In some areas, the change in estimated sea level may have been as much as 100 feet. Their study was published in the *Journal of Archaeological Science*.



» *Figure 2: Hammerstone fragment from the Southern River Valley section of the 2019 VLIZ/Europe's Lost Frontiers Brown Bank survey. Image courtesy of Sketchfab.*



» *Figure 3: The archeosub, Zeno, a tiny autonomous underwater vehicle (AUV) equipped with video and sonar equipment, has been used by Italy, in cooperation with the Israel Antiquities Authority, to facilitate the discovery and mapping of archaeological finds spread out across the bottom of the Mediterranean Sea. Photo credit: Walter Daviddi.*

» *Figure 4: The Black Sea MAP project utilizes the RV Stril Explorer, a state-of-the-art offshore survey vessel equipped with advanced underwater survey systems, which are carried on two ROVs.*

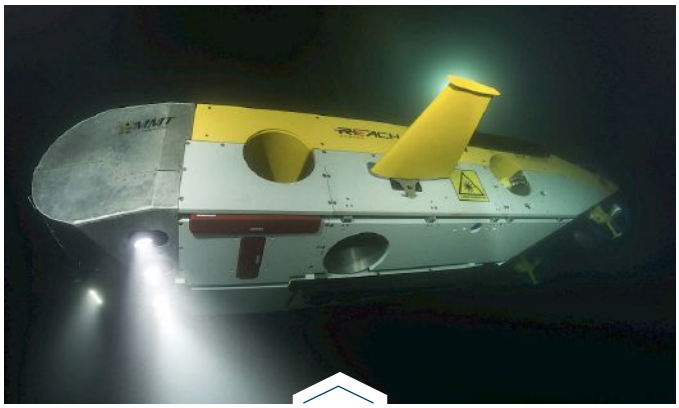
"This new look at sea level changes helps explain how that earlier introduction into the Americas could be possible," said Clark. "It is also important for predicting where coastal villages that are now submerged on the continental shelf may be located."

In 2016, yet another Oregon State product, anthropologist Jon Krier, collaborated with the Confederated Tribes of Grand Ronde on Predictive Modelling of Submerged Sites. Predicting the location of ancient coastal villages that are now submerged is of tremendous interest to the Confederated Tribes, who say they need to conduct a thorough cultural resource assessment before energy companies are given access to the coastal areas their ancestors occupied.

To inform his project, Krier researched the traditional oral histories of Indigenous Northwest groups. While tribal stories had already led to real world findings, such as a now submerged natural dam in the Columbia River and the location of sunken ships, Krier also found clues in ancient creation legends. For example, the history of the Haida people says that they came to their current home on British Columbia's Haida Gwaii Island in order to escape advancing ice, a tale that has been confirmed by geological studies.

For the Confederate Tribes study, Krier used sonar data provided by NOAA to model the coastlines of the past, but it's not as easy as just plugging the data into a model. This was adjusted for the silt and glacial deposits that have changed submerged landscapes, as well as the movement of continental glaciers, which caused tremendous bulges and depressions.

As a result of Krier's work, a new set of coastline change models for the last 20,000 years were developed. These models were examined for landscape features that would have likely been culturally significant, such as drainage systems on submerged areas, as well as looking at how the landscape changes compared and related to traditional tribal histories. The analyses revealed a highly dynamic coastal landscape that was very different from the modern coastline, with peninsulas, bays, and even a large coastal plain that disappeared beneath the sea as water levels rose after the end of the Pleistocene. According to Krier, the main features of the region's modern coastline dates from about 4000 years. (Figure 7)



» *Figure 5: Surveyor Interceptor ROV. Photo credit: Jonas Dahm.*

For the Pacific Northwest coast of North America, *in situ* study remains limited, but predictive modelling could greatly reduce the amount of time and money spent to find submerged resources.

Can we increase funding available for submerged landscape archaeology?

Sometimes, underwater archaeology happens by accident. In 2018, divers from Seasearch were studying marine life near the shoreline of England's Norfolk coast when they discovered a prehistoric forest dating back 10,000 years. Their photos offered our first glimpse of a vast forest into which the inhabitants of Doggerland must have once hunted. Indeed, the study of this vast submerged landscape has benefitted by leveraging other work from a multitude of sources. Recently developed maps of the region would be based on informed guesswork if not for extensive seismic reflection surveys carried out for petroleum exploration.

The key lesson is not that underwater archaeology can be done on the cheap or by chance. Quite the opposite. The fact that Doggerland went unmapped for so long underscores the incredible amount of evidence that remains beneath coastal waters. If we truly want to understand how our ancestors lived, a long-term source of dedicated funding is required, preferably with cooperation by stakeholder industries.

For example, marine archaeology was part of a nine-year scheme funded by the UK's Department of Rural Affairs, which gathered information to help address the environmental impacts of marine aggregate (e.g., sand and gravel) extraction. Called the English Heritage Aggregates Levy Sustainability Fund (ALSF), 2002-2011, that program aimed to reduce the impact on the historic environment of aggregate extraction (e.g., sand and gravel). Among the worthwhile projects it funded was the reconstruction of prehistoric landscapes and the development of tools for the virtual exploration of deep underwater archaeology sites.

For more recent high-profile discoveries, partnerships between commercial companies and archaeological researchers have played a major role in reducing costs. Of course, when archeologists and commercial marine survey companies collaborate, both entities can benefit, in particular when the contribution from the commercial entities is integrated into their normal operations.[iii]

In the case of the University of Southampton's Black Sea MAP, an international team has been funded by the charitable Expedition and Education Foundation, which was established to support marine research. The team includes researchers from the University of Southampton's Centre for Maritime Archaeology (CMA), the Bulgarian National Institute of Archaeology with Museum and the Bulgarian Centre for Underwater Archaeology (CUA). Partner institutions include the Maritime Archaeological Research Institute at Södertörn University, Sweden; the University of Connecticut, USA; the Hellenic Centre for Marine Research, Greece; and Swedish commercial marine survey company MMT.

The project utilized MMT's RV *Stril Explorer* (Figure 4), a state-of-the-art offshore survey vessel equipped with advanced underwater survey systems which are carried on two Remotely Operated Vehicles (ROVs): *Supporter* and *Surveyor Interceptor*. The *Supporter* is optimized for high resolution 3D photogrammetry and video. The *Surveyor Interceptor*—designed by Ola Oskarsson and developed in close cooperation between MMT Sweden, Reach Subsea, and Kystdesign—flies at three times the speed of conventional ROVs and carries an entire suite of

geophysical instrumentation as well as lights, high definition cameras and a laser scanner.

The demands of archaeological research can generate new technological solutions that have commercial application, as well as producing results with wider educational and social benefits. In the course of the Black Sea MAP project, *Surveyor Interceptor* set new records for both depth (1800m), sustained speed (over 6 knots), and covered a distance of 1,250 km.

Provided that archaeological investigations are embedded in the normal commercial operations of the company, such collaboration can be cost-effective for both parties, and is further enhanced by collaboration with film companies, which generates wider public interest and publicity for all concerned."[iv]

One of the most successful funding apparatuses for underwater archaeology was a research network funded by the European Commission under its COST program (Cooperation in Science and Technology) called SPLASHCOS (Submerged Prehistoric Archaeology and Landscapes of the Continental Shelf, 2009 to 2013). That program was instrumental in providing the scientific basis for funding the high-resolution mapping of submerged landscapes in the southern North Sea. Aside from researchers, the workshop was also attended by representatives from the Bureau of Ocean Energy Management (BOEM) and Native American tribal leaders.

At a June 2019 NSF Workshop on the Submerged Paleolandscape Archaeology of North America held in the Smithsonian Natural History Museum, Dr. Loren Davis and Dr. James Dixon focused on the topic of making national progress on the search for submerged pre-contact period sites on the US continental shelf zones. Specifically, they talked about a SPLASHCOS-type organization that might unify the many interested parties in some way under a single framework. In conjunction with that discussion, the two invited Geoff Bailey, Vince Gaffney, and Martin Segschneider to attend and share their experiences with SPLASHCOS.

Davis informs ON&T that he and Dixon are working to complete a report that summarizes insights from the NSF workshop and makes recommendations for next steps. Once it's been submitted to NSF, ON&T will share insights from that report. Given the success of the European Commission's efforts, it could be just a matter of time before efforts of a similar scale are underway off the coasts of North America.

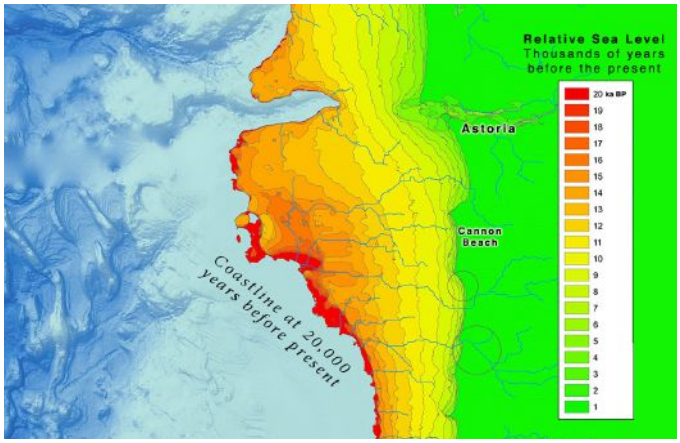
[i] *Dellino-Musgrave, Virginia, et al. (2009) Marine Aggregates and Archaeology: a Golden Harvest?, Conservation and Management of Archaeological Sites, 11:1, 29-42.*

[ii] *Loren G. Davis, et al. (2019) Late Upper Paleolithic occupation at Cooper's Ferry, Idaho, USA, ~16,000 years ago. Science, Aug 30th, 2019.*

[iii] *Holmlund J., Nilsson B., Rönnby J. (2017) Joint Explorations of the Sunken Past: Examples of Maritime Archaeological Collaboration Between Industry and Academia in the Baltic. In: Bailey G., Harff J., Sakellariou D. (eds) Under the Sea: Archaeology and Palaeolandscapes of the Continental Shelf. Coastal Research Library, vol 20. Springer, Cham*

[iv] *Holmlund, J, ibid.*

» *Figure 6: The scientists surveying Brown Bank in the southern North Sea were able to take samples from a submerged Mesolithic landscape, including a fossilized forest. Image courtesy of Dr. Simon Fitch - Europe's Lost Frontiers Project (University of Bradford).*



» *Figure 7: Isostatically Adjusted Paleoshorelines Map for portions of what is today southern Washington and northern Oregon. This area, which includes the coastal basin of the Columbia River, is a detail from a larger map, which shows the entire coast for both states. Image courtesy of Oregon State University and the Confederated Tribes of Grand Ronde.*

» *Figure 8: ROV image shows the level of preservation that the Black Sea offers. Coils of rope and carvings are still looking fresh after hundreds of years. Photo Rodrigo Pacheco-Ruiz.*

THE BLUE INNOVATION SYMPOSIUM
TO KICK START A NEW DECADE FOR THE BLUE ECONOMY

The Blue Innovation Symposium is gearing up for its annual event in in Newport RI. The founding principle of the conference, which takes place from January 14 – 16, 2020, was to create a specific meeting of blue tech market players with a focus on business-to-business networking and creating partnerships between New England and the global marketplace. The event works to shine a light on some of the more dynamic and exciting breakthroughs in the market. This has proved particularly attractive to startups over the years as it affords them the unique opportunity to engage hard-to-reach industry leaders, government officials and marine tech associations.

The 2020 Blue Innovation Symposium theme, **Sensors and the Next Wave of Data**, fits right into that principle.

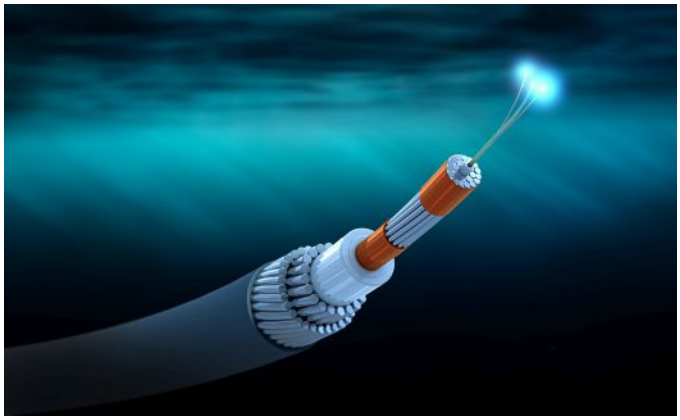
THE DEMAND FOR DATA

Oceans are notoriously difficult environments to study and it's only within the last 50 years that sensor technology has enabled us to make any systematic and scientific interpretation of what lies beneath. Advances in software and hardware, especially in consumer electronics and the internet, have yielded a massive scaling of data in recent decades. But the implications for the maritime realm are yet to be felt—compared to the terrestrial data we harvest to make informed decisions on dry land, we're oceans apart.

The tides seem to be shifting, however; today, our demand for secure, real-time data acquisition compels sensor manufacturers to respond with ever-smarter solutions powered by increasingly efficient, integrated and perceptive components. After all, the capacity of sensors—along with advances in Artificial Intelligence, Big Data analytics and IoT-enabled devices—is what truly defines the reach, accuracy and applicability of the highly technical systems used in marine research and exploration. In short, sensors are the eyes and ears of the Blue Economy.

INNOVATION, OUT OF THE BLUE

According to Tobias Stapleton, Dean of Graduate Studies at Salve Regina University and one of the event's founders, the



intimacy of the format has become increasingly important to participants: "Since its inception in 2015, the Blue Innovation Symposium has always been an event organized by the blue tech community, for the blue tech community. Our goal remains to facilitate a 'meeting of minds' and offer participants an 'Access All Areas' pass to this fertile ground for business development and networking."

If attendance is any indicator, it appears to be a recipe for success; year-on-year attendance continues to grow and last year's Blue Innovation Symposium welcomed more than 250 attendees, 36 sponsors, and key representatives from the US Navy, the US Naval Undersea Warfare Center (NUWC), and Association for Unmanned Vehicle Systems International (AUVSI). Registration for 2020 is in full swing.

SPONSORS AND EXHIBITORS ON EQUAL FOOTING

As sensor technology races into a new decade, so does our ambition and appetite for meaningful data. The theme for January's event—Sensors and the Next Wave of Data—is right on point. While the full agenda is still being finalized, the program is compelling. The recent announcement of several high-profile keynoters, including Jim Bellingham, Director of the Center for Marine Robotics at Woods Hole Oceanographic Institution (WHOI), and Olivier Cadet, President of Kongsberg Maritime US. This caliber of confirmed speakers is supported by an impressive cast of company sponsors, such as FLIR, Hydroid, and Geospectrum Technologies. Refreshingly, there's no distinction between sponsors and exhibitors—they are one and the same—and there are tiered packages to fit all budgets.

FLASH TALKS

Another standout aspect of the Blue Innovation Symposium is the conference's approach to its call for papers. The agenda is populated with a series of technical presentations and panel discussions, naturally, but it's also punctuated by a succession of five-minute flash talks, which essentially gives companies a chance to showcase products and services to a captive audience of key influencers and decision makers.

This approach has proved popular over the years according to Justin Manley, President of Just Innovation Inc. and member of the organizing committee: "The flash talks have become a central feature of the Blue Innovation Symposium. At larger, more traditional conferences it's often easy to get drowned out by the noise and distraction but our aim has always been to encourage attendees to network. Flash talks allow a large portion of our audience to directly participate in the program."

Also new for 2020 is the participation of a media partner, none other than ON&T. Whilst the ON&T editorial team have covered the event in the past, this is the first time that the publication has sponsored the conference. The publisher of ON&T, TSC is one of the event's organizers, alongside Salve Regina University and The Canadian Consulate in Boston.

For more information about the Blue Innovation Symposium, including details about how to attend, sponsor or submit a flash talk proposal, visit at *www.blueinnovationsymposium.com*.

STORMQUAKES:
STRONG STORMS OFTEN GENERATE EARTHQUAKE-LIKE SEISMIC ACTIVITY

» *The term "stormquakes" describes a newly identified geological phenomenon where hurricanes or other strong storms trigger seismic events.*

A Florida State University researcher has uncovered a new geophysical phenomenon where a hurricane or other strong storm can spark seismic events in the nearby ocean as strong as a 3.5 magnitude earthquake.

"We're calling them stormquakes," said lead author Wenyuan Fan, an assistant professor of Earth, Ocean and Atmospheric Science. "This involves coupling of the atmosphere-ocean and solid earth. During a storm season, hurricanes or nor'easters transfer energy into the ocean as strong ocean waves, and the waves interact with the solid earth producing intense seismic source activity."

The research is published in the journal Geophysical Research Letters .

Fan and his colleagues analyzed nearly a decade of seismic and oceanographic records from September 2006 to February 2019 and found a connection between strong storms and intense seismic activity near the edge of continental shelves or ocean banks.

Specifically, researchers found evidence of more than 10,000 stormquakes from 2006 to 2019 offshore of New England, Florida and in the Gulf of Mexico in the United States, as well as offshore of Nova Scotia, Newfoundland and British Columbia in Canada.

"We can have seismic sources in the ocean just like earthquakes within the crust," Fan said. "The exciting part is seismic sources caused by hurricanes can last from hours to days."

Fan and his colleagues developed a novel approach to detect and locate seismic events and determine whether the seismic event is a stormquake. It must occur during a stormy day and meet other geophysical standards to determine the robustness of the correlation between the storm and the seismic event. Additionally, other seismic events such as earthquakes must be ruled out.

One example the researchers cited was Hurricane Bill, an Atlantic hurricane that originated on August 15, 2009, strengthened into a Category 4 hurricane and ultimately struck Newfoundland as a tropical storm. It was a Category 1 hurricane when it approached offshore New England on August 22, 2009.

When the hurricane arrived, numerous seismic events were located off the New England and Nova Scotia coasts, which produced transcontinental surface waves.

Similarly, Hurricane Ike in 2008 caused stormquake activity in the Gulf of Mexico and Hurricane Irene in 2011 did the same near Little Bahama Bank off Florida's shore.

Fan and his colleagues noted that not all hurricanes cause stormquakes. There are hotspots. Scientists detected no evidence of stormquakes off of Mexico or from New Jersey to Georgia in the United States. Even Hurricane Sandy, one of the costliest storms on record in the United States, did not spur stormquakes.

This suggests that stormquakes are strongly influenced by the local oceanographic features and seafloor topography, Fan said.

"We have lots of unknowns," Fan said. "We weren't even aware of the existence of the natural phenomenon. It really highlights the richness of the seismic wave field and suggests we are reaching a new level of understanding of seismic waves."

Researchers from Woods Hole Oceanographic Institution as well as Scripps Institution of Oceanography and the U.S. Geological Survey contributed to this research.

WWW.FSU.EDU

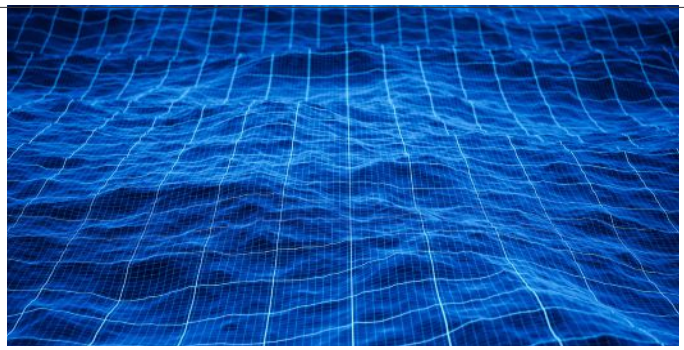
OCEAN DATA PLATFORM SUPPORTS MARINE RESOURCE MANAGEMENT

Only five percent of the ocean has been fully explored, but a new consortium is working to develop a comprehensive, opensource, digital platform to inform actions and policies designed to ensure protection of our ocean, responsible management of marine resources and sustainable future economic growth.

The Ocean Data Platform (ODP) initiative was officially launched on 22 October 2019 at Norway's Our Ocean Conference in Oslo.

Data Fusion technology from Cognite—the Scandinavia technology company that recently expanded into the US (Austin and Houston)—will serve as the backbone of the ODP initiative. The platform is not a traditional data center, rather a cross-sector partnering between commercial and non-profit entities working as the Ocean Data Foundation. It's on a mission to create an ecosystem around ocean data to let algorithms and applications harness the power of different sources and formats, contextualize that data, and provide APIs that enable all users to build applications.

The Ocean Data Foundation is also one of the key partners at the newly established Centre for the Fourth Industrial Revolution Norway (C4IR Norway), launched in September at the World Economic Forum (WEF) as part of its global C4IR network. The



Centre will provide a platform for partnerships on governance policies, research and business solutions that can accelerate the application of science, data and technology in the public interest. The Centre will be an independent non-profit foundation, financed initially by founding partner the Aker group. Aker has gained valuable experience through engaging in cross-sector partnering between its own commercial and non-profit entities, such as REV Ocean, Ocean Data Foundation and VI Foundation. Once operational, the Centre will be open to new partners and projects from both the public and the private sector.

The Aker group, founding partner of the C4IR Norway, is composed of Aker, Aker BP, Aker BioMarine, Aker Energy, Aker Solutions, Cognite and Kvaerner, as well as Ocean Data Foundation and REV Ocean. The Centre will at first be based at the Aker headquarters at Fornebu, Norway, before moving into the World Ocean Headquarters, an ocean cluster being developed by Aker and REV Ocean. It officially opens on 1 January 2020.

www.weforum.org/centre-for-the-fourth-industrial-revolution.

ENERGY DEPARTMENT FUNDS MARINE AND HYDROKINETICS SECTORS WITH CLOSE TO $25M

The US Department of Energy (DOE) has announced selections for up to $24.9 million in funding to drive innovative, industry-led technology solutions to advance the marine and hydrokinetics industry and increase hydropower's ability to serve as a flexible grid resource. Some key projects being funded under this initiative are listed below, for a full list, visit *www.energy.gov/articles/doe-announces-249-million-funding-selections-advance-hydropower-and-water-technologies*.

Littoral Power Systems of New Bedford, Massachusetts, will partner with Whooshh Innovations to develop a fish passage module that can be used to accommodate multiple species simultaneously and can be easily integrated into Littoral's SMH system. The prefabricated modular hydropower system, known as ZAO, is a kit of parts that can be flexibly configured for a variety of small, low-head hydropower projects.

