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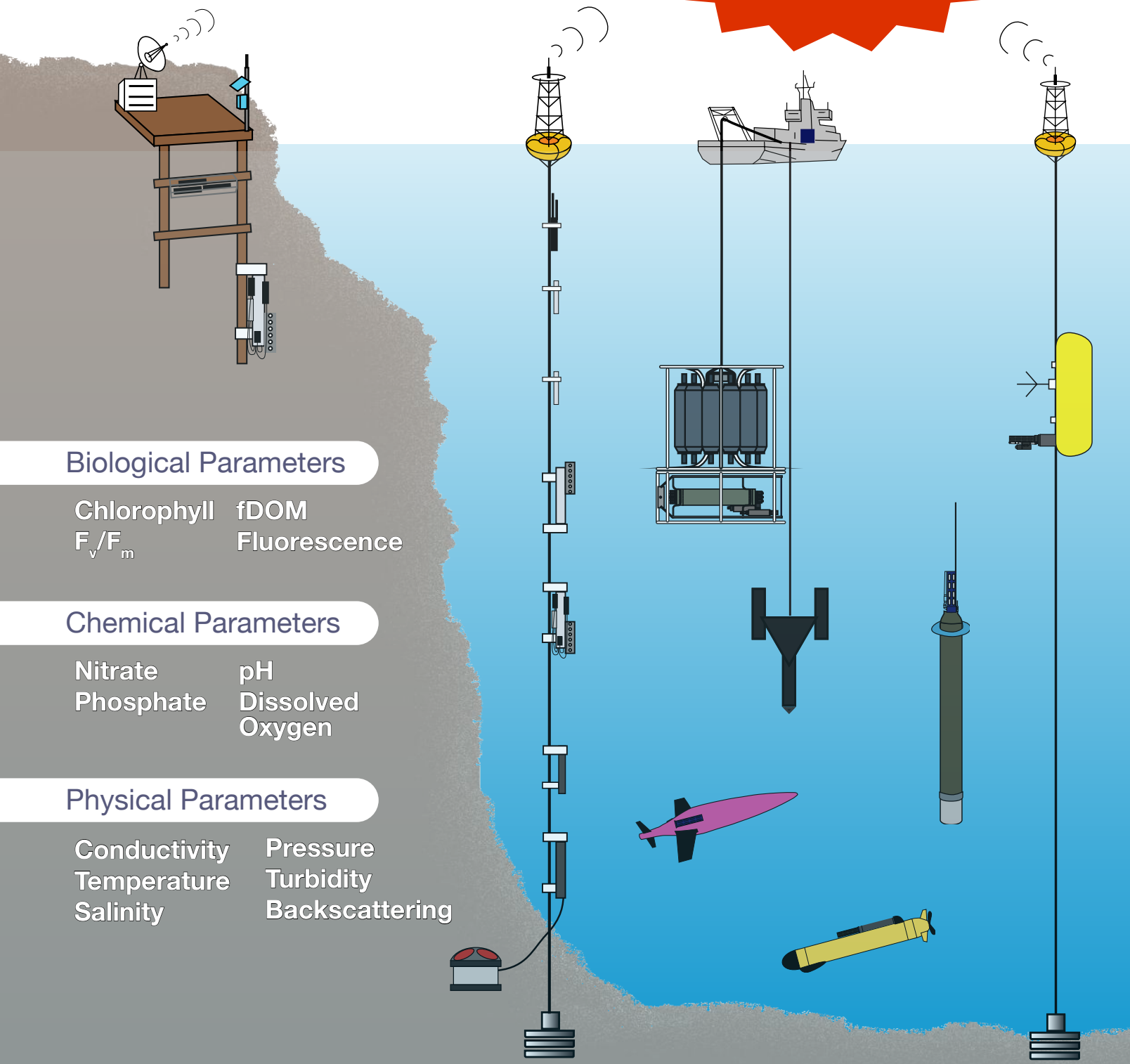

Biological Parameters

Chlorophyll
F_v/F_m
fDOM
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Phosphate
pH
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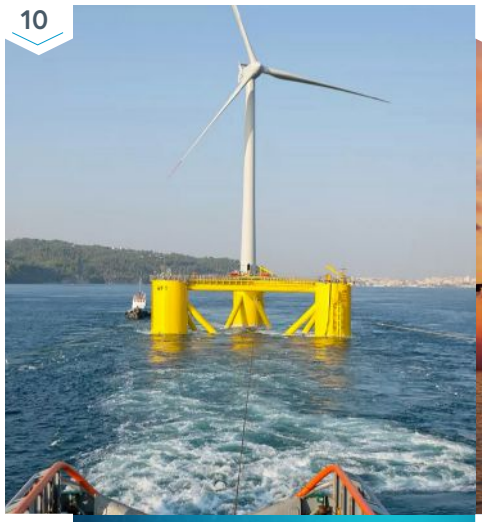

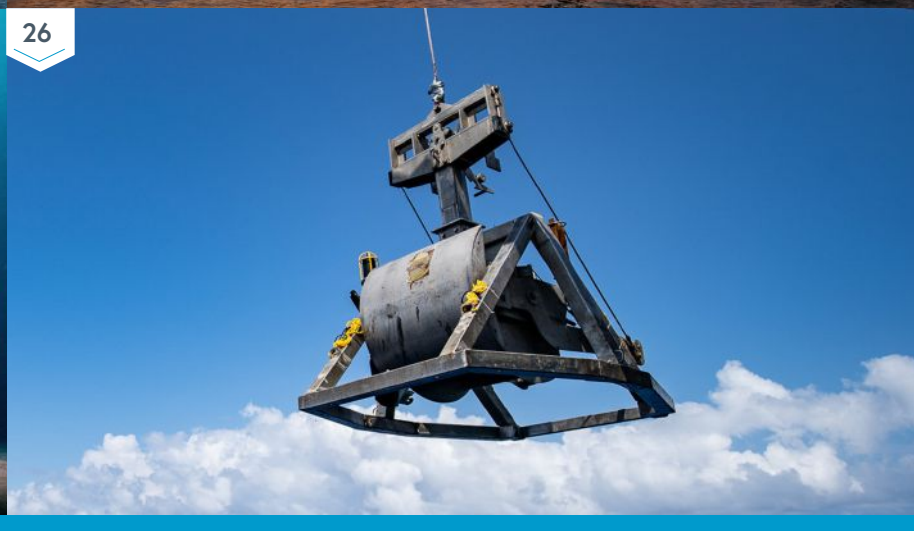

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ON THE COVER:
ULC Robotics is developing unmanned aircraft technology and services to increase safety and reduce the costs of offshore work. (Photo credit: ULC Robotics)

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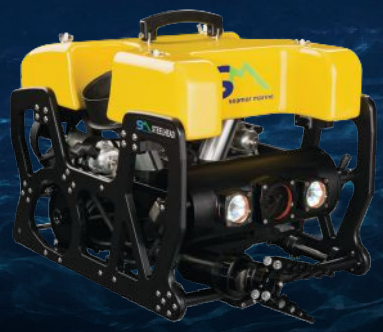

SEAMOR STEELHEAD

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SEAMOR CHINOOK

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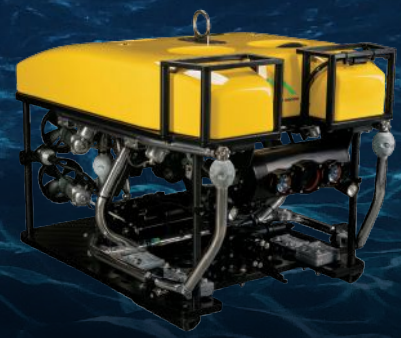

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THE SUCCESS OF GLOBAL OFFSHORE RENEWABLE WIND ENERGY IS RELATIVELY SHORT AND HIGHLY REGIONAL

DR. PHIL HART
Director of Energy and Power, Cranfield University, UK

Europe has led the way, with overt policies such as Renewable Energy Certificates and Feed in Tariffs (FiT's) designed to establish a position in the new energy sector and drive a green energy agenda. Such policies have been instrumental to offsetting the initial costs of turbine deployment offshore and supporting breakthrough technology. The UK currently has the largest offshore portfolio with more than 2,000 turbines across 39 projects, with a combined capacity of over 10GW (compared to 13.5GW of UK onshore wind). This represents about 40% of the global offshore wind market.