Ocean Renewable Power Company of Portland, Maine, will develop and demonstrate a modular system where each turbine generator unit is installed as a standalone unit with the option for attaching adjacent modules to form either horizontal or vertical arrays. The modules can be used to fit specific river geometries and other river constraints.

ABB Inc. of Cary, North Carolina, will use a pair of vertical cycloidal rotor modules with independent blade control to deliver a 30-kilowatt (kW) power generation system. The rotor can propel and maneuver the floating platform at the deployment location.

Columbia Power Technologies of Charlottesville, Virginia, will develop a standards-compliant, fabrication-ready design of its next-generation WEC. Using composite materials to reduce capital expenditures and a permanent magnet generator to maximize efficiency, the project will design a scaled-up version of the existing Water Power Technologies Office-funded device that is set for testing at Hawaii's Wave Energy Test Site.

CalWave Power Technologies of Berkeley, California, will design the next generation of its submerged pressure differential WEC. Using depth control and variable geometry for load shedding, the WEC will be capable of an annual average power output of 45 kW.

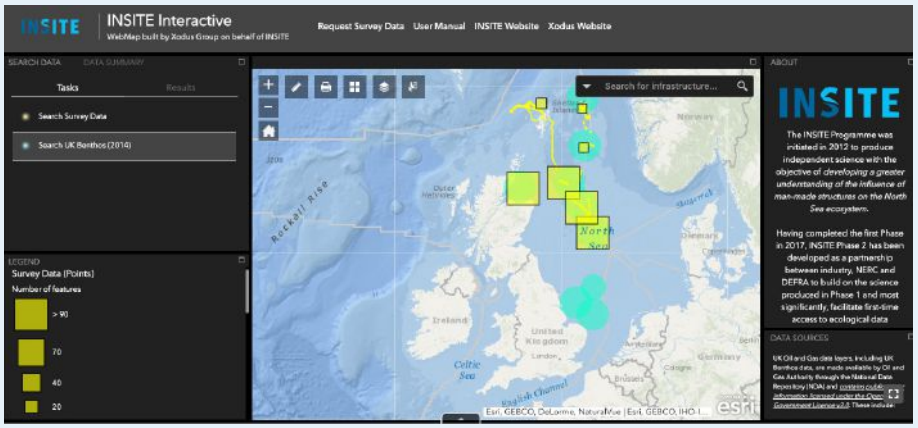
IDOM of Minneapolis, Minnesota, will build the next generation of its oscillating water column device, previously tested off the coast of Spain. The team will develop a more cost-competitive device by using advanced controls, improved structural design, and improved turbine design.

Stevens Institute of Technology of Hoboken, New Jersey, will design a 100 kW annual average electrical power WEC that utilizes two surge devices mounted on a single buoyant platform. The devices will be controlled by an integrated control system to maximize power production based on wave conditions.

Pacific Marine Energy Center (formerly known as the Northwest National Marine Renewable Energy Center) , operated jointly by Oregon State University, the University of Washington, and the University of Alaska Fairbanks, facilitates the development of wave, tidal, and in-river energy converters through research, education, outreach, and environmental characterization, design, and operation of testing sites.

Hawaii National Marine Renewable Energy Center, operated by the University of Hawaii, emphasizes wave energy and ocean thermal energy conversion and boasts a collaborative wave energy test site with the U.S. Navy.

Southeast National Marine Renewable Energy Center, operated by Florida Atlantic University, focuses on ocean currents and ocean thermal energy conversion and specializes in environmental baseline observation systems.



INSITE PROGRAM LAUNCHES MAJOR INDUSTRY-SCIENCE COLLABORATION

The INSITE Program has launched a major collaboration between offshore industries and researchers, designed to give marine scientists access to valuable industry-acquired ecological data.

INSITE is a scientific research programme to increase understanding of the influence of man-made structures on the ecosystem of the North Sea. It has attracted recognition and support from industry, government through BEIS and DEFRA, and the scientific community through the Natural Environment Research Council (NERC). Now in its fifth year, following the completion of a Foundation Phase of research, the Program has moved into a second phase.

A key outcome from the Foundation Phase was that new data is needed to maximize the outcomes from the science program. The second phase of INSITE has been developed in partnership with NERC and CEFAS, which in addition to a significant funded research program, also includes a ground-breaking data collaboration between industry and science. A new GIS-based data sharing portal 'INSITE Interactive' has been developed to give scientists visibility of industry data made available for INSITE researchers.

Commenting on the launch of INSITE Interactive, INSITE Program Director, Richard Heard said: "This data Initiative is crucial to furthering the scientific objectives that were set out by INSITE in 2014. At the conclusion of a successful INSITE Phase 1, the need for high quality data to describe the ecosystem in the North Sea and enhance the scientific outcomes from the research was clear.

"This tool has been developed to provide a robust process for scientists to identify data collected by industry during their operations, which could be used to further research into the role of anthropogenic structures in the ecosystem. The new portal provides a GIS-based reference for sourcing industry held ecological data relating to offshore structures. We are pleased that the initiative has been enthusiastically embraced by the research community developing proposals under the NERC call and look forward to extending access to the wider scientific community."

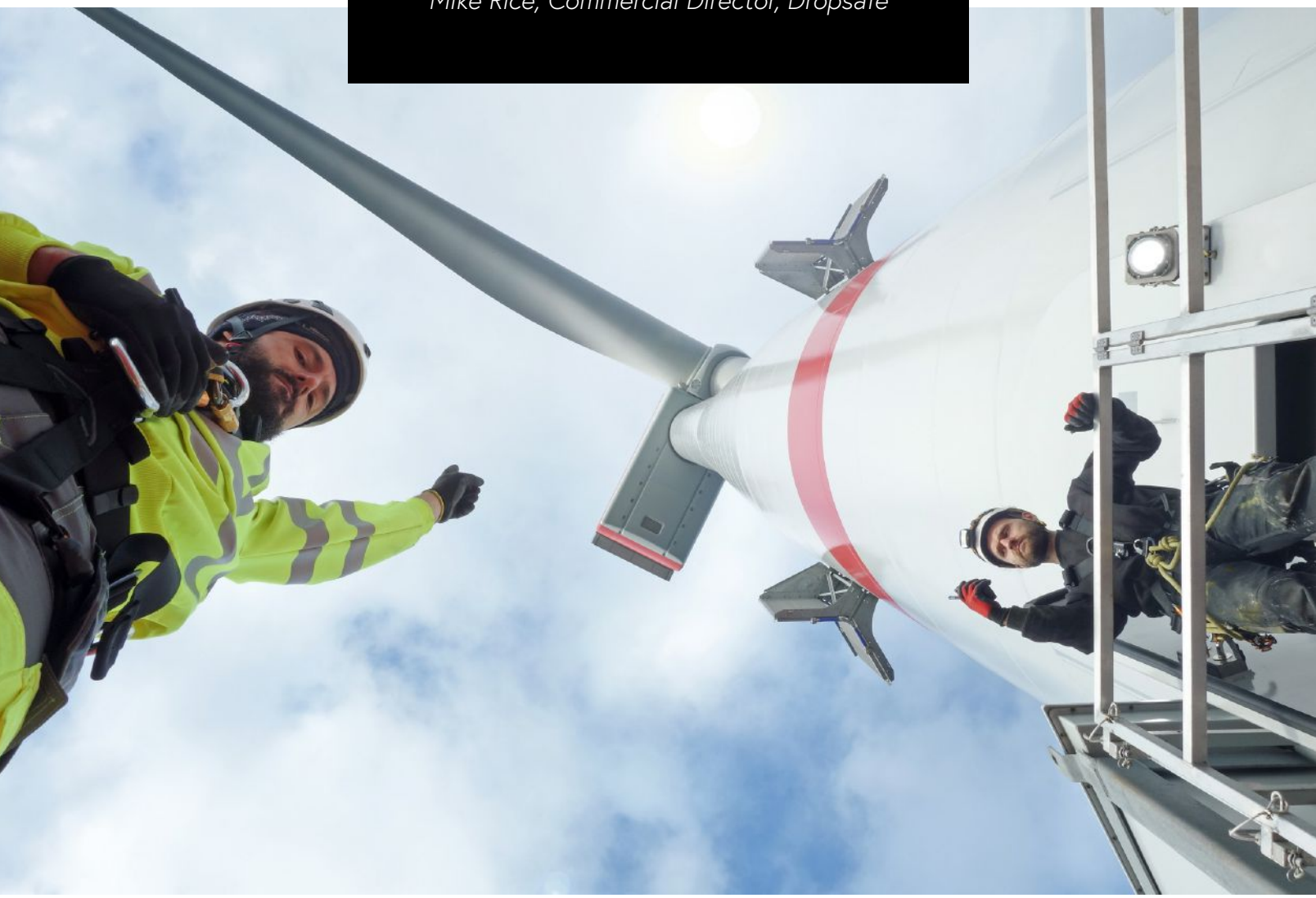
With its specialist GIS capability, Aberdeen based energy consultancy Xodus Group was selected to facilitate the delivery of the tool.

The INSITE Program is an independent scientific research project, developed and launched by industry in 2014; its aim is to provide all stakeholders with the independent scientific evidence-base needed to better understand the influence of man-made structures on the ecosystem of the North Sea. Man-made structures include oil and gas and wind energy infrastructure and wrecks. The Program is based on an innovative governance model, which ensures the direction and scientific scope is determined by an independent science board and its findings are published in peer reviewed journals.

For more information visit:
WWW.INSITENORTHSEA.ORG

LESSONS FOR OFFSHORE WIND: THE OIL & GAS EXPERIENCE

Mike Rice, Commercial Director, Dropsafe



As the acknowledgement of Dropped Object (Drops) risks in offshore environments evolves, the offshore wind sector is beginning to take steps to mitigate these risks. Firms have the opportunity to take a leadership role in implementing Drops prevention measures, gaining benefits in personnel safety, long term cost reduction, and recognition as industry leaders in health and safety best practice.

The Oil & Gas (O&G) industry has built on decades of experience to refine its Drops mitigation best practices. There is now extensive support for Drops prevention within the sector, largely a by-product of proactive efforts by Health & Safety managers. For offshore wind firms, there are clear lessons to be learned from O&G and its approach to 'self-regulation'.

DROPPED OBJECT RISK IN THE OFFSHORE WIND SECTOR

The offshore environment poses inherent risks to personnel and assets. There is a lack of comprehensive data on the incidence and effects of Drops within offshore wind. It is clear however, that as the offshore wind sector expands globally, the number of Drops has the potential to increase accordingly, unless action is taken.

Drops can be 'static', from normally immobile objects such as a broken light fixture or a loose bolt, or 'dynamic', including hand-held equipment carried by maintenance teams and objects from moving components. A Drops incident can occur for a number of reasons, including corrosion of wind turbine components as a result of harsh offshore environments, vibration from operations, or human error.

Drops incidents present a risk to the immediate safety of technicians and engineers. There are clear emotional consequences of severe Drops incidents that lead to injuries and fatalities, impacting firm morale, as well as the family of the workers involved. Drops incidents involving workers result in operational time being lost from injuries, but there are also compensation costs involved with more severe incidents.

Of all the Drops incidents recorded in 2018, over 10% caused asset damage[1]. The costs associated include the repairs and replacement of damaged equipment and components, but also the costs incurred due to asset downtime, which can be even more significant.

Data regarding asset damage costs is not widely available, as companies generally avoid publishing statistics which might risk reputational damage. Unless there is a widespread movement to combat Drops risks, the end result could be tragic, resulting in severe reputational damage to the firms involved and the wider industry.

The current regulatory situation in the offshore wind sector places responsibility on operators to manage foreseeable risks under general construction regulations mandated by the UK's Health & Safety Executive. The 2018 edition of *Working At Height In The Offshore Wind Industry*[2] , a Good Practice Guideline by G+, refers only to the pre-existing guidelines from DROPS, the Oil & Gas industry-wide working group on Dropped Objects[3].

There is also a gap between official recognition of best practice standards in offshore wind, and the consistent implementation – or lack thereof – of this guidance indicated by highly variable safety performance. For instance, in 2017, G+ reported 169 Drops incidents, which is more than double the incidents in 2016[4]. G+ statistics from 2017 to 2018's Incident Report showed a 60% reduction in Drops occurrences. This shows the industry still has a significant distance to go before reliable Drops prevention across the board is achieved.

HOW OFFSHORE WIND CAN LEARN FROM OIL & GAS

The offshore O&G industry has historically faced similar Drops risks to offshore wind, due to operating in adverse weather conditions and in similar environments with personnel working at height. The O&G sector is however, larger and more mature than offshore wind, thus providing a good standard for new offshore markets, such as wind energy, to follow.

Drops are one of the top ten most frequently reported causes of accidents in O&G[5], an industry that has historically prioritised health and safety. This means that robust safety solutions are now commonplace throughout the sector, leading to a widespread use of secondary retention nets, tethered equipment pouches and barriers to tackle Drops risk.

Similar to offshore wind, there is still no completely comprehensive and specific Drops legislation in O&G. Despite this, the O&G sector has adopted a measure of self-regulation. This allows individual projects to implement tailored solutions, rather than suffering the imposition of outside regulation, which may result in delays and additional costs. This experience shows that Drops risk can be suitably tackled by the prompt and proactive actions of companies.

BEST PRACTICE IN THE OFFSHORE WIND SECTOR

The experience of the O&G sector provides an opportunity for offshore wind to take on lessons learnt in the sector regarding Drops best practice. The recognition of the problem within O&G has driven innovation by Drops prevention firms to supply cost-effective solutions for a wide variety of offshore applications.

These solutions can easily be installed at wind farms around the world. For example, the Formosa 1 windfarm in Taiwan set a new standard in safety with the installation of Dropsafe Nets, preparing the operator to deal with typhoons and prevent dropped tools falling from the turbine platform during the installation phase of the project. Companies which lead the way in this respect will gain a competitive edge compared with companies which fail to prepare.

If the Offshore Wind industry as a whole does not take swift action to comply with Drops best practice, operators could lose their independence, as outside regulatory bodies step in to fill the vacuum. This will incur unnecessary costs and reduce the flexibility of firms to react to new developments.

Ultimately, the reputation of offshore wind is inextricably linked to the sector's capacity to proactively manage health and safety risks to workers and assets. By pre-empting this threat, lives could be saved, and investors can be assured of the security of their assets.

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[1] *https://www.gplusoffshorewind.com/__data/assets/pdf_file/0005/638861/PDF-G-2018-incident-report.pdf*

[2] *https://www.gplusoffshorewind.com/?a=633556*

[3] *https://www.dropsonline.org/*

[4] *https://www.gplusoffshorewind.com/__data/assets/pdf_file/0003/633567/gplus-2017-incident-report.pdf*

[5] *http://www.dropsonline.org/assets/DROPS%20Intro.pdf*

FOUR IMPRESSIVE TECHNOLOGIES EXHIBITED AT OCEANS 2019

The annual OCEANS conference and exhibition is a hotbed of the latest amazing tools, and this year's edition in Seattle, Washington did not disappoint. Below are four technologies that caught our eye during OCEANS '19. You can find these technologies in our Check the Tech spotlight (pg. 24) and catch a sixth in our Subsea Intervention and Survey Section (pg. 34).

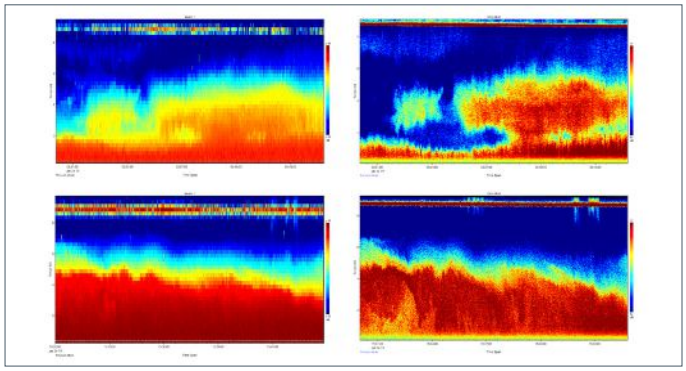


Figure 1: Regular backscatter (left) and echosounder data (right) from Signature1000. Both events are records of 15 minutes of data. The vertical resolution of the echosounder is 1 cm. It does not show any outliers near the surface.

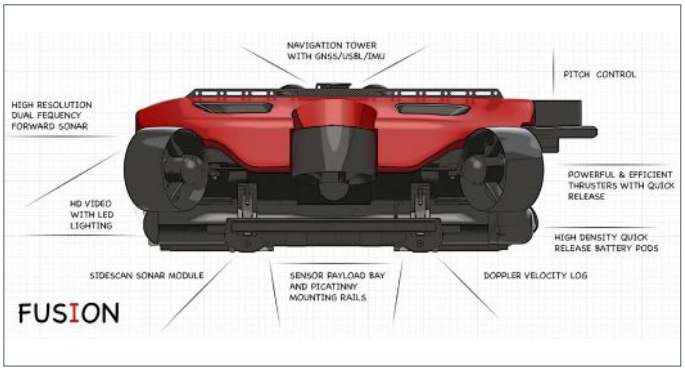


Figure 2: SRS' Fusion works as an ROV or an AUV and includes a highly intuitive interface.

Figure 3: The MSS Defender is designed for precise control, heavier payloads, and demanding intervention.

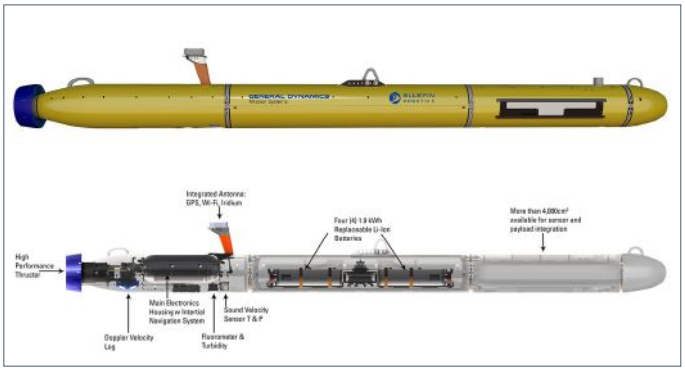


Figure 4: The base Bluefin-12's extended modularity supports the integration of user-designated sensors and payloads to deliver new mission-critical capabilities.

Nortek's New Echo-Sounder Mode for ADCPs Aids Interdisciplinary Research

Acoustic Doppler Current Profilers (ADCP) are great for current measurements, but users have found them lacking when it comes to biomass assessments. However, the new scientific echosounder hardware and firmware feature added to Nortek's existing ADCP line enables high-resolution imaging of particles (such as biomass) in the water column. The new capability is available in the Signature 1000, 500, 250, and 100 systems.

Dave Velasco of Nortek says, "ADCP and echosounder data complement each other and are often deployed together. However, these two technologies have historically been developed by separate companies, with different objectives, leaving the end user to integrate the two solutions together. Nortek's approach has been to leverage its expertise in underwater acoustic technology, transducer manufacturing, electronics and firmware architecture design to combine these two tools into a single instrument."

The Signature 100 version operates in multiple frequencies in both narrow and broad bands. At one megahertz, that translates into the ability to image down to 3 mm resolution. Data can be transmitted in real time or stored on the device until it returns to shore. Nortek provides software for core data processing, analysis, and triage, but Nortek ADCP systems also work seamlessly with existing software.

Velasco demonstrated how the Signature 100 ADCP (equipped with a broadband fisheries echosounder) works in a fish tank where bubbles played the part of krill.

As bubbles migrated vertically within the tank, a screen showed a red line rising on a digital plot. Velasco explained that the device also works well for sediment plumes, plankton, fish, or anything else with a decent acoustic signal. It was easy to envision how useful this tool could be in tracking pollution, chemicals, or even harmful algae blooms back to their source. The device measures flux components of water (how fast, what direction, how deep), which is key for tracking, modelling, or assessing particulates.

"The device has a 300- to 400-meter range, so users can do both physics and biological work at the same time," said Velasco. (Figure 1)

Strategic Robotic Systems' Fusion Next Generation UUV

The Fusion underwater vehicles exemplify design, capability and intuitiveness. As a tightly integrated system built around a high-end suite of sensors, the exhaustive attention to detail establishes Strategic Robotic System's Fusion as a benchmark for professional unmanned underwater vehicles.

Fusion incorporates a suite of high-end sensors designed for complex missions. From imaging sensors to navigational aids, the Fusion improves vehicle dynamics and eliminates troublesome cables/connectors. Beyond the included sensors are optional instruments designed to quickly interface with the Fusion system through auxiliary ports, picatinny rails or the unique utility cavity located on the underside of the vehicle.

Fusion's intelligent control and navigation system features intuitive supervisory control. Vehicle characteristics and dynamics are carefully mapped to improve responsiveness, stability and predictive nature. Careful attention was given to ensure accurate feedback and precise data.

Speaking to ON&T, Doug Austin of Strategic Robotic Systems said, "The Fusion can work as an ROV with a very slim tether, or you can unplug the tether and use it independently as an AUV. As a battery-operated vehicle, it can operate on a single-fiber tether, which allows the compact Fusion to pull up to 3 kilometers of cable."

Fusion's flexibility has appealed to defense customers who use the onboard sensors to inspect for mines, dispose of explosive ordinance, and so forth. However, the device also provides superior survey capabilities for offshore energy and other commercial activities. Austin told us that because the Fusion runs on SRS' proprietary navigation and command and control software with a single user interface, it presents an entire package of data on a single screen, making the Fusion highly intuitive for new users. The company also offers a two-day training course at the client's location, which is enough for even beginners to master operation, according to Austin. (Figure 2)

VideoRay Adds to Its Mission Specialist Series

VideRay brought two vehicles from their Mission Specialist Series to OCEANS '19, both with exceptional capabilities:

"The Mission Specialist Series design methodology includes modular components. All of the modules—thrusters, lights, the camera, and communications—are connected using mateable adaptors. This makes repair and maintenance easy," said KevinMcMonagle of VideoRay. "If a thruster were to fail in the field, you could unplug that thruster, plug in a new one, assign its job task, and be up and running again."

The VideoRay Mission Specialist Series (MSS) Pro 5 configuration is designed for speed and efficiency, weighing in at 10kg. The three-thruster system has forward speed of over 4.4 knots, and utilizes a system of interchangeable, modular components residing on a single, intelligent network. The Pro 5 is designed to handle missions with size, space, weight, and deployment speed constraints, such as infrastructure inspections beyond the reach of divers, search & recovery, exploring the ocean floor up to 305m, and various others.

The Mission Specialist Defender configuration is designed for more precise control of the vehicle position and orientation, heavier payloads, and demanding intervention, such as rendering unexploded ordnance safe or cleaning nets for offshore fish farms. With seven thrusters, the Defender is able to move in any direction, and maintain active pitch to face the vehicle in an upward or downward orientation. The addition of third-party control and navigation software from Greensea Systems or Seebyte makes the Defender a popular configuration for dangerous or heavy-duty missions. (Figure 3)

General Dynamics Mission Systems' Redesigned Bluefin-12 UUV

General Dynamics Mission Systems showcased their new Bluefin-12 autonomous UUV. This new vehicle builds upon proven Bluefin autonomy and uses shared Bluefin Robotics' core capabilities, increased mission modularity and embedded intelligence to complete users' long endurance, high-consequence and changing missions.

The base Bluefin-12's extended modularity supports the integration of user-designated sensors and payloads to deliver new mission-critical capabilities. Its core autonomy with Standard Payload Interfaces, open-architecture compatibility and greater than 4,000 cubic centimeter-payload section supports the rapid integration of sensors and payload.

The illustration shows the base model configuration, but the Bluefin-12 may also be configured with an optional turnkey survey package delivering integrated survey capabilities including high-resolution sonar, environmental sensing, powerful on-board data processing and highly accurate navigation. (Figure 4)

CHECK THE TECH:

NIOBICON™: MIXING ELECTRICITY AND WATER SPARKS A REVOLUTIONARY IDEA

By Mary Casillas

We've long been taught that water and electricity don't mix, but in the real world they run alongside each other all the time. A team of Northrop Grumman engineers set out to create a safe, reliable and affordable way to connect electric currents in a wet or corrosive environment and keep the power surging. The results are no less than shocking.

A Duo Of Northrop Grumman Engineers Have Invented a Revolutionary Way to Connect Electric Currents Underwater and Keep The Power Surging.

Systems engineer Jim Windgassen and Northrop Grumman fellow Harvey Hack were each working on connector technology for different reasons but with the same end goal — to extend the relatively inefficient battery recharging of unmanned underwater vehicles while submerged. Windgassen had been taking a related but different approach to the underwater connector problem when he learned that Hack used a metal called niobium for its corrosion resistance. This sparked Windgassen to think about how to apply fundamental principles of tantalum capacitors to make underwater connectors. Niobium and tantalum are similar metals and it made Windgassen think about how a tantalum capacitor works in the first place, thus becoming the genesis of NiobiCon™.

What is NiobiCon™?

NiobiCon™ is a revolutionary self-insulating wet-mate electrical connector that can be mated and de-mated while fully exposed to water — a first of its kind. Contacts will not corrode and electronics will not short out. This new connector technology has the potential to be less expensive, smaller, lighter, more reliable and safer than current wet-mate connectors. Typically, underwater connectors attempt to exclude water from their contacts by using expensive, less reliable rubber seals, oil or moving parts. NiobiCon™ inverts this paradigm and can be used while submerged or anywhere there is a wet, corrosive environment such as in chemical processing plants, agriculture, automotive applications and undersea operations.

> *Other Connectors Try To Fight The Sea; Niobicon™ Works In Harmony With It.*

Diverse Backgrounds and Collaboration Essential for Success

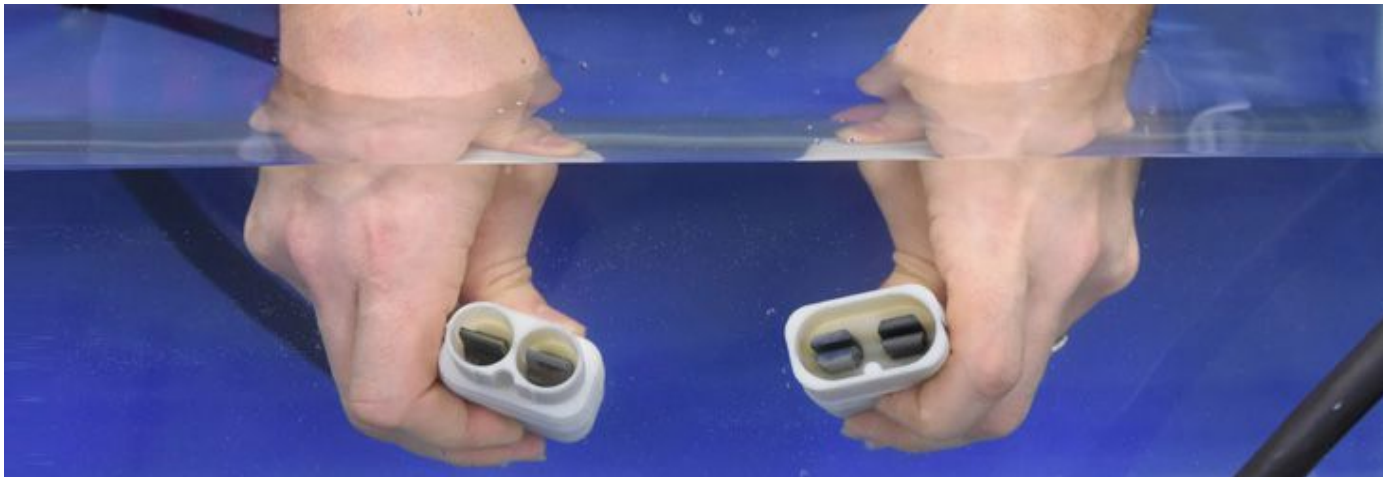
Teamwork and collaboration with cross-functional teams was essential for the development of NiobiCon™. Initially a team of three worked on the proof of concept: the two inventors and a technician to construct the test device. As they developed the design, their mighty team of three eventually grew as more people were invited to lend their skills in finite element analysis, intellectual property (IP) licensing, and business development.

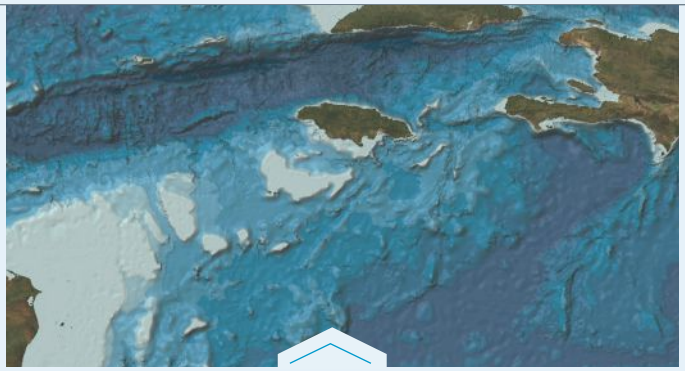
"Without this large group of people the concept would not be developed to this point," says Hack. "Jim [Windgassen] is an electrical engineer with a strong mechanical background while I'm a corrosion electrochemist and metallurgist. It is the combination of these two diverse backgrounds that resulted in the concept being thought of. Also, involvement of Keith [Johanns] as the IP licensing manager has helped to get the first commercial connector design developed and has structured terms and conditions for licensing agreements. Jim is excellent at sales, Keith is excellent at licensing promotion, and I do the electrochemistry to develop the technical details."

Northrop Grumman Crowdsourcing Platform Allow Employees to Innovate

Northrop Grumman promotes innovation in its employees through its SPARK program, a company-wide crowdsourcing platform for employees to propose new, innovative ideas and collaborate with colleagues from across the enterprise. By allowing Hack and Windgassen the freedom and resources to develop their unique concept, what began as a SPARK project became a unique solution for which two U.S. patents have since been granted. The first connectors could be in the marketplace as soon as 2020.

"It is immensely satisfying to see this initial concept generate so much interest," Hack says. "In addition, the interest from potential users as we display this technology is incredible, with many people becoming so excited about the concept that they start to tell us about potential use scenarios that we may not have envisioned ourselves."





» *Screen shot from the GEBCO Ocean Map 2019. Credit: GEBCO*

FROM VISION TO ACTION: NEW INITIATIVES IN PURSUIT OF MAPPING OCEAN FLOOR

Three new global initiatives for mapping the world's entire ocean floor were announced at a conference organized by The Nippon Foundation-GEBCO Seabed 2030 Project, the international collaborative project to produce a complete, freely available map of the seafloor by the year 2030. They will be overseen by the new Seabed 2030 Director, experienced UK hydrographer and former naval officer Jamie McMichael-Phillips, whose appointment was also announced at the conference.

From Vision to Action, which took place at the Royal Society in London on Tuesday 22 October, was convened to mark the progress made in the two years since Seabed 2030 was launched, and to look ahead to the remaining challenges of mapping the gaps in our understanding of the seafloor. In the short time that it has been operational, Seabed 2030 has already seen a doubling of the bathymetric data available to produce the definitive map of the world's oceans – an increase equivalent in size to the landmass of the entire African continent.

THREE INITIATIVES

As part of plans announced in London by Mr. Yohei Sasakawa, Chairman of The Nippon Foundation, Seabed 2030 will provide vessels around the world with data-gathering equipment to enable them to contribute to the project. These vessels will have data loggers installed to record bathymetric information, increasing mapping capacity and capability and establishing new connections between Seabed 2030 and owners of vessels including fishing fleets, tourist boats, and pleasure craft.

In some of the most remote and poorly mapped frontiers of the ocean, Seabed 2030 will fund additional dedicated mapping days for already scheduled expeditions, and create a pool of experienced multibeam echosounder (MBES) operators that can assist expeditions lacking this data acquisition capability to ensure that vital data are collected at all the times, including during transit. This model was recently employed in Seabed 2030's partnership with the pioneering Five Deeps Expedition, led by explorer Victor Vescovo, which gathered detailed bathymetric information at each of its dives to the five deepest points in the world's oceans.

Seabed 2030 will also champion the development of innovative, scalable new solutions to increase the efficiency, safety, and cost-effectiveness of deep-sea mapping, paving the way for public participation on the widest scale possible to meet the project's goals.

ESRI'S SEA ICE AWARE APP PROVIDES BIG PICTURE VIEW OF POLAR CHANGES

By Dan Pisut, Lead Environmental Content Developer for ArcGIS Living Atlas of the World

We've all seen the striking animations of polar sea ice extent using satellite data, often coming from NASA or NOAA. Sometimes they show the seasonal wax and wane, a rhythmic heartbeat of the poles. Sometimes they're more dramatic, showing the annual minimum from year to year with a very perceptible trend (at least in the Arctic). But what if you want to know what is happening with the sea ice right now?

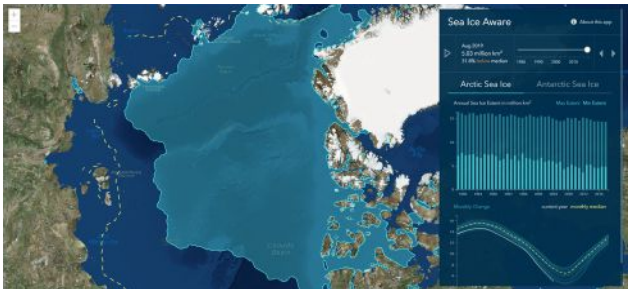
Sometimes it can be challenging to find that information (let alone the data), especially for both poles. But there's a new application that allows you to track the status of sea ice in the poles. The Sea Ice Aware app leverages a series of new layers and maps available in ArcGIS Living Atlas of the World from the National Snow and Ice Data Center and NOAA. Updating each month, this information is important for understanding big picture changes in the poles, and also for analyzing regional trends such as the opening of shipping lanes and ports, along with areas for natural resource exploitation.

Using this web application, you can dig deeper into the NSIDC information to:

- Display the monthly mean ice extent for each month from 1979 to the present, along with the historical median as a reference for above/below normal (yellow line).
- Interact with graphs of the minimum and maximum extents for each year – click on the bars to select the corresponding time in the map display.
- Compare the month-to-month changes of ice extent from the current year to other years and the historical median.

Unlike animations you've seen on social media or in documentaries, these layers and web maps have full analytical capabilities. Skip the downloads and complex FTP sites, and use the layers directly in the ArcGIS platform, including in ArcGIS Online, ArcGIS Pro, or even products like ArcGIS Notebooks to support your workflows. For questions or comments on the Sea Ice Aware app, please visit esri.com and search for GeoNet.

Editor's Note: This article first appeared on the ArcGIS Blog. It has been edited by ON&T staff. To read the original, visit *https://www.esri.com/arcgis-blog/products/arcgis-living-atlas/mapping/sea-ice-aware/*.



BRIM EXPLORER DEMONSTRATES SOCIETAL APPETITE FOR CLEAN SHIPPING SOLUTIONS

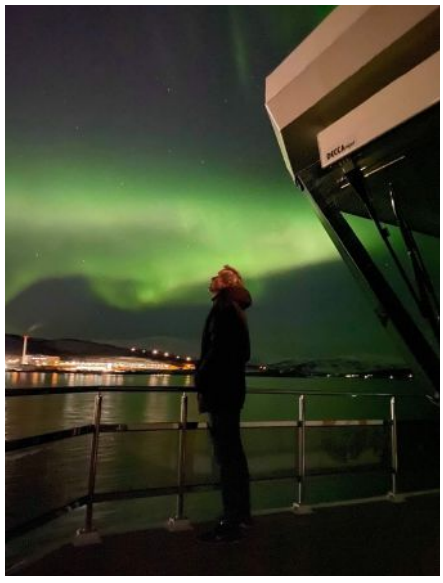
The award-winning electric ship Brim Explorer has entered service in Tromsø as one of the world's first hybrid-electric powered aluminum whale watching vessels.

The vessel, built at Maritime Partner shipyard in Ålesund, Norway has been constructed to go beyond even the very latest of environmental requirements. Following a month of tests and the official launch and baptism ceremony, it is now in its home port of Tromsø, offering tourists the voyage of a lifetime.

Hundreds of people gathered to witness the ceremony, taking an opportunity to appreciate the silent operations of the unique hybrid electric vessel, designed specifically to meet growing environmental requirements now and in the future, while allowing tourists to witness the peaceful beauty of the North Norwegian Fjords.

The silent beauty of the region can truly be appreciated when the vessel is propelled by batteries alone, eliminating the noise and vibration of a normal ship engine running on diesel.

"This has been super rewarding even though it has been hard work," says Brim chief executive and co-founder Agnes Arnadottir, explaining the process of being inspired to build a new generation of boat and convincing backers, yards and suppliers to work on something so novel. "We now know every single part, every nut and bolt, on this ship".



» *Brim Explorer*

Agnes founded the company two years ago with Espen Larsen-Hakkebo, company chief financial officer.

The duo was responsible for bringing in the NOK 46m (USD 5.2m) financing for a project which he says entailed enlisting a shipyard and suppliers to deliver a uniquely aesthetic design and ultra-clean propulsion system.

"We have had to do things from scratch, including financing the project, using so much innovative design and technology," he says. "But now we have delivered the first electric ship for northern Norway and now we can start twice daily tours from Tromsø."

The aluminum hulled vessel with huge windows and observation platforms can take up to 140 passengers out on sustainable whale watching and sightseeing tours powered by a battery system supplied by Corvus Energy, a driveline by Servogear, and system integration by Brunvoll Mar-El.

Investor support for designing a vessel from scratch rather than adapting an existing design has allowed Agnes and Espen to build a vessel that meets their own goals, as well as the tightening societal and regulatory requirements for shipping.

One of the benefits for the vessel design will be the ease with which its batteries can be recharged – the vessel will need only a 400V 124 amp industrial power outlet to recharge.

During the ceremony, Bente Holm, director of VisitNorway, was named as the vessel's godmother. In her speech she emphasized that "Brim represents a breaking, environmental wave in the tourism in the north. The standard they set represents Tourism 2.0 in Norway and the rest of the world."

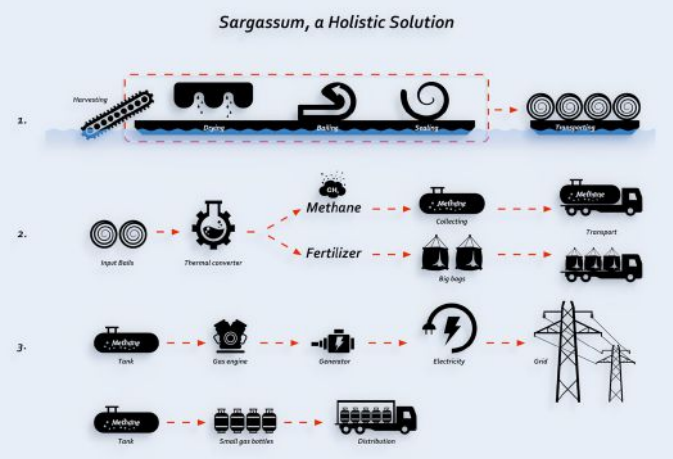
Among the guests at the ceremony and able to witness the capabilities of this new vessel were the Mayor of Tromsø Gunnar Wilhelmsen, environment profile and founder of Bellona Frederic Hauge, as well as friends, family and investors and of course curious onlookers and competitors.

From the shipyard Maritime Partner, CEO Peder Myklebust described the project as "a series of innovation in both hull design and propulsion as well as its characteristic design" and that the great collaboration with Brim made it possible to solve challenges together.

Bellona founder Frederic Hauge explained there is a difference between the talkers and the doers, and that Brim Explorer represents the doers. "Brim is at the forefront in the green maritime industry, an industry that needs to take steps in order to achieve our climate commitments."

Brim already has a second vessel nearing completion and set to enter service in Spitsbergen on the remote Northern island of Svalbard. This will be the first ultra-clean vessel specifically built to Polar regulations. The vessel will be operated in conjunction with the Norwegian cruise and ferry operator Hurtigruten, allowing passengers and guests from Hurtigruten to enter waters that may be off limits to other cruise goers.

WWW.BRIMEXPLORER.COM



DAMEN PARTNERS WITH MARIS TO TURN SARGASSUM INTO BIOGAS

Damen Shipyards Group and Maris Projects have joined forces to tackle the issue of invasive Sargassum seaweed in the Caribbean region – including the Dutch Caribbean Islands. The partners are working towards the developments of a holistic solution. The work of the two companies is expected to increase knowledge of bioprocessing, leading to the design of efficient and scalable technologies with the capability to deliver both environmental and socio-economic benefits.

A significant – and to date, inexplicable – rise in the quantity of Sargassum in Caribbean waters and along its shores, has been recorded in recent years. The weed is causing considerable problems in the region. Aside from the stench it gives off when decomposing, which has led to beach closures, the seaweed also clogs the engines and nets of fishing vessels. Additionally, it is also smothering sea grasses and coral reefs as well as releasing greenhouse gases as it decomposes.

To attempt to find a solution, Damen Green Solutions has partnered with Maris. Damen's role in the partnership is to develop a dedicated solution based on a specially developed MultiCat for harvesting, preprocessing and transportation Sargassum. Maris brings experience in scalable preprocessing and anaerobic conversion technology. With this, the consortium is assessing the viability of turning the Sargassum into methane for energy purposes.

The two partners have identified a local operating partner – CMC – that can harvest the seaweed in Martinique and Guadeloupe. Currently, the partners are discussing a contract that will create the consortium to be known as Blue Caribbean Energy Solutions.

The consortium aims to collect and purify Sargassum, then turn it into biogas via a two-step process using low temperature anaerobic digestion as the first step. The residues of this process will then be fed into a high temperature anaerobic thermal reactor to turn them into usable methane. As well as the short term aim of turning Sargassum into energy, the partnership will consider the economic viability of turning the harvest into fertilizer and/or feedstock for the agriculture industry.

TURNER DESIGNS INTRODUCES TURBIDITY PLUS SENSOR WITH INTEGRATED WIPER

Turbidity measurements at very low levels of detection can be of great importance to those interested in harbor dredging, underground pipeline installation, and riverine applications in general. With these applications in mind, Turner Designs is excited to introduce a new turbidity sensor with a minimum detection limit of 0.05NTU and a maximum range of 500NTU. Keeping the instrument optical face clean is particularly important in these applications so Turbidity Plus includes an integrated wiper which is triggered by the user. Turbidity Plus is designed for integration with multiparameter systems and dataloggers from which it receives power and the wiper trigger. It delivers a voltage output proportional to the turbidity of the sample which can be correlated to nephelometric turbidity unit (NTU) values by calibrating with a standard of known concentration. Deployable to 200m, Turbidity Plus is available with or without a plastic housing for simplified integration.

WWW.TURNERDESIGNS.COM

ORCA HUB'S SHOWCASE UNVEILS AUTONOMOUS TECH TO SUPPORT OFFSHORE ENERGY INFRASTRUCTURE

» *Autonomous drone in flight with wind turbine in background. Photo courtesy of Orca Hub.*

A consortium of five universities working with 35 industrial and innovation partners, has unveiled the latest results from its multimillion-pound collaboration. The largest academic center in the world for research into robotics technology for offshore energy infrastructure, the ORCA Hub's aim is to advance robotics and Artificial Intelligence technologies for the inspection, repair, maintenance and certification of offshore energy platforms and assets.

Creating solutions to some of the most challenging, hard to reach and hazardous real-world problems in the energy sector, ORCA Hub was launched in October 2017. It forms part of the Government's £93m R&D funding on "Robotics and AI for Extreme Environments" through the Industry Strategic Challenge Fund (ISCF).

The ORCA Hub is led by the Edinburgh Center for Robotics, a partnership between Heriot-Watt University and the University of Edinburgh. The consortium also includes Imperial College London, the University of Oxford and the University of Liverpool.

Unveiling recent results at its third presentation to industry, the ORCA Hub showcased the application of 16 autonomous and semi-autonomous robotic solutions at ORE Catapult in Blyth, near Newcastle. Designed to boost safety, improve efficiency and support the environmental objectives of offshore energy infrastructure, the Hub demonstrated the applications of its work in a renewables themed showcase, reflecting the growing importance of renewable energy to the UK's energy mix.

The event, attended by over 30 industry stakeholders, included a demonstration of state-of-the-art autonomous drones by Dr. Mirko Kovac, director of the aerial robotics laboratory at Imperial College London. He explained: "Drones are currently used to visually inspect offshore wind turbines, but these inspections are remotely controlled by people on-site at the offshore location. Should an area of concern be found, technicians are required to carry out further inspection, maintenance or repair, often at great heights and therefore in high-risk environments.