In contrast, the US has until recently largely ignored offshore wind resources while growing its onshore capacity. As of Q1 2020, US wind assets are approximately 107GW, providing about 7% of domestic power (IEA) and supporting 120,000 USA jobs. Only 30MW, however, comes from offshore (Block Island, RI).

With onshore wind, installation, operation and maintenance (IO&M) are relatively easy and cost-effective. Resources, including equipment and land, are widely available or easily adapted from other industries. So, *why bother considering offshore?*

It's all about power (and local politics). Winds offshore are generally more powerful and more consistent, resulting in a higher Capacity Factor (CF). In short, for onshore Europe you might expect a 30% CF whereas offshore, in the North Sea, this would be more than 45%. That is a lot more power revenue to offset IO&M costs. Secondly, though I personally find wind turbines quite fetching, there are those that lobby in NIMBY opposition. The solution is to install the turbines offshore. The European model has matured, fuelled by technological breakthroughs, to a point of economic sustainability, so the timing for bulk offshore deployments in the US seems right.

The American Wind Energy Assoc. (AWEA) suggests that offshore wind in the US could create 83,000 jobs by 2030, which CNBC reported could drive a $70BN industrial pipeline. Meanwhile, the DoE suggests that total offshore wind resources equate to over 2TW (that's 2,000,000MW) and that at least 87GW could be developed by 2050. Certain states, especially in the north-east, have led the charge; there are currently 15 active wind leases in play, totalling more than 20GW of offshore potential.

Advances in turbine and related technologies are key to now being the optimal timing for the US. Efficiency across a project lifetime, from installation to maintenance, improves as the turbine count reduces per unit power, and thus payback improves dramatically as turbine sizes increase. Turbines are now reaching impressive scales. Siemens (industry leader with approx. 50% market share) has locked horns with GE for the *size matters* kudos, recently touting a 14MW device, topping GE's Haliade-X 12MW turbine launched last year. They both have a 700+ft blade span and are capable of powering more than 10,000 average households alone.

Maintenance and inspection technologies are also developing quickly. Understanding how turbines decline in performance with age is critical to designing future generations. The use of airborne drones for inspection, condition monitoring systems for offshore infrastructure, and the advent of digital real-time reporting/twinning of turbines are all helping to refine our understanding of operational efficiency and design.

What's the result of all this? An offshore technology with a proven track record and a self-sufficient and competitive sector with commercially acceptable returns. But it's also an industry that still welcomes innovation and fresh thinking and ultimately invites established companies to share best practice and hard-won lessons from other geographies. Sounds like opportunity…

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» *One of 55 Vesta V90-3.0 MW turbines that make up the Belwind 1 Wind Farm in Belgium: The European experience of offshore wind farm construction and maintenance could prove invaluable to the U.S. offshore wind supply chain. (Photo: Courtesy of MHI Vestas Offshore Wind)*

THE RESILIENCY OF OFFSHORE WIND

By Liz Burdock
president and CEO of the Business Network for Offshore Wind

Offshore wind has proven incredibly resilient to the ongoing economic crisis created by the COVID-19 pandemic, both in the United States and globally. Offshore wind projects worldwide saw a record $35 billion dollars in final investment decisions made January through June 2020. This offshore wind investment figure more than offset the declines observed in global investment in solar, onshore wind, and biomass projects during the same period. In the U.S., the Coastal Virginia Offshore Wind (CVOW) project has stayed on schedule and on budget; its turbines are now mechanically complete, and commissioning is expected soon. CVOW withstood Tropical Storm Isaias on August 4 with no issues, a positive indicator for the resiliency of OSW turbines installed along the U.S. Mid-Atlantic coast.

The Global Wind Energy Council's (GWEC) recently released the Global Offshore Wind Report 2020, which described 2019 as "the best year in history for the global offshore wind industry" with 6.1 GWs of new capacity added. 2.4 GWs of that single-year installed capacity was found in China alone.

More than 80 GWs of offshore wind has been approved by national permitting regimes, reached financial close, is under construction, and will be operating by 2025. This striking statistic illustrates the pace and rapid expansion of offshore wind globally. GWEC also estimates that 900,000 jobs will be created by the offshore wind industry over the next decade, showing the industry's potential to lead the green recovery.

GET THE ECONOMY MOVING AGAIN

When the world economy shut down in March, the uncertainty that we all felt was palpable. One question looming large was, "would governments, particularly in the U.S., divert resources and commitments from the climate change fight to prop up the economy elsewhere?" The answer was a resounding no. With the best scientific minds focused on vaccines and treatments, policy makers continued to make decisions to keep citizens safe while simultaneously pushing forward meaningful policies to mitigate climate change within the decade.

Policy support from state leaders has been steadfast. During the heightened response to COVID-19, Virginia's Governor Northam signed legislation that included a 5,200 MW commitment of offshore wind. Overall, U.S. states have committed to support more than 29 GWs of offshore wind. These commitments codified in legislation firmly set the U.S. offshore wind market.

Eleven projects totaling 10 GWs have been awarded a state financial mechanism. Recently, New York and New Jersey released second-round offshore wind solicitations totaling 5,000 MWs of power. By August 2021, the U.S. offshore wind project development pipeline will be over 15 GWs with New York and New Jersey offshore wind ports under construction.

Offshore Wind, with its long development lead times, is an energy technology that is eminently capable of shrugging off the economic challenges imposed by COVID-19. This solidifies offshore wind's role as an infrastructure sector that is well positioned to kickstart America's economic recovery.

» *Siemens Gamesa recently launched a 14 MW offshore Direct Drive turbine with 222-meter rotor, commercially available in 2024: The turbine's capacity provides enough energy to power approximately 18,000 average European households every year. (Image credit: Siemens Gamesa)*

Seven U.S. offshore wind projects reached critical milestones in the long permitting process after submitting their Construction Operations Plans (COP) to the Department of the Interior's Bureau of Ocean Energy Management. These projects now sit in a holding patten as they wait for the federal permitting greenlight to start construction. When the first project receives approval to

begin construction, private investment will be unleashed into the U.S. offshore wind market. A contracting cascade will occur and the need for suppliers for port construction to vessel building will skyrocket.

However, the U.S. offshore wind industry does not exist in a vacuum. The U.S. must compete with Europe's mature market and Asia's rapidly emerging demand for bandwidth, attention, and investments of the sophisticated multinational suppliers that are key industry players. Timely permitting decisions are key to the U.S. securing manufacturing commitments, establishing its position as a global player in the offshore wind market and reinvigorating our economy.

THE INDUSTRY OF THE FUTURE

To date, globally, more than 80 GWs have received permits, achieved financial close and/or are under construction. (The U.S. has zero as the industry is waiting on a federal permitting approval.) The International Energy Agency (IEA) estimates that global offshore wind capacity could power every home and business on the planet eighteen times over and that more than US$ 1 trillion will be invested in the offshore wind sector by 2040.

These are just a few of the numbers that demonstrate that offshore wind industry is the energy industry of the future. Its potential is limitless.

This summer, Siemens Gamesa announced a 14-GW turbine, more than doubling the average capacity of an installed offshore wind turbine. Turbines are predicted to average 11 MWs each in the 2023 to 2025 timeframe.

Ørsted selected GE's 12-MW Haliade-X turbine for the Ocean Wind project and Dominion Energy selected Siemens Gamesa's 14-MW SG14-222 for its 2.6 GW project. The National Renewable Energy Laboratory has released a reference offshore wind turbine design rated at 15 MWs, and individual turbine capacities in the 20+ MWs range have been predicted within three years. Technology advancements along with supply chain maturity and cheaper finance are driving costs to parity or below fossil fuel prices. The public announcement of the Massachusetts Mayflower Wind price of $69/Mwh is globally competitive.

Meanwhile, Germany's commitment to build 500 MW of offshore wind solely to produce green hydrogen is an interesting development that will continue to increase demand and market opportunities for offshore wind. This is a model approach that should be seriously considered in U.S. regions where supply chain infrastructure exists, but the cost of electricity is too low to justify offshore wind as a power generation.

The recent advancements in floating offshore wind and coupling offshore wind with green hydrogen open new markets within the industry. Floating technology is becoming increasing feasible as technical readiness levels improve and larger scale developments are deployed. The third and final MHI Vestas V164-8.4-MW turbine was installed on Principle Power's semi-submersible WindFloat floating platform. It has completed testing at the WindFloat Atlantic project site, and is generating clean, renewable wind power to the Portuguese grid. The total floating pipeline was 6.6 GW in 2019 and 1.5 GW have been installed.

The U.S. finally entered the floating offshore wind race when Diamond Offshore Wind and RWE Renewables invested US$100 million in the University of Maine Aqua Ventus floating offshore wind demonstration project. The industry should expect to see significant cost reductions with this technology in the coming years as developments progress from demonstration to full scale commercialization.

GREEN PORTS

The design and construction of ports also must anticipate future offshore wind technology changes. As individual turbine capacity increases, a port's design requirements—from crane tonnage to soil load-bearing capacity to necessary pier length—change. These technological advancements are certain at this point.

Offshore wind ports should incorporate net-zero carbon technologies and be factored into the design of ports. In August 2020, Red Hook Terminals, announced that it will deploy a fleet of ten all-electric yard tractors for its intermodal yard in Port Newark, New Jersey. This is the largest fleet of heavy-duty electric trucks operating on the U.S. East Coast. Further south, the Port of Virginia recently received funding to replace diesel-powered cargo handling equipment, including yard tractors and ship-to-shore cranes, with electric counterparts.

» Floating wind technology is becoming increasing feasible: The third and final MHI Vestas V164-8.4-MW turbine was recently installed on Principle Power's semi-submersible WindFloat floating platform. (Photo: Courtesy of MHI Vestas Offshore Wind)

According to the EPA, emissions associated with diesel engine usage at ports can contribute to "premature mortality, increased hospital admissions for heart and lung disease, increased cancer risk, and increased respiratory symptoms." The reduction—or better yet, elimination—of diesel engines at port facilities is important for the health of works as well as the environment. DNV GL recently released a report entitled, "Ports: Green Gateways to Europe." The recommendations include the electrification of port-connected activities, greater integration of port facilities with offshore wind and the broader energy system and using hydrogen as a feedstock and energy vector.

GOING BEYOND 29 MWs

Although U.S. states can serve as early adopters of offshore wind power, governments should not be expected to support the market in perpetuity. As the price decreases, the industry must consider developing policies that expand offshore wind to private off-takers.

One of the key developments in overseas offshore wind markets has been the increasing amount of private sector off-takers of electricity generated by offshore wind facilities. In July 2020, Ørsted

announced the world's largest offshore wind corporate offtake deal to supply 920 MWs to Taiwanese semiconductor manufacturer TSMC. This is the fourth such deal that Ørsted has executed. Private offtake of offshore wind power is also occurring in Europe. During 2019, Microsoft signed a deal with Dutch utility Eneco to buy 90 MWs for its data centers for 15 years.

As corporate entities commit to reducing their carbon footprints, offshore wind is an attractive large-scale renewable generation choice for private offtake. Offshore wind, described by the International Energy Agency as the only variable baseload power generation technology, has capacity factors around 50 percent, which is significantly higher than onshore wind and solar, and a flatter load profile.

GRID AND TRANSMISSION

An often overlooked, but extremely critical aspect of offshore wind development is the connection to the grid. Thoughtful consideration to onshore grid upgrades is vital to the development of the industry. Investment in the electric transmission grid to replace aging facilities, modernize technologies, expand and integrate renewable energy such as offshore wind can be a major economic driver. One study forecasts an increase in transmission investment from US$7-10 billion per year in the 2020s to as much as US$40 billion per year between 2030 and 2050 to satisfy new electric loads and to accommodate the changing generation mix. For every US$1 billion in investment, 13,000 new jobs are created. Another study suggests that a planned transmission approach can save US$1.1 billion in the New England region alone.

States and national regulators are finally beginning a constructive dialogue on what the ocean grid of the future should look like. Does it take shape as a shared and open transmission grid or as a radial network with multiple onshore injection points?

LEADING THE WAY FOR OTHER OCEAN RENEWABLES

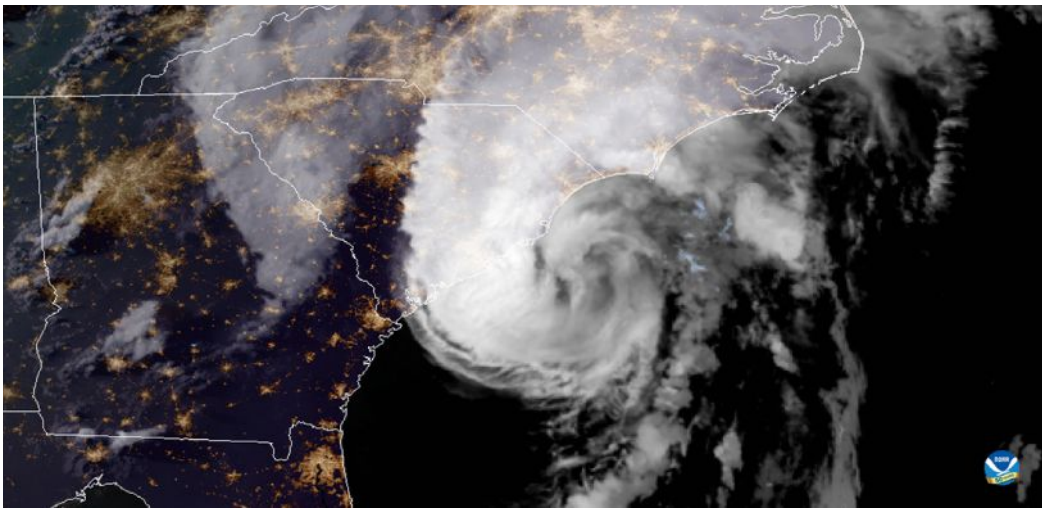
As the industry and policy makers grapple with the tough conversations on grid and transmission, decisions should also take into consideration fostering the development of other nascent ocean renewable energy technologies, including wave, tidal, floating solar and hydrogen. Whether it is a state- or regional-planned or radial transmission system, an ocean grid will make connecting marine renewables less costly and more feasible. An ocean transmission system can drive the growth of a broader and more robust U.S. blue economy. This would drive down the levelized cost of marine renewables, help faster adoption, and support the supply chain developed through the offshore wind industry. While this may seem too futuristic, five years ago no one would have bet that the U.S. offshore wind industry would today have two projects in the water and 10 GWs under development. What's more, nobody would have foreseen the resiliency shown by the industry in the face of a global economic crisis created by a world health pandemic.

» *The offshore wind industry must develop policies to encourage private off-takers. Ørsted announced in July 2020 the world's largest offshore wind corporate offtake deal to supply 920 MWs to Taiwanese semiconductor manufacturer TSMC. (Photo credit: Ørsted)*

The Business Network for Offshore Wind, the only non-profit focused solely on growing the U.S. offshore wind industry and its supply chain. Follow her at @LizBurdock1.

» *DNV GL recently released a report entitled, Ports: Green Gateways to Europe: Recommendations include the electrification of port-connected activities and a greater integration of port facilities with offshore wind.*

'EXTREMELY ACTIVE' HURRICANE SEASON POSSIBLE FOR ATLANTIC BASIN



» *Hurricane Isaias. (Image credit: NOAA)*

Atmospheric and oceanic conditions are primed to fuel storm development in the Atlantic, leading to what could be an "extremely active" season, according to forecasters with NOAA's Climate Prediction Center, a division of the National Weather Service. The agency recently released its annual August update to the Atlantic Hurricane Season Outlook, initially issued in May.

The 2020 Atlantic hurricane season has been off to a rapid pace with a record-setting nine named storms so far and has the potential to be one of the busiest on record. Historically, only two named storms form on average by early August, and the ninth named storm typically does not form until October 4. An average season produces 12 named storms, including six hurricanes of which three become major hurricanes (Category 3, 4, or 5).

"This is one of the most active seasonal forecasts that NOAA has produced in its 22-year history of hurricane outlooks. NOAA will continue to provide the best possible science and service to communities across the Nation for the remainder of hurricane season to ensure public readiness and safety," said U.S. Secretary of Commerce Wilbur Ross. "We encourage all Americans to do their part by getting prepared, remaining vigilant, and being ready to take action when necessary."

The updated outlook forecasts 19–25 named storms (winds of 39 mph or greater), of which 7–11 will become hurricanes (winds of 74 mph or greater), including 3-6 major hurricanes (winds of 111 mph or greater). This update covers the entire six-month hurricane season, which ends Nov. 30, and includes the nine named storms to date.