"Our drones are fully autonomous. As well as visually inspecting a turbine for integrity concerns, ours make contact, placing sensors on the infrastructure, or acting as a sensor itself, to assess the health of each asset. Our technology could even deposit repair material for certain types of damage. This has far reaching applications including removing the need for humans to abseil down the side of turbines which can be both dangerous and expensive. Our drones could also reduce the number of vessels travelling to and from wind farms, providing the industry with both cost and environmental benefits. The ORCA Hub's objective is to remove humans from hard to reach, hazardous and dangerous work environments and our demonstration to industry presents the far-reaching potential of this robotic solution."

Other demonstrations included Limpet, a cost-effective, integrated multi-sensing device designed for deployment in large collectives. Limpet can be used on or around an offshore asset for integrity monitoring and inspection. Equipped with nine sensing devices and four methods of communication integrated into a single, robust and compact platform, Limpet replaces the need for multiple sensors to be used for integrity monitoring on wind turbines. Able to wirelessly communicate with each other, or a human operator, Limpet works subsea or topside and can provide an early warning system for asset inspection and maintenance requirements.

WWW.HW.AC.UK

DNV GL SELECTED FOR EQUINOR'S BAY DU NORD OIL FIELD PROJECT

DNV GL will ensure that new infrastructure to be built for Equinor's Bay du Nord oil field project is compliant to local and global safety requirements. DNV GL will oversee design review activities and site surveillance during construction, commissioning and installation, after being awarded the Certifying Authority and Classification contract.

The Bay du Nord field is located approximately 480 km northeast of St. John's, Newfoundland and Labrador, in the Flemish Pass Basin. The distance to shore is a challenge in itself, and the Bay du Nord is the first field to be developed in this basin. No existing infrastructure is in the immediate area, which is known for its harsh environmental conditions including large sea states, high winds, sea ice and icebergs.

Bay du Nord is an oil field discovered in 2013, aiming to produce its first oil 2025. The project is currently in Pre-FEED phase and Final Investment Decision is planned Q2 2021. The field development comprises an FPSO, a disconnectable turret and moorings system, steel lazy wave risers, and a subsea development with four subsea templates. Equinor is the operator and holds a 65% working interest.

"DNV GL possesses the deep knowledge, experience, and technical standards that will help us deliver the Bay du Nord project safely and on-time," says Halfdan Knudsen, Equinor's Project Director.

Both Equinor and DNV GL will manage the project out of offices in St. Johns, Newfoundland and Labrador, Canada.

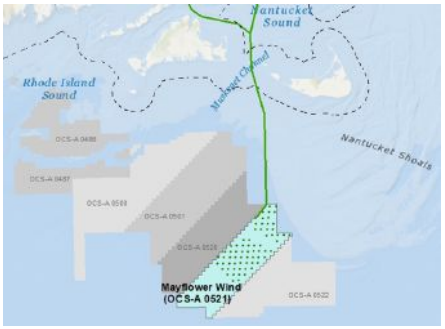
WWW.EQUINOR.COM

MASSACHUSETTS AWARDS ITS SECOND 800MW OFFSHORE WIND POWER PROCUREMENT

Mayflower Wind submitted the winning bid for the second Massachusetts offshore wind energy solicitation, joining Vineyard Wind 1 as an approved wind farm in the state.

"This is evidence that the U.S. offshore wind industry is becoming a mainstream clean energy source for U.S. coastal states, and the opportunity for the U.S.-based supply chain is only going to grow," said Liz Burdock, CEO & President of the Business Network for Offshore Wind. "It also underscores that states' energy procurement policies, like those of Massachusetts, are vital for the nation's transition to a clean energy economy."

"Major oil and gas companies and utilities understand the future of electricity generation along the U.S. Coast is offshore wind. The selection of Mayflower Wind, a joint project between oil and gas giant Shell New Energies and the Portuguese utility EDP Renewables, truly demonstrates the rush to fuel supply diversification. This team will bring regulatory expertise and utilize a supply chain that will expand across America," added Burdock.



Massachusetts DOER issued the RFP on May 23, and bids were due in on August 23, which shows that the state is speeding up its solicitation review process.

The next steps are for Mayflower Wind and the state to negotiate the long-term power contracts by December 13, and for long-term contracts to be submitted to the Massachusetts Department of Public Utilities (DPU) for approval on January 10, 2020.

POLAND'S OFFSHORE WINDFARM SECTOR SET TO 'BOOM'

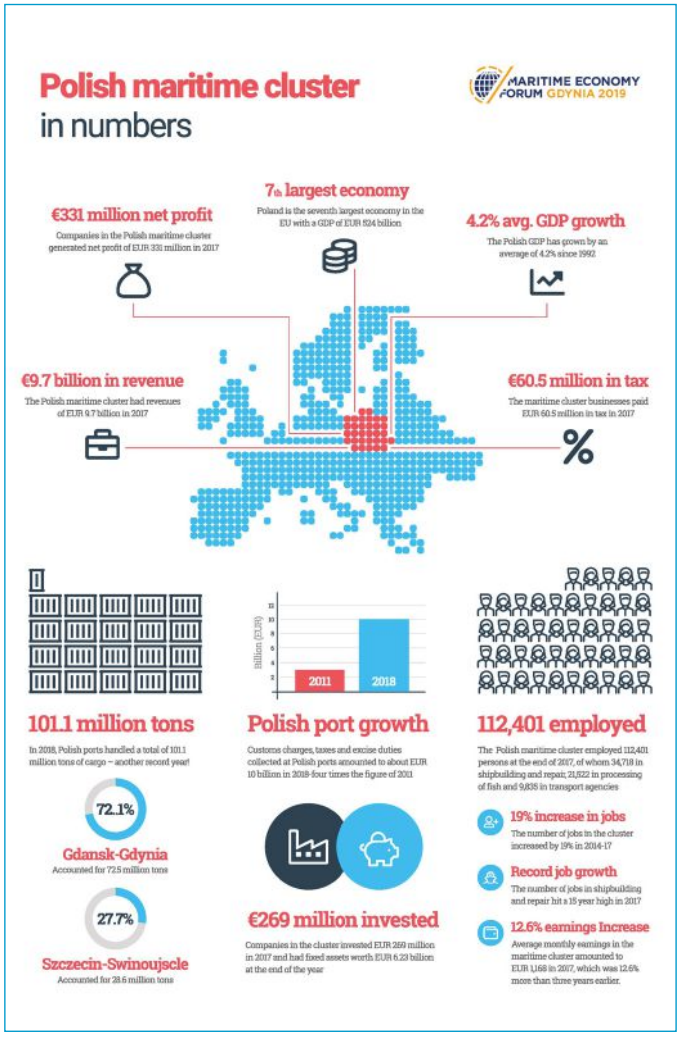
Poland's leading maritime thought-leadership conference heard that the country is set to become one of the biggest centers in Europe for offshore wind, turbo-charging billions of Euros of investment.

The Maritime Economy Forum Gdynia, held on 11 October 2019, was told that the investment will create a 'boom' in the offshore wind sector generating an estimated 77,000 jobs and 14.1 billion Euros for the economy by 2030. Poland's biggest energy company PGE presented forecasts to the conference showing Poland's Baltic Sea has the capacity to generate nine to 12GW of energy ranking it second only to the North Sea, which has capacity for 13GW. In total 13 windfarm projects are under consideration in Poland's Baltic Sea territory with an ambition to generate 25pc of Poland's energy by offshore wind by 2040. The plan currently being debated is for 4.6GW to be installed by 2030, scaling up to 6GW by 2035 and 10GW by 2040.

Radosław Pachecki, Maritime Logistics Project Manager with PGE's offshore company PGE Baltica said the company is looking to build three windfarms with an option to develop more of the 13 'concession' sites together with other energy companies. He reported new positive findings from a 20-month feasibility study PGE has undertaken into the Baltic Sea's suitability for offshore wind. He said the report, which is still ongoing, has found favorable wind speeds, relatively low sea depths and calmer sea conditions than the North Sea. He said PGE now has confidence that the business case for building windfarms is 'cost optimized' with overheads dramatically reduced due to better technology and know-how.

Work on PGE's windfarms, which will generate 2.5 gigawatts of power combined, is due to start in 2022 and be installed by 2035. The proposed windfarms are situated 20 kilometers from the Polish coastline and are expected to create maintenance work for 18 years with the first electricity coming online in 2025-2026.

Wojciech Szczurek, the mayor of Gdynia, said the forum sent the most powerful messages in its 19-year history that Poland is about to enter a new era of huge investment and opportunity in its maritime and offshore industry. The MEFG event featured almost 40 speakers and attracted more than 600 senior figures from the maritime sector.



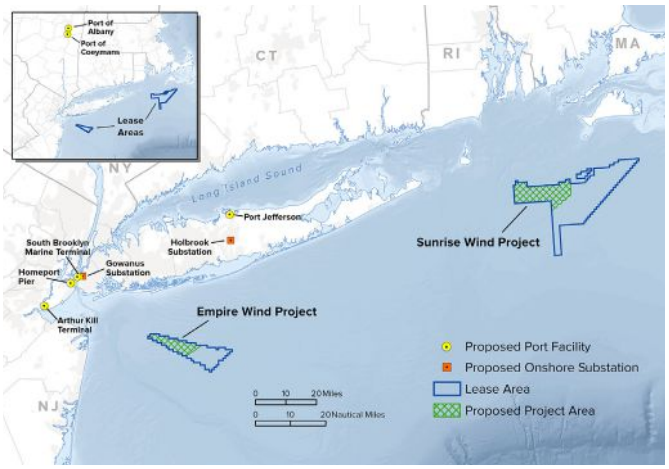
For more information, visit
WWW.FORUM.GDYNIA.PL/EN

NEW YORK OFFSHORE WIND INDUSTRY REPORT RELEASED

The New York State Energy Research and Development Authority has finalized contracts with Equinor Wind US LLC for its 816 megawatt Empire Wind Project and Sunrise Wind LLC (a joint venture of Ørsted A/S and Eversource Energy) for its 880 megawatt Sunrise Wind Project to deliver clean, affordable renewable energy to New Yorkers. As the largest procurement for offshore wind in the nation's history, this announcement advances Governor Cuomo's nation-leading Green New Deal goal to develop 9,000 megawatts of offshore wind by 2035 and position New York State as the regional hub of this rapidly growing industry in the United States.

NYSERDA concurrently submitted its comprehensive filing, "Launching New York's Offshore Wind Industry: Phase 1 Report," to the New York State Department of Public Service. The Report documents the successful results of New York's first large-scale offshore wind solicitation with a combined total capacity of nearly 1,700 megawatts and provides important details about these highest scoring projects.

As detailed in the Report, the State's first large scale offshore wind solicitation resulted in Offshore Wind Renewable Energy

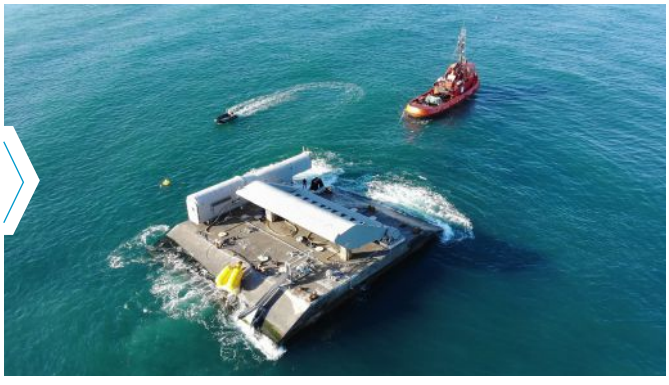


Certificate prices approximately 40 percent less than projected by NYSERDA's 2018 analysis, signaling that the costs to deploy offshore wind are declining. An Offshore Wind Renewable Energy Certificate (OREC) represents the environmental benefits associated with one megawatt-hour of electricity generated from offshore wind resources and consumed by retail customers in New York State. By compensating offshore wind generators for these investments, ORECs provide financial support necessary to lay the groundwork for the industry, which should yield long-term dividends for New Yorkers.

WAVE ENERGY PASSES FIRST MILESTONE IN PORTUGAL

The first-of-a-kind commercially-ready offshore wave power generation device is soon to be completed thanks to the experts from Finnish-based AW-Energy — the world-leading wave energy technology developer. The team has deployed its WaveRoller® device offshore at Peniche, a seaside municipality and a city in Portugal.

"I am delighted to confirm we have successfully installed WaveRoller® 820 meters offshore from Peniche. At this phase

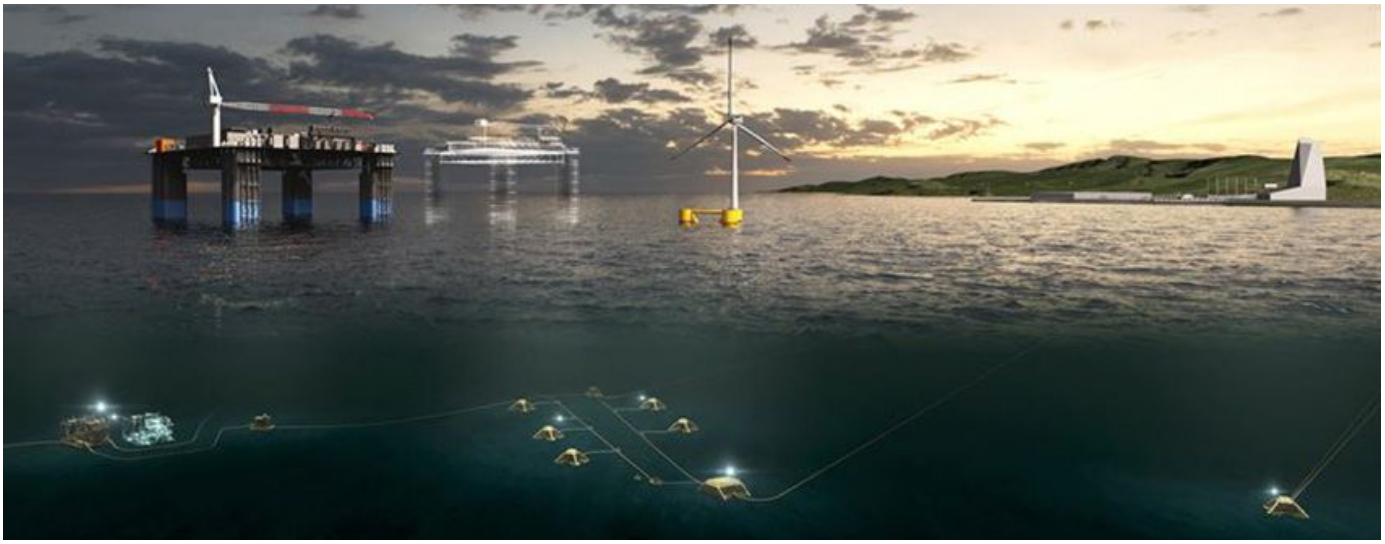


of the installation, we are collecting data 24/7 to monitor the performance of the device using motion, pressure and strain gauge sensors that are engineered into its panel, foundation and bearings," said Christopher Ridgewell, CEO of AW-Energy Oy. "The data we are receiving indicates WaveRoller® is operating well and performance is in accordance with our expectations."

Extended sea trials are being used to fine-tune the WaveRoller®'s control system to maximize its performance and yield. Engineers are also monitoring the device's performance using the company's next generation monitoring software which can be used to remotely access the device by any of the engineers from anywhere in the world and at any time, to help assess and manage the performance of WaveRoller®.

Ridgewell says: "The next phase of the project is injecting the power output to the Portuguese National Transmission Grid from the onshore substation. Commissioning work is already in progress with the local authorities to connect the substation to the local grid which will ensure residents of Peniche can benefit from sustainable energy supply using wave energy."

For more information, visit
WWW.AW-ENERGY.COM



AKER SOLUTIONS TO TARGET GROWTH IN LOW CARBON AND RENEWABLE ENERGY

Aker Solutions aims to generate about half of its revenue from renewable or distinct low carbon solutions by 2030, according to the company's 20/25/30 strategy. The oil and gas industry will remain Aker Solutions' biggest market, but over the next decade the company will have a more balanced portfolio of products and technologies that either generate renewable energy or removes or substantially reduces CO2 emissions.

"The world will continue to see rising energy demand and the challenge for our industry is the need to deliver this with a significantly lower carbon emissions," said Luis Araujo, chief executive officer of Aker Solutions. "No company is better positioned than Aker Solutions to deliver the solutions to realize renewable energy offshore and at the same time decarbonize the oil and gas industry."

In all forward-looking scenarios, the industry will need to provide more energy, with a lower carbon footprint. The pace of the energy transition will be dictated by a number of drivers, such as electrification, efficiency gains, low-emission fuels and accelerated cost reductions of renewables. Still, demand for oil and gas is expected to grow over the next decade, although not as fast as the expected growth in renewable energy.

20/25/30

In its updated enterprise strategy, Aker Solutions set out its growth ambitions. The company aims to derive 20 percent of its revenue from renewable energy and 25 percent from distinct low-carbon solutions by the year 2030. Summarized, the update is labelled 20/25/30.

The renewable energy solutions will primarily come from floating wind while the low carbon segment is a set portfolio of existing Aker Solutions offerings, including: carbon capture, utilization and storage (CCUS), subsea gas compression, electrification of production assets and unmanned platforms. Aker Solutions has developed and invested in renewable energy and low carbon solutions for years, and the company has delivered or is involved in several projects in these segments, including:

Renewable Energy

- A 23 percent stake in Principle Power, which has a proven concept for floating wind and is currently installing the WindFloat Atlantic project.
- Major wind farm developments in the US and South Korea.

Low Carbon Solutions

- Developed CCUS since delivering the Sleipner storage solution in 1996. Positioned to realize the first industry-scale carbon capture facility at a cement plant with Norcem Heidelberg in Norway. Delivering modular Just Catch plant to a waste-to-energy plant in the Netherlands, where the CO2 will be utilized as a fertilizer. Deploying subsea expertise in the Northern Lights CO2 storage project in the North Sea.
- Delivered the world's first subsea gas compression system to Equinor's Åsgard field in 2015. Currently involved in developing the first subsea gas compression project outside Norway, at the Jansz-Io field for Chevron in Australia.
- Low emission power from shore to Johan Sverdrup and Gina Krogh can generate CO2 emissions savings equivalent to removing 150,000 cars annually. Aker Solutions is involved in several studies for the electrification of fields.

For more information, visit
WWW.AKERSOLUTIONS.COM

SIEMENS GAMESA FIRST TO POWER OIL AND GAS OFFSHORE PLATFORMS WITH FLOATING WIND

The world's largest floating wind power plant will be installed in Norway, equipped with 11 Siemens Gamesa SG 8.0-167 DD turbines. Scheduled to be commissioned in late 2022, Hywind Tampen will be the first ever floating wind power plant to power offshore oil and gas platforms.

"We are pleased to have received the firm order from Equinor to be the supplier of this ground-breaking project. Thanks to our strong collaboration and joint focus on innovation, we are now at the forefront of developing this exciting technology and unlocking the vast potential for floating offshore wind power," highlighted Andreas Nauen, CEO of the Siemens Gamesa Offshore Business Unit.

Hywind Tampen will have a total capacity of 88 MW and be located some 140 kilometers from shore in an area with water depths of 260-300 meters between the Snorre and Gullfaks oil and gas platforms. Specifically, this wind power plant will be capable of meeting about 35 percent of the annual power demand of the Snorre and Gullfaks platforms.

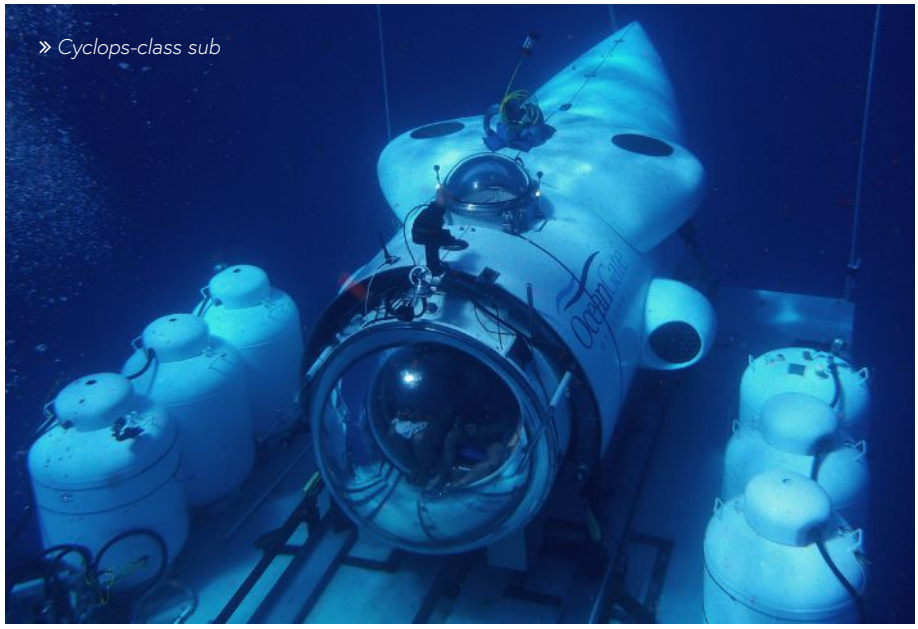
By reducing the use of gas turbines on the fields, the project helps cut CO2 emissions by more than 200,000 tons per year, equivalent to the annual emissions from 100,000 passenger cars.

The floating foundations in the Hywind Tampen project are ballast-stabilized and anchored to the seabed with mooring lines. With their lightweight nacelles, Siemens Gamesa large direct drive wind turbines are particularly suited for floating foundations.

The innovative partnership between Siemens Gamesa and Equinor dates back to 2009, when the world's first full-scale floating wind turbine project, Hywind Demo, was successfully installed in Norway. This initiative was followed in 2017 by the 30 MW Hywind Scotland floating wind power plant, currently the world's largest, installed at water depths between 90 and 120 meters. Hywind Scotland is a hugely successful project which has world-class safety performance and the highest capacity factor of any offshore wind farm in the UK. The Hywind Tampen project continues this partnership, bringing industrial-scale floating wind a giant leap forward.