A comprehensive measure of the overall hurricane season activity is the Accumulated Cyclone Energy (ACE) index, which measures the combined intensity and duration of all named storms during the season. Based on the ACE projection, combined with the above-average numbers of named storms and hurricanes, the likelihood of an above-normal Atlantic hurricane season has increased to 85%, with only a 10% chance of a near-normal season and a 5% chance of a below-normal season.

"This year, we expect more, stronger, and longer-lived storms than average, and our predicted ACE range extends well above NOAA's threshold for an extremely active season," said Gerry Bell, Ph.D., lead seasonal hurricane forecaster at NOAA's Climate Prediction Center.

Current oceanic and atmospheric conditions that make an "extremely active" hurricane season possible are warmer-than-average sea surface temperatures in the tropical Atlantic Ocean and Caribbean Sea, reduced vertical wind shear, weaker tropical Atlantic trade winds and an enhanced west African monsoon. These conditions are expected to continue for the next several months. A main climate factor behind these conditions is the ongoing warm phase of the Atlantic Multi-Decadal Oscillation,

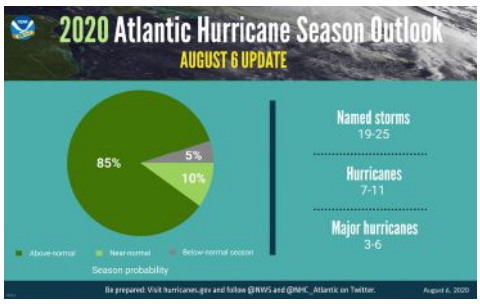
which reappeared in 1995 and has been favoring more active hurricane seasons since that time.

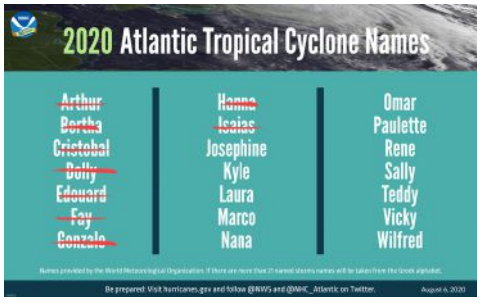
Another contributing climate factor this year is the possibility of La Nina developing in the months ahead. Indicative of cooler-than-average sea surface temperatures in the equatorial regions of the eastern Pacific Ocean, La Nina can further weaken the wind shear over the Atlantic Basin, allowing storms to develop and intensify.

NOAA's hurricane season outlook is for overall seasonal activity and is not a landfall forecast. Landfalls are largely determined by short-term weather patterns, which are only predictable within about a week of a storm potentially reaching a coastline. NOAA's National Hurricane Center provides tropical weather outlooks out to five days in advance, provides track and intensity forecasts for individual storms, and issues watches and warnings for specific tropical storms, hurricanes and the associated storm surge.

"NOAA has the most highly trained and dedicated forecasters that serve to protect American lives and property. With improved forecast skill, new storm surge products, and new observations, such as GPS Radio Occultation, we are better positioned than ever before to keep Americans out of harm's way," said Neil Jacobs, Ph.D., acting NOAA administrator. "It is now more important than ever to stay informed with our forecasts, have a preparedness plan, and heed guidance from local emergency management officials."

This hurricane season FEMA encourages residents in hurricane-prone regions to keep COVID-19 in mind when making preparations and during evacuations. Visit *https://www.ready.gov/hurricanes* for more information. Stay tuned to the National Hurricane Center for the latest about tropical storm and hurricane activity in the Atlantic.





» *The updated 2020 Atlantic hurricane forecast. (Image credit: NOAA)*

| FEATURE |

SMARTER OFFSHORE WIND CABLE MANAGEMENT

The R&D evolution of turbine cable hardware brings durability and maintenance advantages

By Tyler Burger
Manager, Engineering – Renewable Energy

The future of offshore wind energy promises an evolution jump: A web of subsurface cables connects floating wind farms in deepwater locations. Built-in smart cable technology offers proactive maintenance alerts before there's a problem. Drone inspections precede a squad of autonomous robots performing connector repairs as the new norm.

In addition to advanced technology design and integration, wind turbine operators are exploring new frontiers in marine environments. Properly securing wind turbines and effectively maintaining the connections in locations previously inaccessible due to dynamic, harsh conditions is imperative to successful operation in these uncharted waters.

PMI Industries, Inc., with its rich history addressing cable connector design challenges in undersea environments, is answering the call for fresh approaches to connecting wind turbines. Drawing on 30+ years experience designing cable solutions for oil and gas and oceanology applications, the design engineer team is exploring crossover opportunities as they develop the next generation of wind cable hardware systems. The results could increase cable lifespan and save installation and maintenance time in new settings.

For example, engineers at PMI are actively exploring sub-surface smart technology integration in cable hardware, including smart pins for shackles that monitor load and send overload notifications. The technology itself is not novel, but applying it successfully underwater is new.

While sensor integration is one avenue to extended cable life, bringing elegance and durability to mechanical design offers another route with untapped potential. Securing 50 to 250-mm diameter subsea cables into cable decks

of floating and fixed-bottom wind turbines represents a longstanding challenge. The installation process typically costs time, ship and labor resources and introduces cable vulnerabilities.

Typically completed in a J-tube clamped at the cable deck, bending the cables armor wires can create stress points and possible corrosion areas, especially in dynamic conditions. Epoxy used to seal the wiring compartment must typically cure overnight, lengthening time-on-station. If the cable is not properly prepared and cleaned first, the epoxy might not seal or hold.

To address these issues, PMI has adapted its DYNA-HANGER™ system from its 40-ton side load towed seismic array systems into a new patent-pending Cable Deck Hang-off system for 50 to 250-mm diameter cables. This adaptation offers a simpler way to attach subsea cables to the cable decks without the need to expose and use the cable's armor wires. The new system adds a layer of armor rods, insert and housing over the cable's exterior, eliminating the need to strip back the outer layers to expose the cable's inner armor wires. This hang-off assembly is designed to be preinstalled on ship or shore, and can be pulled in place through the J-tube to the cable deck, then clamped and bolted into position.

Optional elastomeric seals to block seawater complete the installation without the need for epoxy or overnight curing. The electrical installers can dress and connect the end of the cable's wires, add the optional seals and finish the hang-off installation, final work that can be completed at a later date if desired. The environmental concerns of epoxy use are eliminated, and the hang-off system can be removed easily later, unlike current designs.

"The extra layer of exterior armor rods offer improved bend protection in dynamic and floating installations. Likewise, adding multiple layers of external armor rods to the system can increase the system's dynamic capabilities, possibly eliminating I and J-tubes," says Terry Zahuranec, Manager, Engineering-New Products, PMI Industries, Inc.

The hang-off system, currently in concept development, will be available in stainless steel, duplex steel or galvanized steel depending on the corrosion protection needed. Design variations with a pull-and-click attachment method that can provide a weak link detachment mechanism for floating installations are nearing completion.

» *PMI's Hang Off assembly shown as it would be installed in the vertical position.*

» *PMI's Helical Rods of the Hang Off assembly applied to the cable prior to testing.*

» *Bend protection assembly developed by PMI to be used with CPS.*

PMI engineers also are rethinking the limitations on where wind turbines can be deployed due to current cable hardware spec ranges. Because offshore foundations and platforms are not all the same, the ability to accommodate length restrictions and flexibility requirements is essential. PMI is in the early design phases of adapting a Cable Protection System (CPS) design to offer a greater range and customization, as well as installation and replacement ease.

The new design applies to subsea power cables ranging from 50 to 250-mm diameter for direct entry into the side of the monopile or through a J-tube for fixed-bottom platforms. The CPS design's holding capabilities are similar to those of PMI's current full-strength terminations while using varying rod lengths and flexibility to fit custom needs. Specific combinations of PMI's helical rods and bend protection segments are configured to withstand necessary dynamic and static loads and allow models ranging variably from short and stiff to long and flexible and variations in between. An added bolt-on assembly ensures faster installation times and no need for special tools or training.