For more information, visit
WWW.SIEMENSGAMESA.COM

OCEANGATE TO BUILD TWO NEW CYCLOPS-CLASS SUBMERSIBLES



» *Cyclops-class sub*

» *Cyclops-class submersible, Titan*

OceanGate plans to build two additional submersibles using its innovative carbon fiber and titanium design to meet increasing expeditionary, research and commercial demand for deep-sea manned submersibles. OceanGate has begun the construction planning for the next two Cyclops-class subs (Cyclops 3 and Cyclops 4), which are planned to be rated for up to 6,000m.

"Increasing demand for Titanic missions, deep-sea research and environmental supervision of deep-sea mining have further reinforced the business case for adding to our dive capacity. Using a new aerospace manufacturing vendor and ensuring aerospace level quality and control will provide a depth capability of 6,000m using the same thickness of carbon fiber as Titan (Cyclops 2), and will allow the new OceanGate submersibles to reach 98% of the ocean," shares Stockton Rush, CEO, OceanGate. "Our second Cyclops-class submersible, Titan, has validated not only the carbon fiber and titanium design, but also the OceanGate real-time hull health monitoring system. With the recent news that the Titanic shipwreck is deteriorating quickly, we have received more interest in our Titanic Survey Expeditions. In addition, ocean habitat research and the discovery of valuable undersea resources are also driving increased demand for manned submersibles. Mission specialists and partners are supporting our quest to make deep ocean exploration more safe, accessible, available and affordable, not only to scientific, governmental and commercial organizations, but also to citizen explorers," explains Rush.

OceanGate is in discussions with two aerospace carbon fiber suppliers and manufacturers. While the new submersibles are in production, OceanGate dive operations will continue throughout 2020 utilizing its three existing 5-crewmember submersibles, Titan, Cyclops 1 and Antipodes. OceanGate is currently accepting applications for expeditions for the Bahamas 2020 whale, shark and wreck missions with the University of The Bahamas and the Hudson Canyon Expedition off of the coast of New York City. Aspiring Mission Specialists interested in joining an upcoming expedition should contact OceanGate for qualifications, availability and additional details. To obtain more information about all upcoming OceanGate expeditions, visit *www.oceangateexpeditions.com*.

NEW DECOMMISSIONING CUTTING TOOL PASSES TESTS WITH FLYING COLORS

Scotland's Balmoral Subsea Test Center's submersion tanks were called into action recently with a requirement to put a new cutting and sealing tool for the decommissioning sector through its paces.

Accrington-based Allspeeds, the manufacturer of 'Webtool' hydraulic ROV cutters and systems, was awarded a contract by Chevron USA to develop an environmentally friendly, fast intervention tool (FIT) for subsea pipeline decommissioning work. The tool is designed to cut and seal pipework to prevent marine environment contamination removing the need for a containment dome during operations. The concept of the FIT relies on a single system that is capable of multiple actions:

The pipeline is initially lifted from the seabed and secured to the tool. It is then crimped in two places on either side of the cutting point to create a cavity without rupturing the pipe wall. The pipe is then pierced between the two crimped sections to prevent any escape of contaminants and a sealant is injected into the cavity to create a 'rubberised' plug. Finally, the pipe is cut through the sealed section creating an additional crimp point and separating the pipe into two pieces. The pipe ends are now fully sealed with the crimps preventing any release of pollutants. When the FIT operations have concluded the tool is removed topside, reset and positioned further along the pipe to repeat at pre-designated lengths creating practical sections of pipe for surface recovery.

» *Allspeeds' fast intervention tool is lowered into Balmoral's submersion test tank*

Test house manager at Balmoral, Derek Weir, said: "This was a complex procedure which involved a number of tests. I believe this demonstrates the flexibility and capabilities of our facility which are now being widely used by the oil and gas, renewables, oceanographic, defence and valve production sectors."

For more information, visit
WWW.BALMORALOFFSHORE.COM

ONESUBSEA® AWARDED INTEGRATED SUBSEA COMPRESSION FRAME AGREEMENT

Schlumberger has announced an award to OneSubsea® by A/S Norske Shell of a frame agreement for an engineering, procurement, construction and installation (EPCI) contract for the supply of a subsea multiphase compression system for the Ormen Lange Field in the Norwegian Sea.

Through the EPCI contract, OneSubsea, the subsea technologies, production and processing systems division of Schlumberger, and its Subsea Integration Alliance partner Subsea7, will supply and install a subsea multiphase compression system that uses the industry's only subsea multiphase compression technology. OneSubsea will, in the first phase of the project, do the engineering and design of the complete system. Following the final investment decision by the license group, the complete scope of the EPCI will be executed.

The compression system will be powered and controlled from the Nyhamna onshore gas processing plant, which is 120 km from the subsea location. This tieback distance is also a world record for transmitting variable speed power from an onshore facility to equipment on the seabed.

The system will be installed at 850 m of water depth and comprises two 16-MW subsea compression stations tied into existing manifolds and pipelines. This multiphase compression system is surge tolerant, does not require wellstream preprocessing, and is adaptable to the varying conditions over the life of the field.

"Our subsea multiphase compression system is a robust, compact and cost-efficient solution that will help Shell unlock the full potential of the Ormen Lange Field. Our unique wet gas compression technology can also help customers lower their carbon footprint," said Don Sweet, president of OneSubsea.

OneSubsea multiphase compression technology results in a simpler, more affordable and easier-to-install subsea compression system. By lowering backpressure on the reservoir, this technology helps customers increase recovery and extend the life of their gas developments. WWW.ONESUBSEA.SLB.COM

» *Photo credit: OneSubsea®*

KONGSBERG'S SEAGLIDER® DIVISION TRANSFERRED TO HYDROID

Hydroid, Inc., a subsidiary of Kongsberg Maritime and a leading manufacturer of marine robotic systems, has announced its integration of the Seaglider® Autonomous Underwater Vehicle (AUV) Division into its organization.

The transfer of Seaglider® from Kongsberg Underwater Technology, Inc. (KUTI) allows Hydroid to leverage complementary technologies and markets across the REMUS and Seaglider® product lines. Integrating Seaglider® into Hydroid also increases the range of technical solutions and program management support that can be offered to customers.

KUTI's current office in Lynnwood, WA has been remodeled so that Hydroid will occupy approximately 18,000 square feet of space for Seaglider® engineering and manufacturing. The integration of the Seaglider® team grows Hydroid to over 200 employees. KUTI will no longer be a subsidiary of Hydroid and will align its business with Kongsberg Maritime, Inc. in Houston, TX. It will continue to provide Full Picture solutions to customers, focusing on sonars, acoustics, subsea docks and monitoring, and underwater science sensors.

Seaglider® AUVs were jointly developed by the University of Washington School of Oceanography and University of Washington Applied Physics Lab starting in 1995 with funding provided by the Office of Naval Research and National Science Foundation. The technology uses changes in buoyancy to move through the water column in a saw-tooth pattern while collecting data. This results in very low power consumption and long endurance of over 9 months depending on configuration and payloads.

For more information, visit
WWW.HYDROID.COM

innovation
out of the blue

January 14 - 16, 2020
Salve Regina University, Newport, Rhode Island

The Blue Innovation Symposium is New England's premier event for connecting the marine technology industry. 2020's theme, ***Sensors and the Next Wave of Data***, is set to gather key stakeholders from the Blue Tech community to discuss the trends shaping the industry, whilst also showcasing the start-ups and breakthrough technologies making sensors smarter, more reliable and cost effective for the maritime industry, research organizations, and state and federal agencies.

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SUBSEA 3D SCANNING SPECIALISTS VIEWPORT3 ENTERS THE DECOM MARKET

Aberdeen-based subsea 3D scanning specialists Viewport3 is entering the decom market after securing two pre-removal scanning contracts with a combined value of £100k.

Viewport3's industry-leading accuracy and ability to understand the precise details of what lies subsea has secured them the North Sea projects with two major operators. The contract scopes will see them providing the operators with the intelligence they need to make decisions about the removal of items from the seabed, reduce ad-hoc engineering and minimise time spent offshore.

Over the last two years, the subsea 3D scanning specialists have grown from strength to strength, saving the subsea industry approximately £10m in the process by using verifiably accurate geometric data to save on remediation and contingency during the removal process.

Decom naturally comes with many challenges, trying to determine what needs to be retrieved using out of date drawings and guesswork leads to mobilisation of equipment that isn't suitable, resulting in delays and excess expenditure with marine contractors.

Richard Drennan, one of the co-founders and directors of Viewport3 said: "We have always believed in securing a better and more accurate way of handling the decom practice. It's important to understand that small misconceptions surrounding the condition of underwater hardware can cost the industry millions of pounds, not least through significant delays and interruptions."

"By investing in reliable scan data, we can ensure the retrieval of subsea equipment is completed successfully. There is little room for uncertainty, and we feel passionate about providing the data needed to achieve smooth running operations. Collecting 3D geometry from seabed hardware prior to launching decom operations is a must, understanding the precise details offers great benefit compared to going in blind."

Richard added: "With increased accuracy, comes increased confidence and we are looking forward to starting work on these projects before the end of the year."

Viewport3 recently became members of Decom North Sea, a partnership organisation working to enhance knowledge transfer and facilitate collaborative activities to deliver "innovative models" that minimise decommissioning costs, ensuring best value for taxpayers and maximising business potential for its member companies.

John Warrender, CEO of Decom North Sea said: "We would like to welcome ViewPort3 into our community of practice and look forward to assisting one of our newest members in delivering its technology and skills to a new market. "

For more information, visit
WWW.VIEWPORT3.COM

3D AT DEPTH DEMONSTRATES ASSET INTEGRITY SOLUTION

3D at Depth Inc. recently conducted a successful technology showcase in partnership with the Norwegian Forum for Offshore Survey and Positioning (NOSP) and OneSubsea, to demonstrate the potential of survey grade measurements from hovering (moving) resident systems with an emphasis on utilizing subsea LiDAR technology.

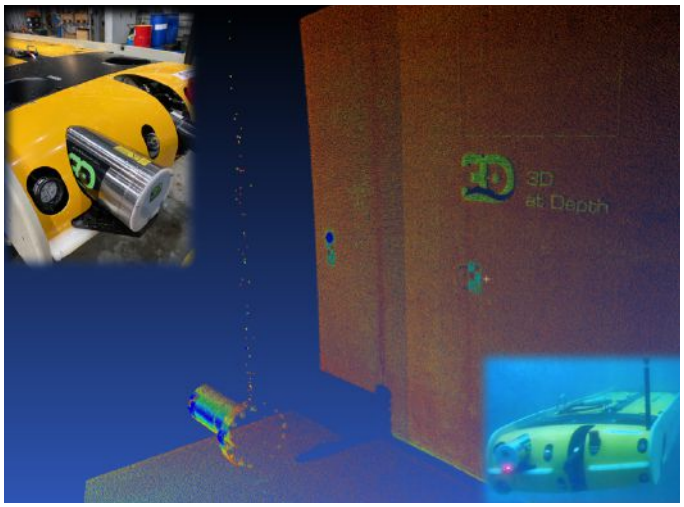
The event took place on October 17 in Horsoy, Norway and was developed to engage subsea energy experts to pose the question, "At what stage does the survey community need to be involved with field layout planning to ensure survey quality measurements are reliable from a resident system?"

The half-day demonstration provided multi-use case studies focused on inspection, maintenance and repair applications, and leveraged whether subsea LiDAR's unique controllable beam patterns were able to maintain measurement accuracies when scanning from static and hovering platforms.

Consistently, 3D at Depth subsea LiDAR laser scans effectively generated survey grade measurements, detected leaks, and provided a unique benefit of infield navigation from the same sensing package. Each subsea LiDAR survey scan mode produced reliable results from a hovering inspection platform while being able to repeat very high resolutions slow scans, as well as lower resolution fast scans. X, Y, Z differences between the static and hovering platform scans ranged between 1mm and 3mm. Each scan mode was completely configurable for resolution to the targets. Scan modes took 3 minutes or 5 seconds per sector respectively.

The program successfully demonstrated that from controlled survey markers (targets) placed around the survey location, 3D at Depth's unique subsea LiDAR controlled beam repeatably acquired survey grade measurements in single sector scans while hovering. Simultaneously during the data acquisition, a small simulated gas leak was also detected — supporting 3D at Depth's subsea LiDAR capability already observed in multiple open water surveys of subsea assets.

"Resident solutions that provide reliable survey grade measurements while capturing additional integrity measurements are the future for offshore field management," said Neil Manning, Chief Operating Officer, 3D at Depth Inc. "Subsea LiDAR's key differentiator is the ability to simultaneously provide accurate digital twin point clouds along with other data integrity information. These technical demonstrations show it's possible to reliably acquire survey grade quality data by combining 3D at Depth Subsea LiDAR with a resident or remote sensing system when it is available. Solutions like these can potentially help oil and gas operators reduce costs, lower risk, and possibly decrease the loss of production period downtimes."



For more information, visit
WWW.3DATDEPTH.COM

A FUNDAMENTAL LINK IN THE US OFFSHORE WIND SUPPLY CHAIN

Subsea Cables Provide the Critical Connection

The UK's dominance in the offshore wind industry is under attack. However, as the assailants—mostly China and the US—jostle to become next decade's renewable offshore energy titans, advances are hindered by the usual barriers to entry, which are plentiful and complex.

Beyond the financial might needed to shoulder the considerable investment in offshore wind infrastructure, the primary requirements include the geopolitical appetite to commit to this relatively nascent means of renewable energy and a robust supply chain. The lack of either in the US has anchored any real progress over the last decade, but there is reason for fresh optimism of late.

The winds of change have set in motion a succession of State-level procurement announcements throughout 2019, including recent news that the New York State Energy Research and Development Authority (NYSERDA) has finalized contracts for the development of the 880MW Sunrise Wind Project with Equinor Wind US LLC and Sunrise Wind LLC. The deal represents the largest procurement for offshore wind in the US to date.

A Mind-Blowing Opportunity for the US

Procurement pledges have become a quarterly feature this year and denote a multi-billion-dollar market lying in wait. And so, as the industry gets its green light, the rally cry is to establish a sustainable domestic supply chain.

Easier said than done. From wind farm design, which includes a raft of environmental, legal and financial services, to turbine manufacture—rotors, gearboxes, hydraulic systems, etc.—to the laying of support towers, platforms and foundations, each aspect of the value chain is multilayered. Factor in the post-construction services and maintenance associated with operating safe and efficient wind farms, and you get the gist of the challenge ahead.

One element often overshadowed by the towering nacelles is the submarine cables required to transfer the harvested energy. In fact, until Nexans and Marmon (Kerite) entered the fray in 2019, the roster of domestic manufacturers of offshore wind cable in the US stood at zero. All this in the wake of market intelligence released earlier this year by SubCableWorld (SCW) in conjunction with the Business Network for Offshore Wind (BIZNOW), which states that the cumulative orders for offshore wind cable in the US could surpass 12,000 kilometers by 2030.

Unprecedented demand on this scale cannot be exclusively reliant on overseas suppliers—a US subsea cable supply chain is not only critical, but inevitable.

Subsea Cables: A Critical Connection

The time for action is now, and for that reason the two organizations, SCW and BIZNOW, are partnering to host an industry-first event to address the cable-specific opportunities presented by the emerging US offshore wind market. This landmark event, Subsea Cables: A Critical Connection, is set for January 23, 2020, in Houston, Texas, and will table the prominent issues involved in establishing a cable element to the US offshore wind supply chain and jump-start the discussion of how the industry must react. Several high-profile speakers and panelists are already confirmed, as are a growing number of title sponsors, including Nexans.

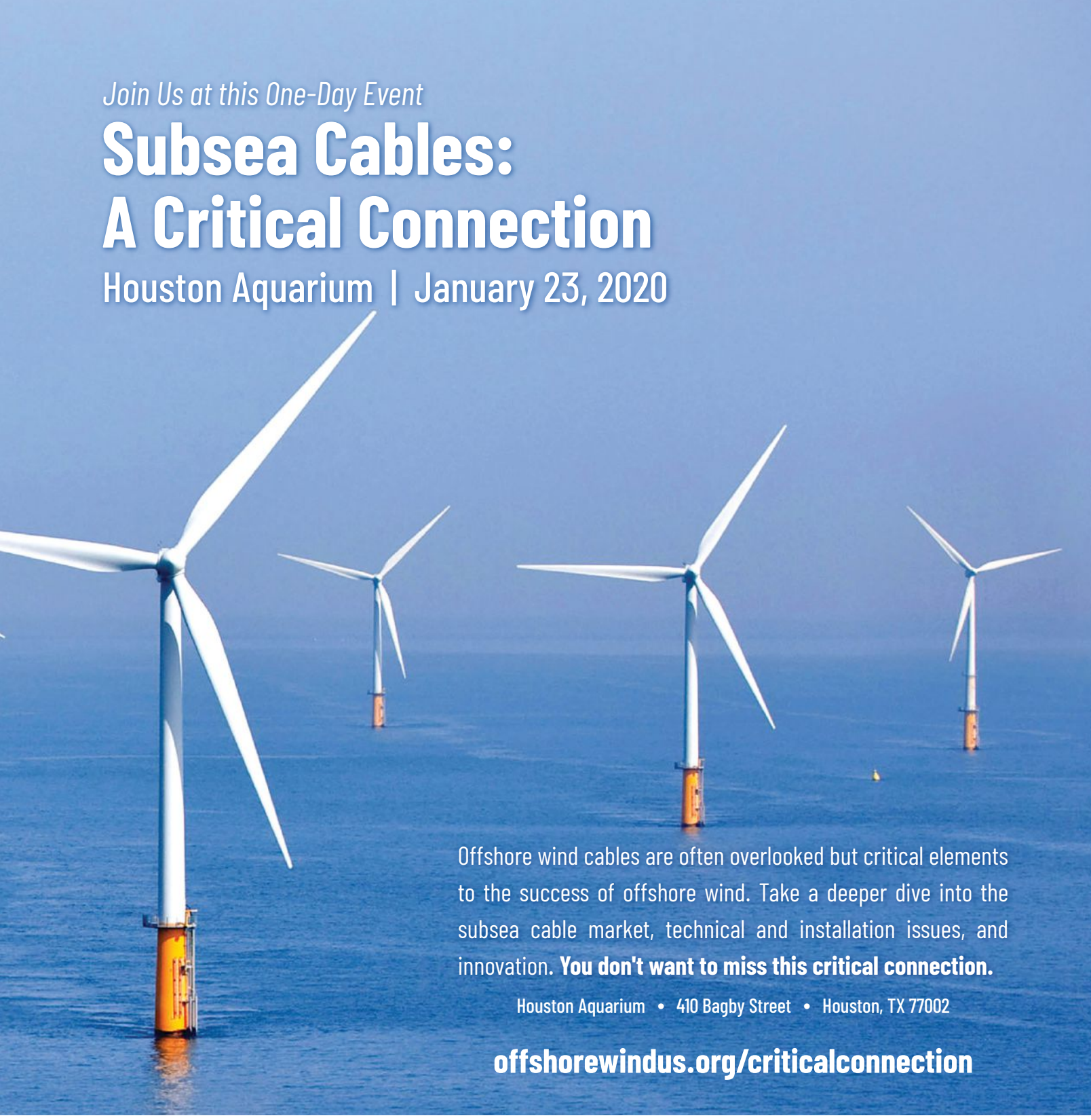
The agenda for *Subsea Cables: A Critical Connection* will include the following presentations:

- Most at Risk: A view from the insurance industry
- Mitigating Risk: Industry reaction roundtable
- US OSW Wind Cable Market: 2020 Market Forecast
- Trends and Challenges: A panel discussion
- Getting it Right from the Start: Industry reaction
- 66KV and Beyond
- Cable Innovation: A panel Discussion
- Technologies and Models for OSW Grid Integration: East and West Coast

Join Us at this One-Day Event

Subsea Cables: A Critical Connection

Houston Aquarium | January 23, 2020



Offshore wind cables are often overlooked but critical elements to the success of offshore wind. Take a deeper dive into the subsea cable market, technical and installation issues, and innovation. **You don't want to miss this critical connection.**

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SOURIAU INTRODUCES SWIM HARNESSES AND CONNECTORS FOR SHALLOW IMMERSION

Immersible connectors have to meet specific mechanical and chemical constraints. SOURIAU has been active in this market for a very long time with connectors for submarines, oceanography, marine renewable energies and the oil and gas industry and is now introducing a range of harnesses and connectors designed for shallow water immersible equipment.

To introduce the SWIM (Shallow Water Immersion) range, Vincent Mansour, Marine Product Manager at SOURIAU explains: "The saying that if you can do more, you can also do less is not always true, just because a connector is watertight at great depth does not mean that it will be equally so in shallow water. The watertight design has to take into account the pressure exerted on the seams, and therefore the immersion depth."

With SWIM connectors, the plug is screwed into the receptacle to lock both parts together and two O-rings at the mating interface ensure the connection stays watertight even at low pressure. Manufactured in thermoplastic material, SWIM connectors are lightweight and watertight. They are resistant to corrosion, cathodic delamination and UV exposure, which makes them particularly suitable for prolonged immersion in a marine environment. The screw mating and the coding pins make it easy to mate the plug with the receptacle, regardless of the number of pins.

SOURIAU harnesses, a real benefit for manufacturers

Manufacturers of shallow water immersible equipment have to confront problems of sealing, contact corrosion and connector installation. With its SWIM half-harnesses and harnesses, SOURIAU provides reliable solutions at a very competitive cost. In the catalogue, the half-harnesses are available on the 2 housing sizes and 13 contact arrangements, in lengths from 1 to 10 metres with cable connector overmouldings that can be straight or 90° angled.

SOURIAU also supplies specific harnesses on request: according to Vincent Mansour, "some customers, for the direct connection of two pieces of equipment without intermediate splices, ask us to produce complete harnesses with a connector at each end. In this case, the customer chooses his cable and connectors as well as the length and type of straight or angled overmoulding on each connector."

The design and manufacturing quality of SOURIAU 's SWIM harnesses ensure secure connections in applications up to 300 m deep. They perfectly match the requirements of surface drone applications. These drones are used for marine mammal research missions, oil and gas exploration or military-type applications such as maritime surveillance. SWIM harnesses also meet the needs of meteo-oceanographic buoys, OCROVs (Remotely Operated Underwater Observation Robots) and

a wide variety of marine equipment integrating sensors (hydrophones, temperature, salinity, etc.) and electronic devices.