"Many hours of R&D are invested not only on the front-end of the design to make sure that the product is able to meet or exceed the industry standard, but time also is invested in continuous improvement as the industry standard transforms. PMI is actively listening to the requests for innovation in offshore wind technology and addressing new problems yet to be considered," says Terrence Mathis, Manager, Engineering-Cable Protection, PMI Industries, Inc.

PMI is working to meet the diverse needs of the growing offshore renewable energy industry. The offshore fixed-bottom wind industry has expanded greatly over the last 10 years, and it's expected that floating wind will surpass fixed in terms of installed capacity. Other offshore renewable energy sources, such as wave, tidal and hydrogen, likely will take lessons from wind's evolution and begin tackling the challenge of remote energy. Ultimately, each source will need to offload energy via a cable or connection. PMI engineers are closely tracking new developments across the renewable energy field and are available to partner with on cable solutions.

FLORIDA CURRENT NOW WEAKER THAN AT ANY POINT IN THE PAST CENTURY

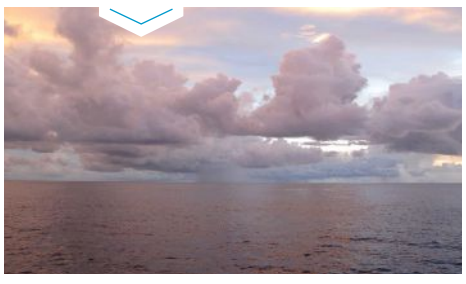
A key component of the Gulf Stream has markedly slowed over the past century—that's the conclusion of a new research paper in Nature Communications published on August 7. The study develops a method of tracking the strength of near-shore ocean currents using measurements made at the coast, offering the potential to reduce one of the biggest uncertainties related to observations of climate change over the past century.

"In the ocean, almost everything is connected," said Christopher Piecuch, an assistant scientist in the Physical Oceanography Department at the Woods Hole Oceanographic Institution (WHOI) and author of the study. "We can use those connections to look at things in the past or far from shore, giving us a more complete view of the ocean and how it changes across space and time."

Piecuch, who specializes in coastal and regional sea level change, used a connection between coastal sea level and the strength of near-shore currents to trace the evolution of the Florida Current, which forms the beginning of the Gulf Stream. The Gulf Stream flows north along the Southeast Atlantic Coast of the United States and eventually east into the North Atlantic Ocean, carrying heat, salt, momentum, and other properties that influence Earth's climate. Because nearly continuous records of sea level stretch back more than a century along Florida's Atlantic Coast and in some parts of the Caribbean, he was able to use mathematical models and simple physics to extend the reach of direct measurements of the Gulf Stream to conclude that it has weakened steadily and is weaker now than at any other point in the past 110 years.

One of the biggest uncertainties in climate models is the behavior of ocean currents either leading to or responding to changes in Earth's climate. Of these, one of the most important is the Atlantic Meridional Overturning Circulation, or AMOC, which is a large system or "conveyor belt" of ocean currents in the Atlantic that includes the Gulf Stream and that helps regulate global climate. Piecuch's analysis agrees with relationships seen in models between the deeper branches of the AMOC and the Gulf Stream, and it corroborates studies suggesting that the deeper branches of AMOC have slowed in recent years. His method also offers the potential to monitor ocean currents like the Gulf Stream from the coast, complementing existing but difficult-to-maintain moored instruments and expensive research cruises.

"If we can monitor something over the horizon by making measurements from shore, then that's a win for science and potentially for society," said Piecuch.



» *The new study uses a method of tracking the strength of near-shore ocean currents from a distance via measurements of coastal sea level. (Photo credit: Carol Anne Clayson, ©Woods Hole Oceanographic Institution)*

» *The blended wing body vertical take-off and landing (VTOL) aircraft is being developed at ULC Robotics' Hauppauge, NY headquarters in order to support offshore wind farms. (Photo credit: ULC Robotics)*

ULC ROBOTICS TESTS DRONE TECH AT FORMER GRUMMAN SITE

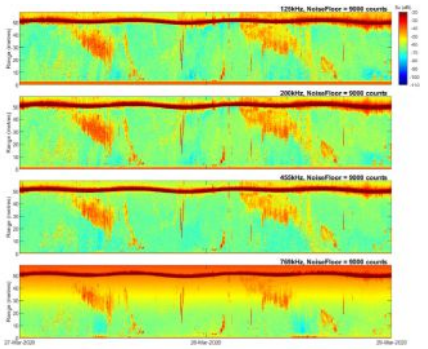
LI-Based Robotics Firm Builds Unmanned Aerial Systems Locally to Support Future Windfarms

ULC Robotics, a rapidly expanding Long Island-based technology firm serving the utility and offshore wind markets, has been granted a license agreement to use the inactive western runway at the Enterprise Park at Calverton (EPCAL) for testing of their unmanned aerial systems (UAS), or drones. The request was unanimously approved at a meeting of the Riverhead Town Board on April 7, 2020 and enables ULC Robotics to use a 2,500 square foot area for flight test operations of their custom-developed, US-built blended wing body vertical take-off and landing (VTOL) fixed wing aircraft.

"Having open space away from the general public is key for us to safely perform flight testing of our new blended wing body VTOL aircraft," said Mike Passaretti, Director of Aerial Services at ULC Robotics. "And there's a lot of great history at EPCAL. It was the former site of the Grumman Corporation, where they assembled and tested their aircraft, so it feels like we're reviving a little bit of Long Island's aviation history."

The VTOL aircraft is being developed at ULC Robotics' Hauppauge, NY headquarters in order to support offshore wind farms, which are to be built off the coast of Long Island. By building and operating their purpose-built UAS to support wind farms, the company estimates a significant 6.8% reduction in the levelized cost of energy (LCOE) and expects a considerable reduction in or elimination of safety hazards. ULC Robotics' unmanned aircraft crews will provide services including protected species observation during offshore wind farm construction, inspection of critical assets, the delivery of parts for repairs, and even search and rescue efforts. ULC Robotics started supporting the offshore wind industry in 2018 by inspecting the wind turbine foundations of the Block Island Wind Farm, the first windfarm in the US. The company continues to work for Orsted, owner of the Block Island Wind Farm, and also performs unmanned aerial services for companies such as PSE&G New Jersey, PSEG Long Island, National Grid, Con Edison and Peoples Natural Gas.

ASL PERFORMS HYDROACOUSTIC STUDY OF EULACHON FISH DISTRIBUTION



» *Image 1: Four frequency AZFP data showing fish schooling and diel migration. (Image credit: ASL)*

ASL Environmental Sciences (ASL) was chosen by Hemmera Envirochem Inc. and the Vancouver Fraser Port Authority (port authority) to perform a hydroacoustic study of eulachon fish (*Thaleichthys pacificus*) distribution in the vicinity of Deltaport Terminals off the mouth of the Fraser River, BC. To support the development of the Dredging and Sediment Discharge Plan that will form part of the Construction Environmental Management Plan of the Roberts Bank Terminal 2 Project (project), the port authority has committed to developing eulachon-specific mitigation that will be used during dredging activities. A pilot study was developed to examine the efficacy of hydroacoustic techniques in detecting adult eulachon.

ASL proposed using the Acoustic Zooplankton Fish Profiler (AZFP), a calibrated multi-frequency echosounder, to measure distribution of the eulachon, particularly during the spring period when they are believed to migrate past Roberts Bank and up the Fraser River to spawn. The AZFP is a four-frequency acoustic profiler that can be deployed for months, continuously measuring day and night, or can be used in real-time transect mode. In the spring of 2020, three AZFPs were moored off Deltaport for six weeks, covering the peak April migration period. The acoustic profile data covered the water column down to 150 m depth at one shallow site and one deep site. The eulachon are known to occur near-bottom, but during migration may be present at shallower depths.

Eulachon can be differentiated from other fish species using multiple frequency acoustics (Gauthier and Horne, 2004) and estimates of aggregated abundance can be made (J. Horne 2020, pers. comm.). *Image 1* shows the typical acoustic signature of individual and aggregated fish schools.

This pilot study will allow the port authority to evaluate the effectiveness of monitoring

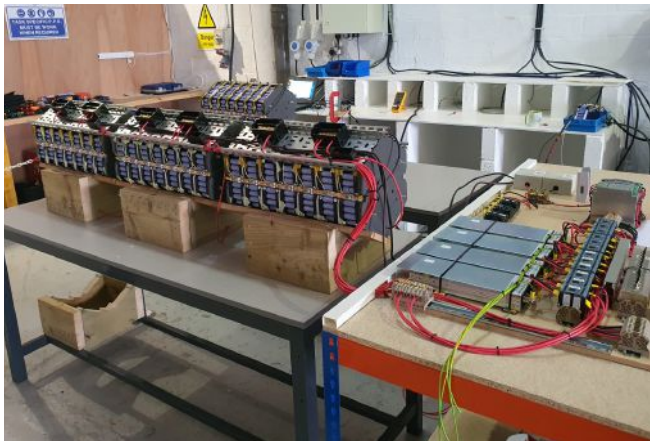
» *ASL's James Bartlett examining data after the recovery of a calibrated multi-frequency echo-sounder. (Photo credit: ASL)*

eulachon distribution using multi-frequency echosounders. If the pilot study is successful, the port authority will consider how best to utilize the technology as eulachon-specific mitigation as part of the Dredging and Sediment Discharge Plan.

SUBSEA BATTERY TECHNOLOGY: A SUSTAINABILITY BUILDING BLOCK

By Paul Slorach
Business Development Director, EC-OG

How do we continue to exploit ocean resources whilst building an environmentally sustainable blue economy? At least part of the answer lies in the fast-emerging ocean power sector; using marine and other renewable energies to power traditional offshore industries. It's at the heart of EC-OG's purpose; driving offshore sustainability by developing innovative subsea battery storage and untethered, clean power systems.



» *Halo battery pack and energy management system under lab testing.*

Existing offshore sectors such as hydrocarbon production and shipping are under huge pressure to reduce their carbon emissions. Emission reduction, or even complete removal, can be partially achieved by electrification of offshore activities, but the source of the energy needs to be clean and reliable in order to be sustainable.

EC-OG is a technology developer, specializing in battery systems, based in Aberdeen, UK. The company ethos is built around a sustainable future for the blue economy and a belief that zero-emission industry is essential for global climate goals. EC-OG has developed the Halo subsea battery storage system to address the needs for clean energy to subsea assets whilst overcoming the intermittency challenges of offshore marine renewable energy generation.

Batteries in offshore and subsea use are already commonplace. In the subsea environment, with applications ranging from small sensors and instrumentation through to fully autonomous robotic vehicles, the possibilities are far-reaching. However, large scale systems for higher power or longer duration activities are not yet a mainstream technology. EC-OG is tackling the challenge with Halo; modular and scalable Lithium ion battery storage developed specifically for the demanding subsea environment.

Offshore oil & gas production has multiple power challenges, not least how to reliably deliver power on-demand to remote subsea well sites that may be multiple tens of kilometers from the nearest host structure. As the industry embraces the energy transition, a step change in behavior and attitudes is underway, with the electrification of new developments and existing brownfield well sites now achievable using battery storage and clean energy system technology.

The Halo system is built around EC-OG's in-house developed battery architecture and energy management systems. The system is designed to provide a reliable and uninterrupted power supply to subsea production control systems, as well as a number of other subsea applications such as autonomous vehicle recharging, sensor packages, CCUS injection wells and over-the-horizon communication systems.

The battery architecture is the first dedicated subsea system to be developed with a clean energy system philosophy in mind. It is configurable to accept charge from a wide range of sources, including wave, tidal and wind energy, but also unconventional forms of offshore energy generation such as fuel cells, floating

solar and even maintenance charging from existing subsea umbilical cables.

Legacy subsea oil and gas production systems have a well-known history of power supply problems and failures. Typically, power is generated by a gas turbine or diesel generator situated on a topside platform or shore-based installation, before being transmitted to the underwater location using umbilical cables. This electrical distribution network can be prone to failures, such as insulation resistance degradation or connector failure. Even accidental damage from dropped objects and fishing gear being dragged across the seabed is not uncommon. Intervention to remedy these issues is typically expensive and any periods of downtime may reduce production levels, significantly affecting the operator's revenue.

Halo offers an alternative solution to the field operator; using battery storage to provide a quick to install temporary power source directly to the subsea production system. The technology safeguards the power supply and therefore the hydrocarbon production and well integrity, which can rapidly degrade during extended periods of shut-in production. Once installed, for a permanent solution, Halo offers the user a flexible operating philosophy, to recharge in-situ using an alternative generation source or by 'fast charge' method using a downline from a vessel or ROV.

EC-OG view battery technology as an important enabler for zero emission tiebacks and greenfield developments, which will be an essential element of a sustainable offshore hydrocarbon industry. Coupling batteries with renewable energy devices can offer a fully autonomous and clean energy system for subsea and offshore applications. Energy security is an important consideration when assessing field development options and subsea energy storage will protect the operator from the intermittency of renewable power generation whilst allowing peak power demands to be serviced, such as during well start-up operations or valve functions.

EC-OG's Halo battery technology is a modular system, built around standard building blocks and power electronics. The battery architecture allows EC-OG to assemble systems in various configurations to suit the energy, power, duty and life cycle requirements of the application. With the technology intended for such a wide range of applications, it is necessary for there to be inherent flexibility in the system so that it can interface with the huge variances of existing subsea architecture currently in operation today.

Operating Lithium ion battery systems in the harsh subsea environment provides many challenges, including safety, reliability, efficiency and thermal management. Placing safety as the number one priority, Halo has been developed with a multi-level battery management system (BMS), with overall control provided by EC-OG's Intelligent Energy Management System (IEMS).

The IEMS constantly monitors the internal battery storage to ensure maximum system performance and reliability over the system design life. Designed to have very low power draw, the IEMS ensures that stored energy is not 'wasted' on management power overhead. This means that the battery autonomy period that Halo can produce is industry leading, whilst at all times, the IEMS and BMS are protecting the battery from operating out with it's safe operating condition.

» *Example 250kWh Halo with protection structure for impact protection.*

Understanding the operating parameters of the possible payloads has been critical for EC-OG's success in developing a system which will work for long durations of up to ten years without intervention. With a background in subsea engineering in the oil & gas and renewables industries, particularly subsea control system and critical well barrier equipment design and operation, EC-OG understand the operability of hydrocarbon production systems better than most. This knowledge has been invaluable in building a robust test and qualification plan for Halo, based on cross-industry learnings and specifications from recognized bodies such as IEC, ISO, API and DNV.

» *Example field layout, showing Halo powering a subsea asset whilst receiving charge from EC-OG's Powerhub.*

» *Powerhub, a seabed tidal energy converter for remote, low power applications at low energy sites, using integrated battery storage to delivery uninterrupted, regenerative power.*

Battery cell longevity in the subsea environment requires good thermal management. Whilst the operating environment of most major subsea hydrocarbon production regions have relatively stable temperatures, this ambient temperature on the seabed can vary greatly from equatorial to arctic waters. EC-OG have adopted a passive cooling system for the battery cells, meaning that the C-Rate of the system is carefully managed to ensure no excess heat is built-up within the internal battery modules.

Heat generation sources such as power electronics and chargers are isolated from the battery cells or contained within a centralized electrical distribution unit; an oil filled housing which also contains all critical subsea electronics and external communication systems, incorporating similar design philosophies as subsea control modules for hydrocarbon production systems. Future applications will mean a switch to active thermal management which is something that EC-OG intend to have available for future product generations.

The first Halo deployment in offshore waters will be completed in Q4 2020, which will be a significant milestone not just for the EC-OG but for the emerging ocean power sector as a whole. There is currently no established track record of large capacity, seabed-based Lithium ion battery systems and certainly none as part of a holistic clean energy system which EC-OG intends to demonstrate with its upcoming installation.

EC-OG started on the journey of developing clean energy systems for subsea applications in 2013 by developing Powerhub, an innovative seabed based tidal energy converter. Powerhub is ideal for remote, low power applications at low energy sites, using integrated battery storage to delivery uninterrupted, regenerative power. By developing its own battery storage systems for Powerhub and Halo, EC-OG has built on its reputation as subsea engineering experts to become leaders in battery storage and clean energy system for offshore applications.

The opportunity for battery storage to be an important building block in a sustainable blue economy reaches beyond the subsea environment which the company is targeting with Halo. Offshore platforms, shipping, aquaculture, offshore mining, carbon storage and offshore wind IRM can all bring a combination of high power and high energy demands, but batteries will play an important part as part of a wider energy mix.