SWIM harnesses contribute to the reliability of immersible systems while facilitating their maintenance and increasing the modularity of their architecture. SOURIAU does all its manufacturing, assembly and testing of SWIM connectors in-house. This vertical integration gives us the flexibility and reactivity we need to satisfy our customers present in all parts of the world.

SSE APPOINTS NEXANS TO SUPPLY CABLES FOR SEAGREEN OFFSHORE WINDFARM

Nexans has been appointed by SSE as the preferred supplier to design, manufacture and install the onshore and offshore export cables for the Phase 1 development of the Seagreen offshore wind farm project. Currently under construction off the Angus coast, Phase 1 comprises the Seagreen Alpha and Bravo wind farms. With a combined capacity of 1,075MW, they will form the largest windfarm project in Scotland when they come on line in 2024.

Nexans will supply and install the three 65 km offshore export cables and three 20 km onshore export cables for the project.

Seagreen Project Director John Hill said, "We are pleased to announce Nexans as our preferred supplier to design, supply and install the onshore and offshore export cable. Nexans is one world leaders in this field and this agreement is a major step forward for the Seagreen project."

Vincent Desale, Nexans SEVP for the Subsea and Land System Business Group commented: "We are delighted to receive this agreement from SSE and we are excited to be helping to bring the biggest windfarm in Scotland to life."

www.nexans.com

PRYSMIAN COMPLETES HVDC TEST ON COBRACABLE SUBMARINE POWER CABLE LINK

Prysmian Group has announced the successful completion of the HVDC test on the submarine interconnector COBRAcable that links The Netherlands and Denmark.

The announcement took place during the COBRAcable link's official inauguration event, simultaneously held in Eemshaven (NL) and Endrup (DK). Prysmian secured this project in February 2016 with a contract awarded by TenneT TSO B.V. and Energinet SOV, operators of the Dutch and Danish power transmission grids, respectively.

The COBRAcable interconnector produces benefits for both Denmark and The Netherlands, ensuring a reliable energy supply in the two countries. It also contributes to the development of a sustainable international energy landscape, a key priority for the European Union, which is supporting the project through the European Energy Programme for Recovery (EEPR).

Prysmian supplied and installed a ±320 kV HVDC bipole system, using single-core cables with extruded insulation technology and running for a total route of around 325 km, from Eemshaven to Endrup) via the German North Sea sector. The project includes two onshore lengths of 1 km on the Dutch side and 25 km on the Danish side that will connect the two onshore converter stations, provided under separate contract by Siemens. All submarine cables were produced in Arco Felice (Italy) and Pikkala (Finland), the Group's centres of technological and manufacturing excellence for this type of cables. Land cables were produced in Gron (France), while telecom cables were manufactured in Vilanova (Spain) and Drammen (Norway).

COBRAcable is a very innovative and tight schedule turn-key project, standing out for its big cross-sections and the various construction methods and installation technologies used, which saw the employment of the Heavy-Duty Plough, Hydroplow and Vertical Injector (able to reach a 10 m burial depth, and thus representing a point of reference for the industry) depending on the local water depth and composition of the seabed.

www.prysmiangroup.com

SWARMING TO SOLVE THE NAVY'S MINE COUNTERMEASURES PROBLEMS

By Dr. Joseph Walsh III, Naval Surface Warfare Center,
Panama City Division via the Center for International Maritime Security (CIMSEC)

» *Naval Oceanographic Office personnel prepare to launch 10 littoral battlespace sensing gliders from USNS Maury in the Eastern Atlantic Ocean. Photo credit: Rebecca Eckhoff, Naval Oceanographic Office.*

The Navy is in a position to create a concrete definition of what swarms of unmanned vehicles (UxVs) can do for the future of mine countermeasures (MCM). Some advantages are ready to be applied while others are still on the horizon. The Naval Surface Warfare Center, Panama City Division has invested in the development of swarming-based technologies for MCM and has developed swarming algorithms that allow otherwise standalone systems to collaborate by dividing up tasks, such as surveying potential minefields, and many of these algorithms are specifically designed to optimize the division of labor. Those optimizations are only the tip of the iceberg for what can be done to improve future naval MCM capabilities.

The Navy of the future might have:

- Swarms that neutralize mines, rather than attempt to detect them
- Swarms that could lead a ship safely through a minefield in a fraction of the time it would take to clear the area
- Swarms that spread out over a minefield, "sniffing" for specific sonar or chemical signatures in the water, in the same way that animals or insects cooperatively search for prey
- Swarms made up of existing MCM systems, using minimal resources to neutralize a minefield with a "divide and conquer" approach
- Swarms that identify and defeat swarm-based mines

By exploiting swarm-based technologies, there is potential for the Navy to shape MCM for a generation. However, in order to take full advantage of swarming capabilities, three significant shifts in how we think about MCM are required.

Economy of Scale: More Units for Less Money

Economy of scale is perhaps the most immediate opportunity for naval MCM development. Existing MCM systems are typically single, large systems that tend to be costly to develop and deploy. We suggest that moving to swarming-based technologies will allow a shift from single, large MCM systems to multiple, lower cost, swarming-based, modular systems. Current naval MCM systems yield significant capabilities and are superior not only in their design, but in their ability to detect mines. A single MCM system, however, can only be in one place at one time. Furthermore, limited resources reduce the overall availability of MCM systems thereby limiting our ability to conduct missions.

Developing large numbers of inexpensive MCM units, designed to work collaboratively in swarms, is one way to advance MCM capabilities. Simply by virtue of their numbers, swarming units provide increased flexibility when dealing with logistical and operational challenges. Swarms can be combined, or subdivided, depending on the strength required. When deciding how much MCM capability to assign to a region, commanders would be able to choose from multiple options. Cost reduction may open up new strategic options. Inexpensive swarm units are expendable and this allows the Navy to build swarming MCM systems designed not to

only detect mines but to also trigger them in efforts to speed the process of mine clearance while being able to accept more risk. With a swarm specifically designed to detect and trigger mines, some of the existing problems we face in mine detection become irrelevant. Certainly, some members of the swarm might be lost to an explosion, but fewer than one might think. Most of the individual swarming units would be scattered but intact, so the remaining swarm agents could simply regroup and continue their work.

Once we consider the paradigm shift of more units for less money, we need to consider how that shift will affect our design of future MCM capabilities.

Modularity: Design Teams Not Systems

Swarm-based MCM designs need to focus on modularity: separating the work into individual components, according to their design and how they will be used. Modular systems are easy to test and upgrade, and when they do break, they are much easier to diagnose and repair. In a modular swarm, individual UxVs are specialized. They perform the fewest tasks necessary, because they can count on their nearby teammates to complete the mission.

A modular approach allows for the creation of highly specialized MCM units. For example, consider the problem of detection. Different types of mines require different, specialized detection approaches, so if commanders know what type of mines might be present, they can deploy swarming sensing units optimized for those detections. If the mines are buried, even more specialized approaches are typically required. Similar trees of specialization and sub-specialization can be constructed for problems of identification and neutralization.

With a single system, all of the parts are designed to work together. Components are judged and chosen based on how they impact the system as a whole. To be effective, swarms need similar consideration. This brings us to the next point.

Compatibility: Metrics to Encourage Collaborative UxVs

Acquisitions that take a single-system approach have a tendency to stovepipe development and while this has been successful, we are suggesting a different approach. Current systems are often tested and evaluated in isolation, without consideration for how they might interact with other systems. A swarm is, by definition, a large group collaborating toward some goal. A swarm-based approach to acquisition will measure the success of a program by its effectiveness in groups, particularly groups composed of a variety of different UxVs.

Specifically, the Navy could test and evaluate how a new product works when applied to swarm-based scenarios. It should offer incentives for the use of multiple kinds of agents, particularly those designed by outside groups. (Increased collaboration between diverse research teams is one side-effect of this approach.) The Navy might also consider developing standard scenarios for swarm-based MCM, both to direct innovation and to offer a concrete basis for measuring success.

Above and beyond standardizing scenarios, the Navy is poised to take the lead in defining what swarm-based MCM means. This would require investments in several important swarm-enabling technologies, such as:

• Improved communications. In contested environments and underwater, messaging is slow and bandwidth is at a premium. Anything that improves these conditions makes swarm-based MCM easier and more effective.

• Secure communication systems. A swarm's communication is, by its very nature, exposed. Effective cybersecurity means preventing those communications from being intercepted, or worse yet, spoofed, by adversaries in the field.

• A rapid-development approach to swarm member creation. Specifically, this does not mean developing a "minimal cost viable prototype," but establishing a process whereby finished products can quickly transition from laboratory to factory, and once there, can be produced inexpensively in large quantities. The focus here should be on single-function swarm members that add specific desirable capabilities, even if that makes them dependent on the results of other projects.

• Improved swarm logistics. If development is not done carefully, rapid deployment of swarms could become an insurmountable obstacle. Ideally, swarm deployment could be as simple as emptying a box of them over the side of a ship, and retrieval as easy as scooping them up in a large net. With a proper recharging station, readying the swarm could be practically painless.

To achieve successful swarm-based MCM, the Navy will need to develop a mindset around large groups of swarming technologies that are low cost and, perhaps, expendable. The human mind is hard-wired to think in terms of action by individuals, or possibly small groups. Yet this is not the only option. In nature, everywhere we look, we see large groups of creatures that cooperate with each other to complete sophisticated tasks. For some problems, such as search and detection, their methods are far superior to our own. We suggest mimicking nature to develop a swarm-based approach with the ultimate goal being the development of advanced MCM capabilities.

About the Author: *Dr. Joseph Walsh is currently the head of the Applied Sensing and Processing Branch at the Naval Surface Warfare Center, Panama City Division. He received his doctorate degree in Mathematics from the Georgia Institute of Technology in 2017. His dissertation is in the area of optimal control and his research has been applied to heterogeneous teams of vehicles. He has published numerous papers in multi-agent coordination.*

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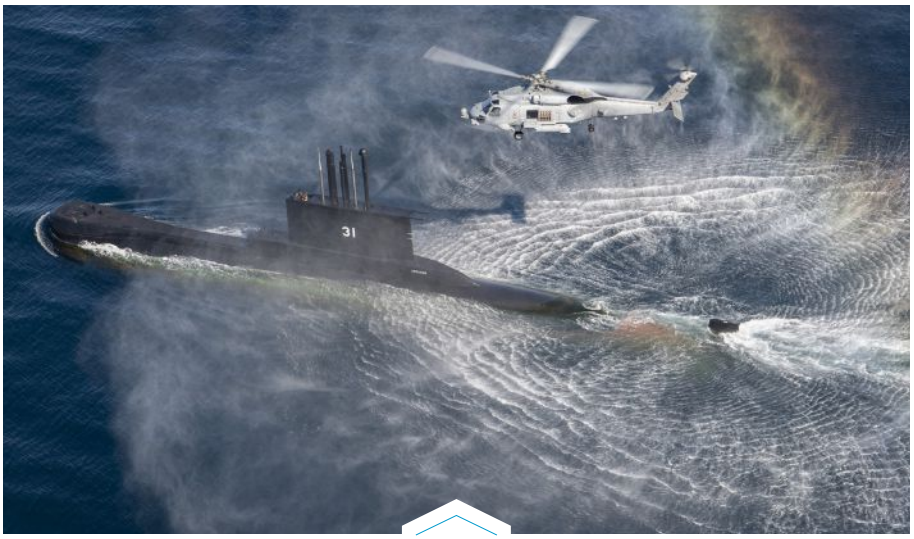
US SUB SQUADRON, PERUVIAN SUB JOIN IN DIESEL-ELECTRIC INITIATIVE



» An MH-60R Sea Hawk helicopter from the Magicians of Helicopter Maritime Strike Squadron (HSM) 35 conducts a hoist exercise with the Peruvian navy submarine BAP Angamos (SS-31) off the coast of San Clemente Island. HSM-35 is conducting antisubmarine warfare training to maintain readiness by utilizing a live submarine. (U.S. Navy photo by Mass Communication Specialist 1st Class Patrick W. Menah Jr./Released)

Commander, Submarine Squadron 11 (CSS-11) and the Peruvian Submarine BAP Angamos (SS-31), a German-built Type 209 submarine (SSK), partnered to enhance and conduct training at Naval Base Point Loma as part of the Diesel-Electric Submarine Initiative (DESI) program, starting October 19.

The staff of CSS-11 and the crew of the Los Angeles-class fast-attack submarine USS Annapolis (SSN 757) joined their South American partners to sharpen their respective warfighting tools.

"Each year, Submarine Squadron 11 looks forward to DESI and we are thrilled this year to be working with our Peruvian counterpart," said Capt. Patrick Friedman, CSS-11. "By having an SSK operate and train with us, it gives us the opportunity to practice on a platform that has a similar signature to our adversaries. Not to mention, there is a great deal of diplomatic good will that is fostered through these engagements."

Cmdr. Marco Goytizolo, commanding officer of Angamos, echoed Friedman's sentiments and shared his excitement to be working alongside a "very well organized and cohesive group led by a great commander who is backed by an excellent team of professionals."

DESI, established in 2001 by U.S. Fleet Forces Command, is an international program led by Commander, Submarine Force Atlantic, which works to enhance the Navy's capability to operate with diesel-electric submarines by collaborating with South American navies.

"Not only are we able to strengthen our bond with our Peruvian partners, DESI allows for us to build on our own anti-surface warfare prowess," said Lt. Alexander Papadakos, the CSS-11 liaison officer for Angamos. "Our hope is that our training benefits them as much as it does us."

During the two-month bi-lateral training, Angamos will participate in a multitude of different exercises, to include surface, air, and sub-surface anti-submarine warfare (ASW) exercises, a carrier strike group composite unit training exercise and a maritime patrol reconnaissance aircraft exercise.

Sailors aboard Angamos will also engage in training ashore at Naval Base Point Loma. The Submarine Learning Center Detachment San Diego will host the Peruvian Sailors for classroom and practical training. This includes fighting simulated fires at the firefighting trainer and learning skills to combat flooding in the damage control team trainer.

Peru continues to provide invaluable support to this premier foreign submarine exercise program. During the past 17 years, Peruvian submarines have participated in a number of fleet exercises and tactical development events with the U.S. Atlantic and Pacific Fleets. The Peruvian Navy operates a total fleet of six SSKs. Notably, Peru is the largest submarine force in South America and is the second oldest in the Western Hemisphere.

CSS-11 is based at Naval Base Point Loma and consists of five Los Angeles-class fast-attack submarines, the floating dry dock Arco (ARDM 5) and Undersea Rescue Command (URC). The squadron staff is responsible for providing training, material and personnel readiness support for each of these units.

CHINA PLAYING CATCH-UP WHEN IT COMES TO LARGE UUVS

Multiple media outlets have reported the unveiling of China's HSU-001 unmanned underwater vehicle (UUV), which played a central role in showing off that nation's military technology during the 70th anniversary of the founding of the People's Republic of China. It's estimated to measure more than five meters long.

While no official statement has come out of China, military experts believe it could be used for general marine data collection and gathering underwater military information.

According to the South China Morning Post, development of this large UUV means China has been paying a lot of attention to the growth of its anti-submarine warfare capability.

"[It] could pose a challenge to prospective adversaries such as the US Navy and allied underwater activities in waters near the Chinese coast, such as the East China Sea and South China Sea," said Collin Koh, research fellow with the Maritime Security Programme at Singapore's S. Rajaratnam School of International Studies.

Such a large drone could be used in long-duration anti-submarine surveillance or more offensive forms of intelligence-gathering operations in distant waters, he said.

China has expanded its unmanned undersea vehicle capabilities, including in oceanographic research, seabed topography and marine sciences. It has also built the Jiaolong manned submersible, which can dive to more than 7,000 meters.

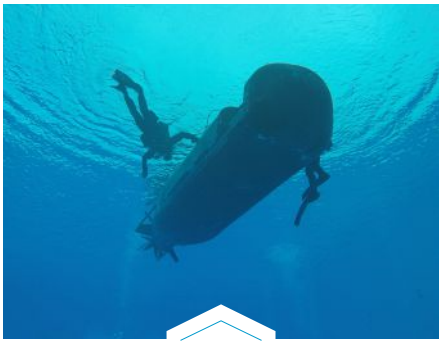
In July 2018, when the South China Morning Post interviewed Lin Yang at the Shenyang Institute of Automation, Yang said that China has plans to develop new-generation military underwater robots by 2021. The goal is to develop AI-driven unmanned submarines to handle surveillance, mine laying, and attack missions.

JR Wilson of Military & Aerospace Electronics reports that may analysts believe that the Chinse navy is developing several AI-enabled vessels, with a focus on autonomous submarines, "as part of a major push to overtake U.S. dominance in the Indo-Pacific region and beyond. That includes 100-foot long extra-large unmanned underwater vehicles (XLUUVs) intended for deployment early in the next decade.

"Another civilian project is China's most ambitious undersea AI effort to date, with significant military potential. In 2018, China announced it was working on an AI-run underwater base, equipped with autonomous submarines to extend its reach."

According to published reports, the submarines would deploy for investigation and scientific surveillance missions, then return to the unmanned base to download data and recharge. The base itself, located on the ocean floor as deep as 36,000 feet, also would conduct research on the immediate area, process and fuse all collected data, and transmit the results to a surface ship or land station. No location or timetable for deployment of the base have been released, but, given the speed with which China is developing AI across the board, and especially for undersea applications, the first elements are expected in the near future."

» *Witnesses reported what appeared to be an unmanned underwater vehicle on a military truck during rehearsals for Tuesday's National Day parade in Beijing. Photo: Handout*



TELEDYNE AWARDED $178 MILLION SPECIAL OPERATIONS SHALLOW WATER COMBAT SUBMERSIBLE CONTRACT

On 21 October 2019, Teledyne Technologies Incorporated announced that its subsidiary, Teledyne Brown Engineering (TBE) in Huntsville, Alabama, was awarded a sole source contract from the Naval Sea Systems Command (NAVSEA) for the follow-on production of MK11 Shallow Water Combat Submersible (SWCS) Systems. The contract, including all options, is valued at $178 million.

The SWCS System is a manned combat submersible vehicle specifically designed to insert and extract Special Operations Forces (SOF) in high threat areas. Under the initial contract with the United States Special Operations Command (USSOCOM), TBE successfully designed, manufactured, tested and delivered the initial Engineering Development Model (EDM) SWCS System. Due to the success of the program's EDM Phase, USSOCOM exercised options for TBE to produce and deliver additional MK11 SWCS Production Systems.

"Teledyne is proud to be supplying advanced technologies and systems enabling our Special Operations Forces to perform their missions successfully," said Al Pichelli, President and Chief Executive Officer of Teledyne. "The Shallow Water Combat Submersible is a complex system that will assist in the safe delivery and return of those who are protecting our nation."

Under the new NAVSEA contract, TBE will continue production and delivery of MK11 SWCS Systems, including spare parts production and the provision of engineering and technical support services, through fiscal year 2024, if all options are exercised.

ℹ www.tbe.com

DAMEN DELIVERS MULTIPLE VESSELS

» *The HST Harri. UK-based High Speed Transfers has taken delivery of the third Fast Crew Supplier (FCS) 2710, at Damen Shipyards Antalya.*

MMS Offshore Takes Delivery Of Second Damen Fcs 2610

MMS Offshore Renewable Services Ltd has taken delivery of a Fast Crew Supplier (FCS) 2610 from Damen Shipyards Group. The new vessel – to be called *MMS Superior* – will be deployed in a variety of roles in the offshore renewables, oil & gas and marine civil engineering sectors.

MMS Offshore Renewable Services is located on the banks of the River Humber in Hull and Grimsby, UK. The company operates a modern fleet that consists of workboats and multi-purpose wind farm support vessels, including another Damen FCS 2610, the *MMS Supreme*.

Third Fast Crew Supplier 2710 Delivered to High Speed Transfers

The delivery of the third Fast Crew Supplier (FCS) 2710 bought by Swansea, UK-based High Speed Transfers has taken place at Damen Shipyards Antalya. Named HST *Harri*, she joins the *HST Hudson*, delivered in May 2018, and the *HST Sofia*, which was handed over in March this year. A fourth FCS 2710 for High Speed Transfers, to be named *HST Euan*, is currently nearing completion for delivery in December.

The *HST Harri* is booked to start on a five-year contract in the North Sea with wind farm operator MHI Vestas, where her duties will include delivering personnel and equipment to multiple sites.

The FCS 2710 builds on the success of Damen's highly successful FCS 2610. While only one meter longer, it is capable of carrying 26 passengers, twice as many as the FCS 2610, and can operate in wave heights of more than two meters due to an extra meter of freeboard. Additional features include more flexibility, more tank capacity, greater deck space, increased comfort and more accommodation.

Bibby WaveMaster Horizon Delivered to Bibby Marine Services

A second Accommodation Support Vessel (ASV) 9020 has been handed over to Bibby Marine Services at Damen Shipyards Galati in Romania. On her arrival in the North Sea, the *Bibby WaveMaster Horizon* will begin maintenance work off the coast of Germany on two EnBW and Enbridge-owned windfarms – Hohe See and Albatros – for Siemens Gamesa Renewable Energy and EnBW.

The 90-meter ASV 9020 has been developed by Damen to meet the specific needs of the offshore renewable energy industry with regard to achieving high-efficiency, low-cost wind farm maintenance. It combines walk-to-work capabilities with an innovative interior and comprehensive features that together ensure maximum efficiency in accommodating and deploying multiple maintenance teams. DP2 and an innovative hull ensure a wide window of operability and excellent seakeeping.

WWW.DAMEN.COM

HEEREMA'S CRANE VESSELS TO SWITCH FROM DIESEL GENERATORS TO WIND ENERGY

Heerema Marine Contractors will provide its crane vessels with clean energy. By switching off the diesel generators, total emissions will be reduced by the equivalent of the annual emissions of approximately 5,000 diesel cars. Eneco will supply power from the wind farm on Landtong Rozenburg. Heerema's crane vessels are often moored in the Calandkanaal in Rotterdam. The use of clean energy reduces noise and air pollution, significantly reduces CO_2 emissions and improves the quality of life in Rozenburg and Maassluis.

To supply the power, an "e-house" of 16 by 9 meters will be built on Landtong Rozenburg together with several transformers. Eneco and the Port of Rotterdam Authority have set themselves the goal of providing vessels, in addition to those of Heerema, with shore power at other locations in the vicinity. To get the project off the ground, the Municipality of Rotterdam has reserved a subsidy of €2 million in its 2020 budget, provided that the e-house on Landtong Rozenburg is properly integrated into its surroundings in consultation with local residents.