Where power can be generated by a number of sources, it remains necessary for energy to be stored and power to be available on demand. EC-OG see this as a huge growth area in coming years, with battery still technology rapidly improving, driven primarily by the battery electric vehicle and onshore storage markets. Whilst the offshore sector may have been slow to adopt, net zero targets are sure to drive fundamental changes in the way we operate offshore assets.

EC-OG

For more information, visit
WWW.EC-OG.COM

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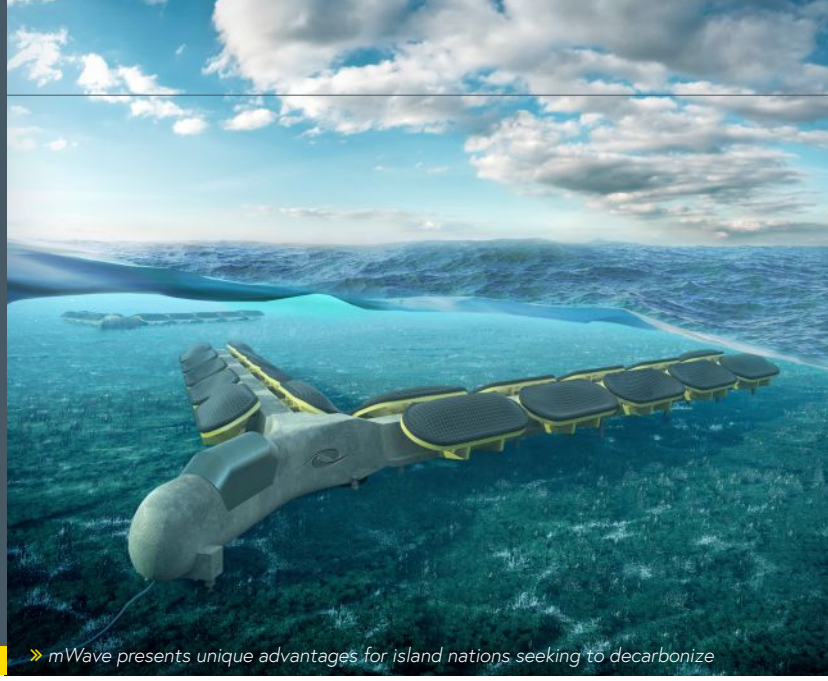
Sea the Difference.

CHECK THE TECH

NEW-WAVE THINKING: mWave



» *mWave presents unique advantages for island nations seeking to decarbonize*

The pioneering engineering team at Bombora are focused on generating clean energy from our seas. Waves could provide a reliable electricity source, crucial in balancing the intermittency of wind and solar power, and ultimately allow us to transition from fossil fuels. To support the full decarbonization of our power supply, we need to exploit multiple renewable energy sources, and, according to the International Energy Agency, wave energy could satisfy 10% of our global energy needs by 2050.

mWave™, Bombora's breakthrough patented wave technology, takes a uniquely simple approach to generating marine megawatts. mWave is the brainchild of two entrepreneurial engineers, brothers Glen and Shawn Ryan and led to the founding of Bombora in 2012, in Australia, before the company relocated to Europe in 2017.

mWave Technology: A New Perspective

Uniquely, the mWave system sits 10 meters below the ocean surface, where it can harness as much as 80% of a wave's energy using the underwater pressure fluctuations caused by the consistent wave motion overhead.

mWave uses a series of air-filled cell modules that are covered by a rubber membrane and attached to an anchored structure. As waves pass above, they apply pressure to the membrane and force air into a duct where it is channelled through a unidirectional energy-generating turbine. The air then passes through a return duct to refill the cell modules ready for the next wave. The electricity produced is transferred to shore via a subsea electrical cable.

The system's modular design simplifies servicing, keeps maintenance costs at a minimum, and facilitates the scaling up of the mWave power rating, a critical factor to bringing down the cost of energy. mWave can be either fixed to the seabed or integrated into a floating platform structure.

Tackling the Decarbonization Challenge:

For island nations seeking to decarbonize, mWave not only presents a cost-effective alternative to diesel power generation but ensures that infrastructure remains out of sight and at a depth that poses no obstruction to recreational vessels.

Bombora is currently assembling a full scale fixed 1.5MW mWave demonstration project in Pembrokeshire, UK due to be installed and commissioned in early 2021. At the same time, the company is progressing a 3.0MW fixed wave park project off the coast of Lanzarote, Spain, a community currently highly dependent on diesel power generation.

Deeper Energy Transition Possibilities

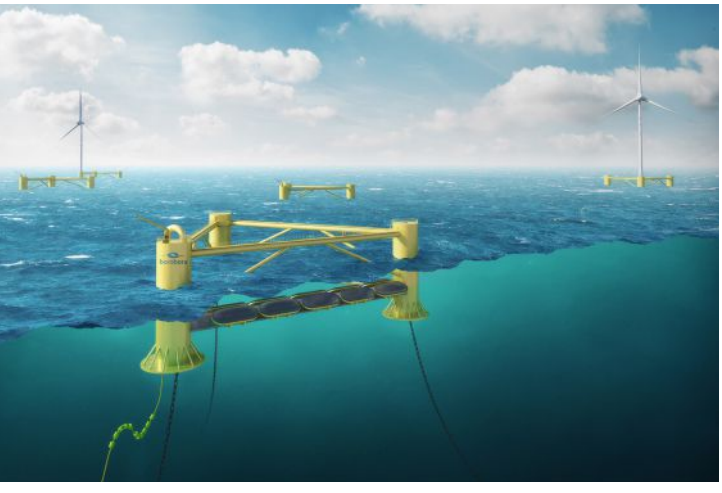
As Oil and Gas operators face up to similar decarbonization pressures, floating mWave platforms alongside offshore platforms could help transition operations from liquid fuel to clean renewable energy. Bombora is currently working in partnership with a global EPC contractor to refine this techno-economic proposition.

Utility Scale Opportunity

Large scale wave farms, fixed and/or floating, become an increasingly attractive prospect for the larger utility market as volumes increase and costs come down. There is also the prospect of deployment further offshore, in deeper waters, where major utility projects could exploit the more powerful, consistent wave resources.

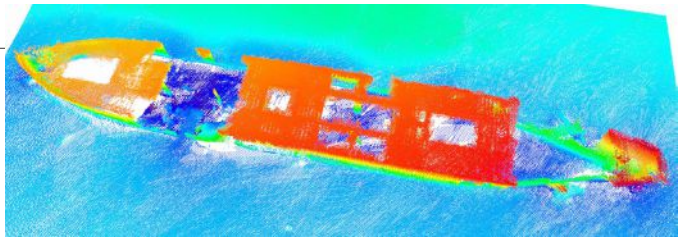
Offshore energy developers can also integrate wave platforms to their existing assets to help drive down the cost of overall energy production.

Bombora is currently working with the Offshore Renewable Energy Catapult's Marine Energy Centre of Excellence (MEECE) to define the optimum floating platform configuration for mWave and corresponding project cost model.

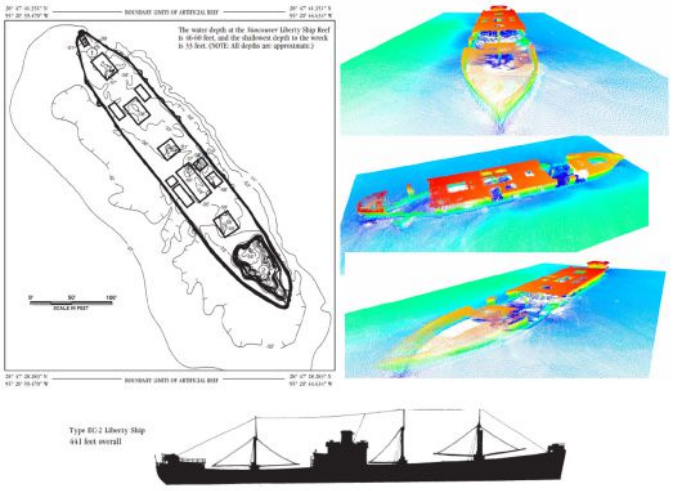


» *Bombora is currently completing a feasibility study to define the optimum floating platform configuration for mWave*

TDI-BROOKS MAPS THE LIBERTY SHIP REEF SITE GEORGE VANCOUVER



» *Multibeam survey data reveals the shipwreck of the Liberty George Vancouver that sank during a storm in 1976 when deployed to the Freeport Liberty Ship Reef site. (Image credit: TDI-Brooks)*



TDI-Brooks recently mapped the Liberty Ship George Vancouver off Freeport, Texas while out on a seabed survey project with the R/V Brooks McCall. The program of multi-phase geophysical and geotechnical site surveys consisted of pipeline routing and subsea structures to facilitate route and project design for offshore developers.