It is not very common internationally that these types of large vessels are connected to shore power. What makes the project truly unique is the direct supply of wind turbine power to these nearby seagoing vessels. Eneco (80%) and the Port of Rotterdam Authority (20%) are now establishing the "Rotterdam Shore Power B.V." with Heerema as their first customer. In addition to supplying Heerema, this new power company wants to supply shore-based power to several companies in the area. Discussions on this are ongoing. Other nearby terminals can be supplied with shore power from the e-house on Landtong Rozenburg.

5,000 Diesel Cars

Heerema's Sleipnir and Thialf are the largest crane vessels in the world. These crane vessels are regularly moored in the Calandkanaal in Rotterdam for maintenance or to prepare for projects at sea. Vessels need energy to run on-board facilities. These include pumps, cranes, lighting, air conditioning and other equipment. Vessels usually deploy their diesel generators to generate the necessary power. They make noise and emit particulate matter, nitrogen oxide (NOx), sulfur dioxide (SO2) and CO_2, among other things. The diesel generators of Heerema's vessels produce approximately the same amount of these emissions each year as do 5,000 diesel cars. By switching off the generators, emissions of CO_2 are reduced by approximately 15,000 metric tons each year.

Municipal Subsidy

With this innovative project, Heerema, Eneco, the Port of Rotterdam Authority, and the Municipality of Rotterdam want to show that it is possible to supply shore-based power to large seagoing vessels. Because of this demonstration aspect, the municipality has reserved a €2 million subsidy for the project in its 2020 budget. This is on condition that the e-house on Landtong Rozenburg, in consultation with local residents, will be well integrated into its surroundings. If the Rotterdam Shore Power B.V. can connect several companies and its income increases as expected, the municipal subsidy will be returned.

Integration into Landtong Rozenburg

The project will apply for the permits in late 2019 and construction is to start in the spring of 2020. Most important is building the e-house of approx. 16 x 9 x 5.5 meters, including several transformers. This e-house will be located near Heerema's berth on the north side of the Noordzeeweg on Landtong Rozenburg. The integration of this e-house into its surroundings is very important and local residents will be invited to express their views on the plans at several meetings in the near future. Heerema's vessels also need to be converted to connect to shore power. If everything goes according to plan, Heerema's vessels will be plugged in sometime next year.

For more information, visit
WWW.HMC.HEEREMA.COM

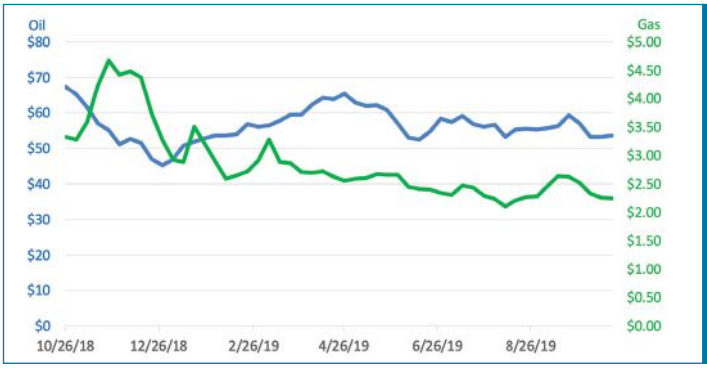
» *Thialf, one of the largest crane vessels in the world.*

CRUDE & NATURAL GAS Spot Prices

PRICES IN US DOLLARS AS OF OCTOBER 18, 2019

Oil prices were again largely stable in the past month, closing at $53.49 per barrel on the WTI Spot Prices. This is almost exactly the closing price on February 1, 2019 ($53.63 per barrel). The International Energy Agency (IEA) warned in October that continued oversupply is expected in 2020 as inventories are high and global oil demand remains sluggish. Meanwhile, Reuters reported that OPEC countries will meet in December to consider production cuts.

After rebounding in September, natural gas prices dropped significantly in the past month. The Henry Hub Spot price for gas dropped to $2.25 per million BTU on October 18 (the most recent EIA data available at press time), down from the $2.63-mark a month earlier, due to high inventories. At press time, however, there were reports that producers would make production cuts, according to the Wall Street Journal, which could push prices higher.



WEEKLY WTI CRUDE & NATURAL GAS SPOT PRICES

Last 52 Weeks

WTI Spot Price

$53.49

$57.92 previous month

TRENDING DOWN

Henry Hub Spot Price

$2.25

$2.63 previous month

TRENDING DOWN

KEY EQUITY Indexes

PRICES IN US DOLLARS AS OF OCTOBER 28, 2019

EQUITY INDEXES CONTINUED
to show volatility in the past month

Equity Indexes moved modestly upward in the past month, during which large swings were largely absent. The Dow Jones Industrial Average gained less than 200 points during the month but move above the 27,000-point mark. Mixed financial results from blue chip companies and ongoing uncertainty over the US-China trade war led to modest movement that, nonetheless, trended upward. The same was true of the S&P 500, which gained about 60 points and surpassed the 3,000-point mark.

The Philadelphia Oil Services Index (OSX) saw similarly modest growth. The OSX gained about one-and-a-half points in October and seems to have stabilized to some degree following large losses last spring when the index hovering around the 100-point mark. It closed at 67.03 points at the end of October.

SELECTED EQUITY INDEXES

CUMULATIVE PERCENTAGE CHANGE

Last 52 Weeks

27,090.72

Up **173.89** from previous month

TRENDING UP

DJIA

67.03

Up **1.53** from previous month

TRENDING UP

OSX

3,039.42

Up **62.68** from previous month

TRENDING UP

S&P 500

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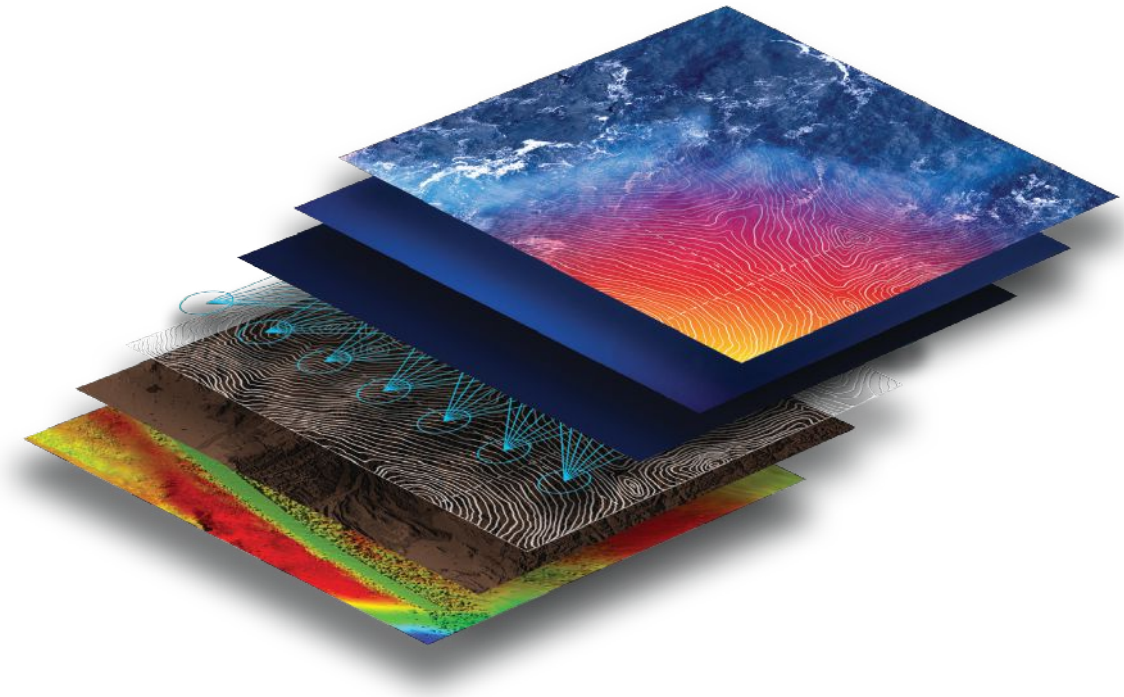

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HEADING INTO WINTER DEMAND SEASON PROVIDES PRICE SUPPORT

BY G. ALLEN BROOKS | Author, *Musings From the Oil Patch* | www.energymusings.com

Crude Oil:

It is hard to believe that barely two months ago the world was shocked by the drone and missile attack on Saudi Arabia's largest oil processing facility, as well as a significant oil field, knocking out half the kingdom's production. Yet today, oil prices are about where they were on the day before that weekend attack. The price reaction is clearly a statement that absent a wider military confrontation, the dynamics of weakening demand due to a slowing global economy and stubbornly rising supply have oil prices capped.

Although no longer the world's leading producer, Saudi currently retains the largest unused output capacity. That spare capacity may prove critical should there be a wider military confrontation or significant production problems among major oil supplying countries.

Although we are heading into the high winter demand period, the world appears adequately supplied with crude oil, making Saudi's spare capacity only an insurance policy. However, this spare capacity represents an oil price-governor, as prices appear to only rise when media reports discuss the possibility of a deeper OPEC+ production cut in 2020 once the current cut ends in March. Not surprisingly, these rumors are welcomed by oil price bulls, when in reality, the need for a deeper cut signals a need for less supply in order to better align supply with anticipated demand. Without a greater cutback, when demand declines in the spring, global oil inventories will grow, putting pressure on oil prices.

The oil industry was shocked by Saudi Arabia's rapid output recovery. Absent another attack or retaliation by Saudi, traders quickly knocked down oil prices following their 20 percent jump, and returned the market's focus to near-term demand and supply factors rather than geopolitical considerations.

Based on the U.S. Energy Information Administration's October Short-Term Energy Outlook, global oil demand and supply are projected to grow in 2020. U.S. production growth is slowing and the forecast calls for OPEC+ to sustain its production cut through March 2020, and likely longer. Despite the supply dynamics, without a greater OPEC+ cut, OECD inventories will continue rising, albeit at only a 2.5 percent annual rate. If demand weakens more than projected, the inventory build could be greater. More supply will pressure oil prices.

In recent days, the spread between Brent and West Texas Intermediate has narrowed after a nearly half year span when the spread had widened. Note in our chart how the recently widened spread began to resemble the spread that existing during 2011-2014. We don't see this as a point of concern, but certainly something to be watched, as it may signal a divergence in market trends. More winter demand, with reasonable adherence to OPEC+ production quotas, should help hold up oil prices.

Natural Gas:

Early cold weather, and prospects for more cold temperatures in the first half of November, is having a positive impact on natural gas prices. The price improvement has come despite larger than 5-year average weekly storage builds. Between September 20 and October 18, weekly storage injections were anywhere from 10 percent to 20 percent greater than the 5-year average weekly injections, with half the weeks showing triple-digit injections. Weekly injections were routinely much greater than then were in the comparable weeks last year.

The rapid storage build occurred despite continued hot weather in parts of the country and record liquefied natural gas export shipments. The industry was also boosting gas exports to Mexico after a period when demand from industrial customers south of the border was impacted by pipeline connection issues that have now been corrected. Storage and shipment gains reflect the continued growth of supply, but also greater renewables energy, too. While some analysts expect gas output growth to slow due to less drilling in the Permian Basin, the start-up of new gas pipelines should contribute to reduced gas flaring, and thus more supply early in 2020.

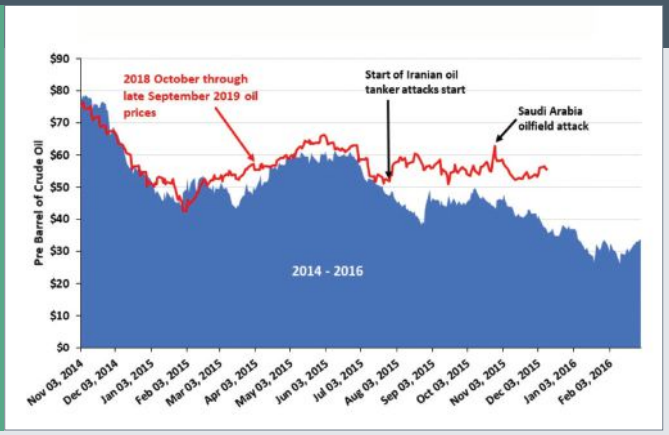
As a result of the strong weekly gas injections, total storage volumes have now surpassed the 5-year average. That is a positive for those concerned about the winter being colder than normal, or at least colder than last winter when storage volumes were driven to very low levels. The storage recovery from that extremely low level earlier this year has been dramatic and surprising to those who anticipated large storage builds could only happen with substantially higher gas prices than experienced.

To see the impact of cold weather and forecasts for more cold weather, covering a large area of the United States, one only needs to see what has happened to gas prices. Our chart of the history of natural gas prices since 2017 shows two periods when prices changed course. We have circled each period along with drawing a line connecting the rising low-price points after the lowest price had been reached.

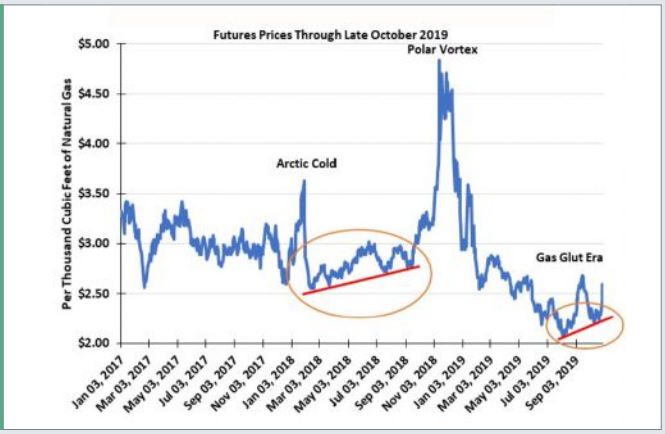
The slope of the low-price line in the current upturn is steeper than experienced in 2018. It will be important to watch the near-term trajectory of gas prices. If one examines the 2018 period, even after gas prices rose and then fell back, they then climbed higher. That happened during the first two-thirds of the period. The last third of that period showed gas prices failing to rise above the previous high price before falling back. We then experienced the polar vortex that took gas prices to modern highs, only to collapse once warmer temperatures arrived.

The current price recovery has seen recent gas prices approaching the prior peak. The odds would suggest prices will go higher before correcting. If they fail to rise above the past peak and subsequently fall, we are likely facing another period of low prices. Since we are just entering the winter cold period, odds would favor gas prices rising further, leading to higher gas prices during the balance of the 2019-2020 winter.

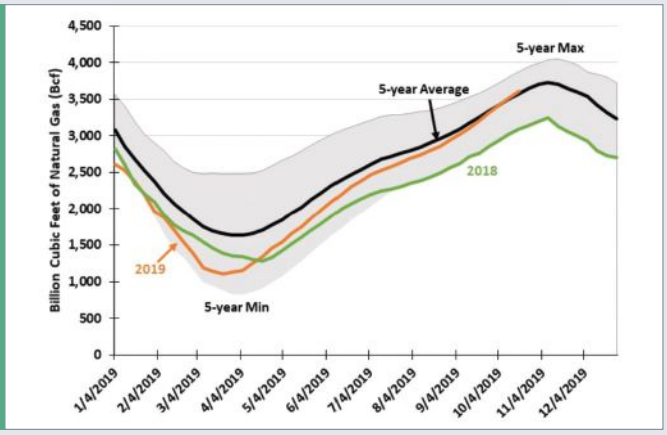
Geopolitical Tensions Have Supported Oil Prices Higher Than Fundamentals Would Dictate



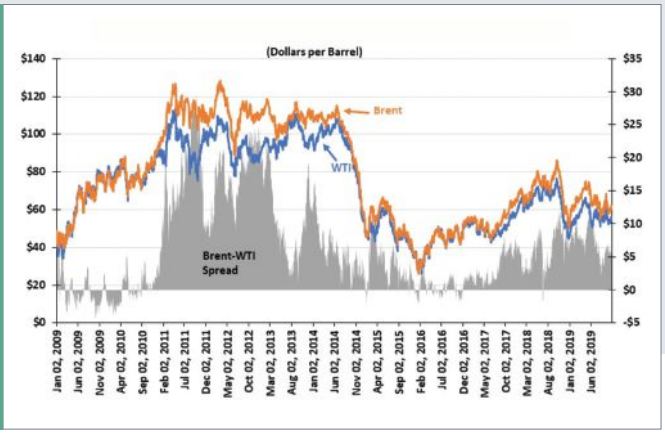
2019 Natural Gas Prices: After Disappointing Are Rising



Low Natural Gas Prices Helping Rebuild Storage



A Decade of WTI and Brent Prices, And Their Spread



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www.blueinnovationsymposium.com

PTC
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www.ptc.org/ptc20

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www.offshorewindus.org/criticalconnection

Offshore Wind Executive Summit
Galveston, TX » February 4, 2020
www.offshorewindsummit.com

Underwater Intervention
New Orleans, LA » February 4-6, 2020
www.underwaterintervention.com

Subsea Tieback
San Antonio, TX » February 18-20, 2020
www.subseatiebackforum.com

Canadian Hydrographic Conference
Quebec City, Canada » February 24-27, 2020
www.chc2020.org

CABSEC/SAMSEC
Cartagena de Indias, Colombia
» March 24-26, 2020
www.defenceiq.com/events-cabsec

Decommissioning & Abandonment Summit
Houston, TX » March 31 – April 1, 2020
www.decomworld.com/gom

IPF
Providence, RI » April 21-24, 2020
www.offshorewindus.org/2020ipf

OTC
Houston, TX » May 4-7, 2020
2020.otcnet.org

EUROPE

Surface Warships
London, UK » January 28-30, 2020
www.defenceiq.com/events-surfacewarships

Euromaritime
Marseille, FR » February 4-6, 2020
www.euromaritime.fr

Subsea Expo
Aberdeen, UK
» February 11-13, 2020
www.subseaexpo.com

Submarine Networks EMEA
London, UK » February 18-19, 2020
www.terrapinn.com/conference/submarine-networks-world-europe

Undersea Defense & Security
Southampton, UK » March 3-5, 2020
www.defenceleaders.com/home/events-page/underwater-defence-security

Seabed Mapping and Survey
Geilo, Norway » March 4-6, 2020
www.tekna.no/en/events/seabed-mapping-and-survey-38497/

Oceanology International
London, UK » March 17-19, 2020
www.oceanologyinternational.com

Eastern Mediterranean Offshore
Cyprus » April 7-9, 2020
www.emc-cyprus.com

Deep Sea Mining Summit
London, UK » May 13-14, 2020
www.deepsea-mining-summit.com

UDT
Rotterdam Ahoy, NL
» May 26-28, 2020
www.udt-global.com

OTHER REGIONS

Asia-Pacific Deep Sea Mining Summit
Singapore » December 4-5
www.asia.deepsea-mining-summit.com

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www.asia-decs.com

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www.2020.otcasia.org

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www.singapore20.oceansconference.org

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RIPTIDE MKII RECOGNIZED AS A MARKET DISRUPTER BY R&D WORLD

Winners of the R&D 100 Awards have been announced by R&D World magazine, and one ocean-industry company was called out as a market disrupter. Judges awarded several submissions in the four Special Recognition categories, potentially giving a Gold, Silver and Bronze in each. For the Market Disrupter – Products category, Riptide MkII Micro-Unmanned Undersea Vehicle from BAE Systems, FAST Labs was recognized with the Silver award.

"This awards program is so well recognized across the R&D community. Being named as one of the R&D 100 is an incredible honor," said Paul J. Heney, Vice President, Editorial Director for R&D World. "These 100 winning products and technologies are the disruptors that will change industries and make the world a better place in the coming years."

Primary organizations that took three or more R&D 100 Awards are: Argonne National Laboratory, Dow Chemical, Idaho National Laboratory, Lawrence Berkeley National Laboratory, Lawrence Livermore National Laboratory, Los Alamos National Laboratory, MIT Lincoln Laboratory, NETL, Oak Ridge National Laboratory, and Sandia National Laboratories.

The R&D 100 Awards Banquet will take place on Thursday, December 5th at the San Mateo Marriott near San Francisco, California — in conjunction with the R&D 100 Conference. For more information, please visit www.rd100conference.com .

BAE Systems, Inc. announced the purchase of the key assets of Riptide Autonomous Solutions in June 2019.

CHARTCO AND MARINA PRESS MERGE TO CREATE ONEOCEAN

ChartCo and Marine Press have announced their merger. The move will result in the creation of a new company called OneOcean, which they say will offer the largest range of navigation and compliance solutions for the maritime sector.

Martin Taylor, Chief Executive Officer of ChartCo, said: "We identified Marine Press as a like-minded partner that would complement our own business and expand the offerings to our growing international client base. Marine Press has created game-changing navigation software and award-winning products and services that will complement our own integrated digital navigation products to really create a huge step forward for both of our customer bases."

Nicholas Bourque, President of Marine Press, added: "OneOcean will have, by far, the largest R&D capability in the sector and will offer the most innovative solutions for maritime compliance and digital navigation. The technology roadmap that the combined group is working on is really exciting, building on 'best in class' solutions from both organizations, and will take ship management into a new digital era."

The merger of these global leaders will provide extensive R&D opportunities towards the development of digital maritime solutions. OneOcean's continued investment in innovation will drive the maritime sector forward, with the overall aim of reinforcing safer, cleaner and more efficient working practices throughout the shipping industry.

OneOcean will be the largest single digital solutions company in the maritime industry, serving almost 20,000 vessels and a variety of shore-based stakeholders. *www.chartco.com*

» *Nicholas Bourque, President of Marine Press (left) and Martin Taylor, Chief Executive Officer of ChartCo (right).*

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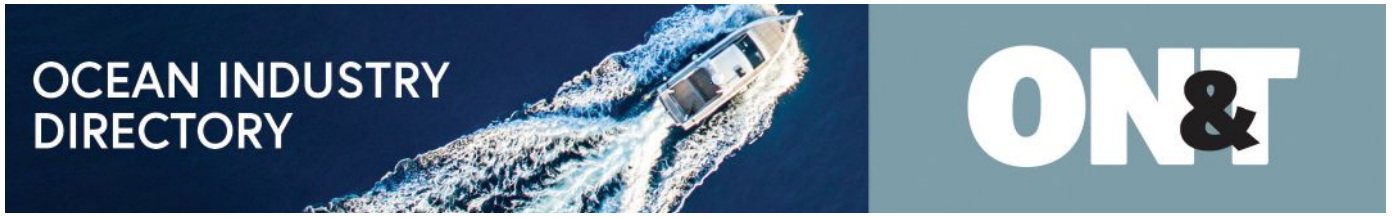
Check the website for registration information and details for both attendees and exhibitors!

UnderwaterIntervention.com



ACOUSTIC SYSTEMS

APPLIED ACOUSTICS ENGINEERING LTD
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Fax: +44 (0) 1493 440720
E-mail: gavinwilloughby@appliedacoustics.com
Website: www.appliedacoustics.com
Contact: Gavin Willoughby

Manufacturer of fully integrated USBL acoustic tracking systems, both portable and vessel based, high quality multi-system compatible beacons for acoustic positioning and release, and seismic sub-bottom profiling systems for coastal, offshore or geohazard surveys. All products are supported by a network of overseas representatives providing a first class service on a global scale.

HIGH TECH, INC
21120 Johnson Road
Long Beach, MS 39560, United States
Tel: 228 868 6632
Email: high_techinc@bellsouth.net
Website: www.hightechincusa.com
Contact: Glenn Pollock

Experts in rugged marine sensor systems utilized in geophysical surveys, anti-submarine warfare, marine mammal monitoring and downhole applications. Products include data acquisition systems, hydrophones, array cables, pressure vessels and peripherals related to marine systems.

OCEAN SONICS LTD.
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Ocean Sonics designs and manufactures icListen, the world's first smart digital hydrophone. Compact and easy to use, its small size makes it the perfect tool for sound data collection. Listen in real-time and improve decision making, or use as an acoustic recorder for long term deployments. The best data is collected by the best tools. icListens internal processing saves time. Digital sound is streamed live.

Ocean Sonics is dedicated to your success. We provide services in deployment, system design and integration, and data processing.

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RTSYS designs and manufactures Real-Time Acoustic Systems (Underwater Recorders and Buoys), Sonar Systems (analog sonar retrofit, portable sonars for divers) and Autonomous Underwater Vehicles.

Our Synchronized Multichannel Acquisition Core System (SDA) can handle various Acoustic Transducers and Hydrophones from 3Hz to more than 1MHz and allows a broad range of applications such as noise impact studies, sediment characterization, or cetacean research.

RTSYS products are used all over the world by Navies, Scientific Research Institutes and Offshore Fields Engineers. Flexibility, passion and Innovation guide our daily decisions.

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Contact: Shannon Searing

Teledyne RESON together with Teledyne BlueView and Teledyne Odom provides a range of high quality underwater acoustic hardware and software solutions for underwater imaging within Teledyne Marine. These solutions are delivered through recognized brands such as SeaBat, BlueView, Odom, HydroSweep and ParaSound Multibeam Echosounder and Teledyne PDS software suite.

Teledyne Marine is a group of leading-edge subsea technology companies that are part of Teledyne Technologies Incorporated. Through acquisitions and collaboration over the past ten years, Teledyne Marine has evolved into an industry powerhouse, bringing Imaging, Instruments, Interconnect, Seismic, and Vehicle technology together to provide total solutions to our customers.

ADCP/DVL

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Nortek excels in the development and manufacture of acoustic Doppler instrumentation. Doppler Velocity Logs (DVLs) are used for subsea navigation. Acoustic Doppler Current Profilers (ADCPs) are used to understand physical processes in the ocean, rivers, lakes and laboratories. We pride ourselves on being innovative in product development and production processes. Nortek provides solutions to engineers and scientists by offering real-time data collection and support from our responsive technical team.

TELEDYNE RD INSTRUMENTS
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Contact: Paul Devine

Teledyne RD Instruments, Inc., located in Poway, CA USA, specializes in the design and manufacture of underwater acoustic Doppler products and oceanographic sensors for a wide array of commercial, academic, and defense applications.

Originally founded in 1982, RD Instruments developed the industry's first Acoustic Doppler Current Profiler (ADCP). Through the years, this innovation has spawned a full line of ADCPs for current profiling in environments ranging from the shallowest stream to the deepest ocean. Expanding on this technology, the company also offers their industry-leading Doppler Velocity Logs (DVLs) for precision underwater navigation onboard manned and unmanned submersibles.

BUOYS

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MetOcean Telematics designs and manufactures drifting buoys, environmental platforms, and the world renowned NOVATECH locator beacon product line. In addition to providing complete end-to-end telematics services, and one of the few manufactures in the world to achieve ISO 9001 certification. MetOcean Telematics's drifting buoy family consists of environmental and weather monitoring, oil spill response, and search and rescue drifters: NOVA profiling float, Iridium SVP (iSVP), iSPHERE, Argosphere, SLDMB, and iSLDMB.

BUOYANCY PRODUCTS

DEEPWATER BUOYANCY, INC.

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Contact: Dan Cote, Sales Manager

DeepWater Buoyancy Inc. is the world's largest producer of subsea buoyancy products for the oceanographic community and has a vast product line of buoyancy solutions for offshore oil & gas, energy and technology companies. This product portfolio has been built over the course of 40 years serving these industries. Though products are offered for shallow water applications, the company specializes in deepwater, providing solutions to depths of 6000 meters and beyond.

NAUTILUS MARINE SERVICE GMBH

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Nautilus Marine Service provides the finest VITROVEX® glass housings that are capable of operating in the most extreme regions of the Earth. VITROVEX® glass enclosures offer the dual advantage of buoyancy and pressure proof housings - a perfect combination for small and autonomous underwater instrumentation packages.

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Contact: Richard Fryburg

Since 1977 Subsalve USA has been America's #1 manufacturer of standard and custom flotation devices and we are the innovators in buoyancy and engineered inflatables. Our products include: Professional, Commercial, Standard, Shallow Water, Enclosed Flotation Bags, Cable & Pipeline Floats, Water Load Test Bags, Rapid Recovery & Mark V/ORCA EOD Systems.

CAMERAS / LIGHTS / LASERS

ARTIC RAYS LLC

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Contact: Lee Fray

Arctic Rays LLC is a specialist in the design and manufacture of deep sea lighting and imaging products specifically for use on AUVs, but also prove ideal for manned vehicles and all other underwater, surface vehicles or platforms. Our designs feature the smallest possible size and lowest power consumption available.

CATHX OCEAN

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Website: www.cathxocean.com
Contact: Alberto Lopez Pastor

Cathx Ocean design and manufacture advanced subsea imaging and precision measurement systems for subsea operations.

Designed to meet stringent technical, operational and integration requirements associated with various subsea applications and vehicle types, Cathx Ocean's systems offer precision, reliability and peace of mind. Products include advanced still imaging, colour laser point cloud and video systems, designed to deliver precision subsea data in a way that allows automation for subsea vehicle operations.

The range includes the Hunter system (AUV Imaging and Laser), the Scout system (Observation Class ROV Imaging and Laser Profiling), the Pathfinder system (Work Class ROV Imaging and Laser Profiling) and the Prowler I & II systems (Towed Vehicle Imaging Range and Scale Measurement).

DEEPSEA POWER & LIGHT

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For over 30 years, DeepSea Power & Light has provided high-quality and innovative products to the oceanographic community. The company's expertise and product line has grown to include underwater video systems, lighting solutions, pressure relief valves, and lasers.

Design criteria for products include ease of service, reliability, high performance, and cost effectiveness. Products are rigorously tested in both the initial design process and manufacturing stage to perform in the harsh marine environment–from wet/dry surface applications to full ocean depth deployments. DeepSea Power & Light offers a versatile product line while developing new designs to continue exceeding market expectations.

SIDUS SOLUTIONS, LLC

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Website: www.sidus-solutions.com

SIDUS Solutions LLC, 'SIDUS' is a worldwide company that designs, manufactures and installs systems in the most extreme of environments. SIDUS products include Cameras, Pan & Tilts, Lights and Lasers for use in hazardous areas for and SUBSEA, serving the, energy, scientific, military, nuclear, and shipping industries. Engineering experience makes us the perfect choice for application specific surveillance systems to provide end to end safety and security. SIDUS provides complete integration, design, documentation, and commissioning for all systems. From sea-floor observation platforms, to surveillance systems on drilling rigs, or sonar deployment systems - SIDUS is a field proven solution.

CABLES

CORTLAND COMPANY

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E-mail: cortland@cortlandcompany.com
Website: www.cortlandcompany.com
Contact: Marco Cano

Cortland has more than 30 years of manufacturing experience supplying custom-designed electro-optical-mechanical cables. We provide solutions that meet the challenges posed by harsh environments, hydrostatic pressures, and high mechanical stresses.

We manufacture custom EOM cables assemblies for various subsea applications which include CTDs, hydrophones, magnetometer, tow cables, ocean bottom, ROV cables, and other custom application. Our global presence and industry-leading design engineers, manufacturing facilities, and management teams, work together to implement integrated solutions with unsurpassed reliability that support the needs of customers worldwide. Visit us online at cortlandcompany.com

SOUTH BAY CABLE CORP

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E-mail: Sales@southbaycable.com
Website: www.southbaycable.com
Contact: Gary Brown, Sales Manager

Since 1957, South Bay Cable Corp has designed and manufactured specialized electrical, electro-mechanical and electro-optical-mechanical cables for use in demanding marine environments. Cables are designed to meet customer requirements and include tether and umbilical cables for ROVs, tow cables, video inspection, faired cables and a host of other customer specific applications.

CONNECTORS

BIRNS, INC.

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E-mail: service@birns.com
Website: www.birns.com
Contact: Eric Birns

BIRNS has served the subsea industry since 1954, and is an ISO 9001:2015 certified global leader in the design and manufacturing of high performance connectors, cable assemblies and lighting systems. With a NAVSEA PRO-020 certified molding facility, it offers sophisticated connector lines, including 6km-rated electrical, electromechanical, coaxial, electro-coax, optical, electro-optical and electro-opto-mechanical hybrids. BIRNS provides the industry's highest volume of cost-effective hydrostatic and helium pressure testing, and has a wide range of ABS Product Design Assessment (PDA) certified fiber optic and electrical penetrators. BIRNS' LED and tungsten-halogen marine, chamber, security and commercial diving lights are trusted in the world's most extreme environments.

BIRNS AQUAMATE LLC

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Website: www.birnsaquamate.com
Contact: Eli Bar-Hai

Birns Aquamate design and manufacture underwater electrical connectors, cable assemblies, and cable terminations. The company produces a wide range of standard industry products such as the **5500 Series, SC, MC, LP, FAWL/FAWM, NANO, TC, Rubber Molded, etc.** Birns Aquamate is the only manufacturer to guarantee compatibility with other uw connectors. Birns Aquamate also specializes in fast turn-around for custom design of special connector solutions. All connectors are manufactured under DNV ISO 9001:2000 certification. Dealers in Canada, Brazil, UK, Belgium, Holland, Norway, Germany, South Africa, Holland, Italy, and China.

SEACON

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For the widest range of connectivity and sensor solutions designed for subsea applications, TE Connectivity (TE)'s portfolio includes over 2,500 underwater electrical and fiber optic connectors, and complete connectivity systems to give you a wide range of advanced connectivity options. The portfolio includes not only SEACON products, but DEUTSCH connectors, Rochester engineered cables, and TE sensors — giving you one-stop access to rugged, reliable solutions.

SOURIAU - SUNBANK | CONNECTION TECHNOLOGIES

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Contact: Vincent Mansour,
North America Product Manager Marine/Space/Milaero

SOURIAU-SUBANK Connection Technologies is a global leader in interconnect solutions engineered to withstand the harshest of environments as aeronautics, space, defense, transport, energy, industrial equipment, healthcare devices, and lighting. It invests in R&D and manufacturing facilities to produce solutions that comply with environmental requirements and international trade rules. SOURIAU-SUNBANK's wide range of products are designed using cutting-edge electrical and optical connection technologies. All are suitable for use in non-hazardous environments as well as those involving extreme temperatures, strong vibrations and corrosive liquids, and meet specific international market standards.

TELEDYNE MARINE

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Teledyne Marine Interconnect Solutions integrates the resources of ODI, DGO, Impulse, and Cable Solutions into a single organization that supplies innovative, high-performance solutions for harsh environment interconnect. Solutions for these harsh environments include wet-mate, splash-mate and dry-mate connectors, pressure boundary penetrators, cable assemblies, cable terminations, and custom-engineered encapsulation and molding. TMIS contains a broad portfolio of field-proven, time-tested electrical, optical, and hybrid interconnect capabilities optimized for applications where performance and reliability are imperative. Products are available as stand-alone items, or as complex solutions that integrate technologies into advanced, value-added systems.

DESIGN & ENGINEERING

HYDRO LEDUC NA, INC.

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Houston, TX 77084
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E-mail: bogden@hydroleduc.com
Website: www.hydroleduc.com

Hydro Leduc is a specialist in the design and manufacture of hydraulic piston pumps, hydraulic motors, hydro pneumatic accumulators, and customized hydraulic components satisfying customer needs with reliable products from a reliable source. As the leader in micro hydraulics, it is feasible to obtain several tons of force from a minimal power source within a restricted space envelope. The techniques of micro hydraulics allow simple solutions to problems that are often beyond the limits of traditional mechanical options. Hydro Leduc's expertise is at your service in varied applications such as oil service tools, oceanographic instrumentation, aeronautics, and any extreme working condition of temperature, pressure, medium, and environment.

DIGITAL VIDEO RECORDING SYSTEMS

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Contact: John Benson

The EdgeDVR is currently used worldwide by most of the major ROV and Diving contractors. With our present Version 4 software, we have 6 models. The EdgeDVR has become an essential part of any ROV and Diving system offshore, easy to use and reliable. The system is capable of recording simultaneous High Definition and Standard Definition video, together with auto creation of Dive, Video, Photo and Anomaly logs. Multi channel digital overlay is also available for all recorded channels, logos and realtime survey data can be displayed. With around 500 systems now offshore, we have a proven record of reliability.

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Ocean Specialists, Inc. (OSI) is a system development and advisory firm for undersea cable projects and technology with global capabilities. OSI works with clients during all project phases of subsea network development, from planning and design to procurement and implementation. Our customers, primarily representing Oil and Gas, Telecommunications and Ocean Observing, recognize the value of fiber optic networks to their field and services solutions, and look to OSI to deliver the skills and experience that developing these networks require.

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Kongsberg Seatex is a leading international marine electronics manufacturer specializing in the development and production of precision positioning and motion sensing systems. Our commitment is to provide quality products and solutions for safe navigation and operations at sea in the commercial offshore, maritime, hydrographics and defence industries.

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ATL specializes in the design/manufacture of custom bladder-type fluid containment systems, including tanks, inflatables, pillows and bellows for surface and subsea. ATL's flexible fluid containers boast unparalleled chemical tolerance, abrasion resistance, and remarkable durability - used with methanol, diesel fuel, gases, ethyleneglycol, hydraulic fluids and chemical cleaning cocktails. Expedited deliveries are also available.

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CSA Ocean Sciences Inc. (CSA) is a marine environmental consulting firm specializing in multidisciplinary projects concerning potential environmental impacts of activities throughout the world. With extensive experience in environmental sciences and technical field operations, CSA is staffed and equipped to offer a complete range of services for projects in offshore, nearshore, estuarine, wetland, and freshwater environments.able solutions.

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MOTION SENSING EQUIPMENT

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Kongsberg Seatex is a leading international marine electronics manufacturer specializing in the development and production of precision positioning and motion sensing systems. Our commitment is to provide quality products and solutions for safe navigation and operations at sea in the commercial offshore, maritime, hydrographics and defence industries.

NAVIGATION & POSITIONING SYSTEMS

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Advanced Navigation is a privately owned Australian company that specialises in the development and manufacturing of navigation technologies and robotics. The company has a focus on generating products of the highest quality standard, both in terms of hardware and software. Advanced Navigation has specialised expertise across a broad range of fields including sensors, GNSS, inertial navigation, RF technologies, acoustics, robotics, AI and algorithms. Advanced Navigation is an ISO 9001 certified company and maintains a strict quality control system across the two research facilities and three manufacturing facilities that they operate in Australia. Advanced Navigation is a carbon neutral company, offsetting all emissions due to energy use through the planting of trees.

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EvoLogics provides the world's most advanced spread-spectrum underwater communication systems (S2C) with multi-channel data management, networking capability, built-in tracking and positioning functions with USBL. Data loggers, acoustic wake-up module and releasers optionally included. Deployments in offshore platforms (FPSO, ABS), environmental monitoring, defense systems, ROV and AUV operations and more. Applications include simple positioning and sensor information to transmission of underwater photos.

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Kongsberg Seatex is a leading international marine electronics manufacturer specializing in the development and production of precision positioning and motion sensing systems. Our commitment is to provide quality products and solutions for safe navigation and operations at sea in the commercial offshore, maritime, hydrographics and defence industries.

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RJE International offers product design, development, evaluation and marketing for military divers, offshore and marine scientific communities, search and rescue teams, and more. RJE has become the industry leader in diver navigation and acoustic relocation. Our team has an extensive background in developing, manufacturing, and supplying underwater acoustic marking and relocation systems, diver navigation platforms, and other subsea equipment.

NETWORK & DATA COMS

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Kongsberg Seatex is a leading international marine electronics manufacturer specializing in the development and production of precision positioning and motion sensing systems. Our commitment is to provide quality products and solutions for safe navigation and operations at sea in the commercial offshore, maritime, hydrographics and defence industries.

OCEANOGRAPHIC INSTRUMENTS/SERVICES

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• **Metocean Equipment Leasing:** Acoustic Doppler Current Profiler ADCPs (including StreamPro & RiverRay), Ice Profilers, AZFP, acoustic releases, wave/tide gauges, pingers, satellite beacons, CTD+DO+Tu profilers, DO & turbidity loggers, weather station, cages, flotation, bottom frames.

•**Oceanographic Products:** Acoustic Zooplankton Fish Profiler (AZFP), Ice Profiling Sonar (IPS5) & shallow water Ice Profiler (SWIP), Imagenex scanning sonar logger (IRIS), instrument cages, bottom frames. Custom acoustic products and system integration.

• **Consulting:** Field work, data collection, analyses, numerical modelling, acoustics, remote sensing, oceanographic mooring design and system integration.

• **Manufacturer's Representative:** Teledyne RD Instruments, Deep Water Buoyancy, WERA Northern Radar.

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RBR creates instruments to measure the blue planet. From the ocean abyss to the polar ice caps, our sensors track water parameters – temperature, depth, salinity, dissolved gases, pH, and many others. With design and manufacturing centrally located in Ottawa, Canada, our team works in a fast-paced, dynamic atmosphere to serve customers all over the globe.

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ROMOR Ocean Solutions provides instrumentation solutions for the geophysical, oceanographic, defense, security, oil & gas, and renewable energy industries. By partnering with world renowned manufacturers, ROMOR is able to offer technical knowledge, value added services, logistics expertise, and the most reliable instrumentation on the market.

SEA-BIRD SCIENTIFIC
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E-mail: info@sea-birdscientific.com
Website: www.sea-birdscientific.com
Contact: Calvin Lwin, Sales

Sea-Bird Scientific provides best-of-class sensors and systems for oceanographic research and environmental water quality monitoring of physical and biogeochemical properties. Sea-Bird Scientific is the leader in accurate, stable ocean instruments for measuring conductivity (salinity), temperature, pressure, oxygen, pH, chlorophyll, CDOM, turbidity, beam attenuation, irradiance, radiance, PAR, nitrate, and phosphate. Our CTD profilers, water samplers, moored CT recorders, wave/tide recorders, DO sensors, and optical sensors are used by research institutes, ocean observing programs, government agencies, and navies globally.

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A manufacturer of miniature data loggers with sensors as temperature, depth/pressure, salinity, tilt/acceleration, compass direction/magnetometer, light levels, acoustic receiving/transmitting. The loggers are used for various researches, including oceanography, fishing gear studies, equipment behavioral monitoring and fish tagging.

SONAR SYSTEMS

ECHOLOGGER
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Contact: Doowon Choi

Echologger represents the best quality sonar products in the market. We are a leading developer/manufacturer of high-end ultracompact echosounders and high resolution scanning sonar that are equipped with state-of-the-art features and essential functionalities to match customers' needs in affordable price.

Founded in 2009 and a company located in South Korea, and with a brand name Echologger, EofE Ultrasonics Ltd. is a knowledge-based company that continuously designs, develops and manufactures high technology sonar devices and solutions to meet the changing needs of the customers. Having been in the industry for years, the company understands how the industry operates and what works best for the benefit of our valued customers.

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Contact: Amy LaRose

EdgeTech designs, manufactures and sells industry-leading side scan sonars, sub-bottom profilers, bathymetry systems and combined sonar systems. Additionally, the company produces world class underwater actuated and transponding solutions including deep sea acoustic releases, shallow water and long life acoustic releases, transponders, reliable USBL acoustic tracking and positioning systems, and custom-engineered acoustic products.

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Celebrating over 50 years in the marine technology industry, Klein Marine Systems continues to be a world leading sensor technology manufacturer of high-resolution side scan sonar equipment and radar-based security and surveillance systems. Klein Marine Systems has developed a worldwide reputation of excellence in the industry by providing quality products and excellent customer service. Klein sonar systems are deployed by government agencies, navies, port authorities, surveyors, oil companies and universities worldwide. Visit our web site at www.KleinMarineSystems.com and discover how Klein is Making the Oceans Transparent!

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Marine Sonic Technology builds high quality, high resolution side scan sonar systems. Located in Yorktown, Virginia, Marine Sonic has been in business for more than 25 years. Our towed systems are rugged, easy to deploy and simple to operate. We also offer highly efficient AUV/ROV embedded systems, which occupy minimal space and low power consumption.

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Kongsberg Maritime is a marine technology company providing innovative solutions for all marine industry sectors including merchant, offshore, subsea, naval and fisheries. The company delivers systems that cover diverse maritime applications. Within subsea, Kongsberg Maritime's sonars, Sub-bottom profilers, multibeam and single beam echo sounders, cameras, positioning and underwater communication & monitoring systems, instruments, software and Marine Robotics are used in survey and inspection operations worldwide. Working closely with customers to develop technology that pushes the limits in subsea applications, Kongsberg Maritime is also dedicated to developing innovative environmental monitoring solutions such as the K-Lander system in addition to cutting-edge Marine Robotic platforms such as the futuristic Eelume vehicle.

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