Equipment used to map the ship was a Teledyne Reson SeaBat T-20 multibeam sonar with integrated Applanix POSMV for Motion. Applying the mesh tools to the multibeam survey shows an example of the shipwreck.

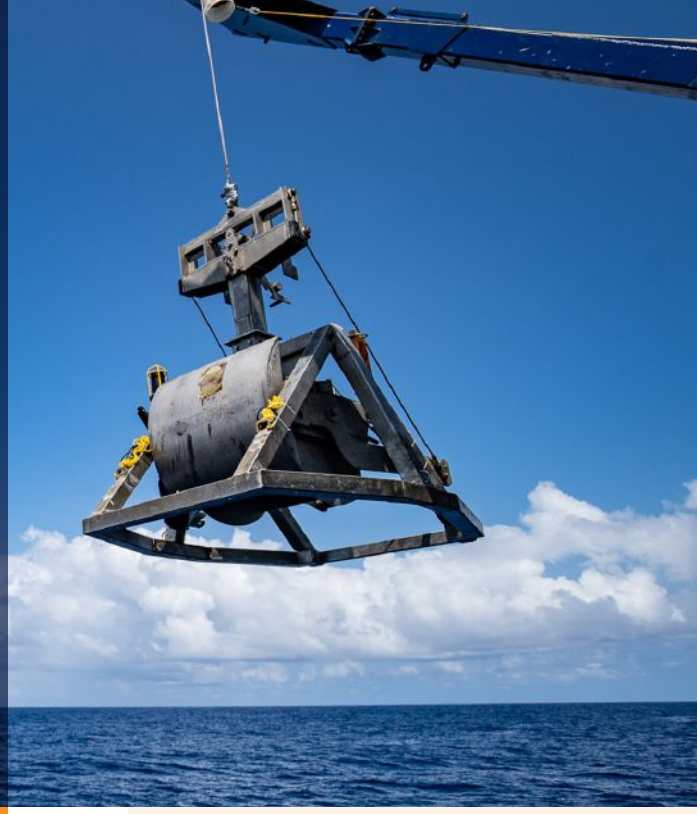
Texas has been involved in artificial reef development for nearly 50 years. Numerous reef building materials have been used over the years. However, the first highly successful artificial reef development occurred during the mid-1970's when 12 obsolete Liberty Ships were sunk at five different sites in the Gulf of Mexico. During deployment to the Freeport Liberty Ship Reef site in 1976, the Vancouver sank during a storm and settled to the bottom of the Gulf at its present position. Eleven other Liberty Ships and two tankers are located at other reef sites along the Texas coast. Brochures for these reef sites are available from the Texas Parks and Wildlife Department.

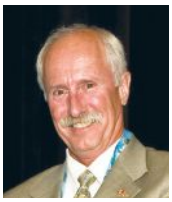
The multi-phase geophysical surveys were performed, all of which included integration of bathymetry, side scan sonar, sub-bottom profiling and magnetometer data. Side scan sonar data was used to determine areas of the seabed with contrasting acoustic properties that relate to different seabed sediment composition, sedimentary features and rock outcrop. The purpose of the geotechnical site survey was to gather sufficient site-specific geotechnical data for the design and installation of the offshore facilities. The geotechnical assessment included box cores, piston cores and CPTs throughout the routes and terminal areas.

Hydrographic Marine Surveys are critical to any site investigation and/or seabed mapping project. Hydrographic survey is the science of measurement and description of features which affect maritime navigation, marine construction, dredging, offshore oil exploration/ offshore oil drilling and related activities. Strong emphasis is placed on soundings, shorelines, tides, currents, seabed and submerged obstructions that relate to the previously mentioned activities.

Each TDI-Brooks vessel uses its multibeam echo sounder to conduct hydrographic surveys. Multibeam sonar measures the depth of the sea floor by analyzing the time it takes for sound waves to travel from a boat to the sea floor and back. In addition to our onboard services, we offer portable tool kits which can be shipped to any vessel of opportunity.

COULD OCEAN MINING BE AN ENABLER FOR OFFSHORE RENEWABLES?





Interview with Ted Brockett
Managing Director, Okeanus Science & Technology

As state-led contractors carry out their environmental due diligence and test their subsea technologies in the Pacific's Clarion Clipperton Zone (CCZ), signs suggest that ocean mining extraction could become a reality within the next few years.

Here we publish part two of our exclusive interview—*The Past, Present and Future of Ocean Mining*—with Ted Brockett, managing director of Okeanus Science & Technology. As a senior member of the subsea engineering team responsible for the first ever pilot test in the CCZ, in 1978, few are better placed to comment on the operational issues at hand and ponder whether ocean mining could make a meaningful contribution to the renewable energy sector in the coming years.

ON&T: What is the current outlook for ocean mining, especially given the unusual challenges of 2020?

» *Polymetallic nodules are typically 4 – 10 cm in diameter and found in abundance on the seabed of the CCZ. (Photo credit: DeepGreen)*

TB: This is an interesting moment for the ocean mining community. Many stakeholders believe that this is the moment to transition from exploration activities to the phased planning for extraction operations. We have the technology and know-how; now all we need is a clear roadmap to commercialization.

However, as with most industries, COVID-19 has been disruptive. For some time, the expectation among stakeholders has been that the draft exploitation regulations for mineral resources in the CCZ, more commonly referred to as the Mining Code, would be published by the International Seabed Authority (ISA)—the UN-sanctioned body with the authority to grant exploration/extraction contracts to state sponsors and contractors in international waters—by the end of 2020.

This is an extremely complicated set of guidelines, procedures and regulations, and with the ISA's July assembly and council meetings postponed due to the pandemic, ratifying the Mining Code may no longer be a realistic goal for this year. The ocean mining community is no stranger to delay, but the clock is ticking as some of the current exploration contracts are due to expire in 2021. Time will tell, but I remain optimistic that the harvesting of polymetallic nodules is possible within 2 – 3 years.

ON&T: Why, specifically, polymetallic nodules?

TB: While there is still interest in mining other mineral seabed deposits—namely cobalt-rich crusts and seafloor massive sulfites—the general consensus right now is that harvesting nodules is the least disruptive to the seabed environment. What's more, we know how to do it. Several mining consortiums ran very convincing full-scale pilot mining tests in the CCZ in the late 1970s, of which Ocean Management Inc. (OMI) was the first, in 1978. I was the lead engineer for OMI and can still remember thinking, as we reeled in these nodules by the thousand, how prosperous ocean mining could be under the right market conditions.

ON&T: So, given your experience, tell us more about these polymetallic nodules.

TB: They are typically 4 – 10 cm in diameter and are often described as potato-like in size and shape. To the touch, they feel somewhat like volcanic rock. Back in the 1970s we called them manganese nodules, on account of their high manganese content (c. 30%). But they also contain other valuable metals, notably nickel (1.5%), cobalt (.25%) and copper (1.25%). Other constituents include iron, silicon, aluminum, titanium, magnesium, potassium, and barium, and traces of other rare earth elements. They are 100% usable. Compare that to the typical yields associated with the terrestrial mining of scarce metals, and nodules promise far greater returns on investment. The difference between today and the late 1970s, of course, is that society's needs have changed; a more sustainably minded planet demands that we explore alternative natural resources.

ON&T: How so?

TB: There is growing interest in harnessing renewable energy as an alternative to using fossil fuels. But renewable energy is reliant on metals, both for building out critical infrastructure and advancing battery

technology. Terrestrial mining grades for those metals are diminishing, so the prospect of tapping the abundant subsea resources available to us seems like a practical next step.

ON&T: How abundant are these resources, and where?

TB: Nodule accumulations of commercial note have been discovered in four geographical locations, including the Penrhyn Basin, the Peru Basin, and the north Indian Ocean. But the CCZ is home to the richest concentrations. The CCZ is an abyssal plain spanning 5,000 km across the central Pacific, at depths of 4,000 – 5,500 m. Nodule distribution varies across the CCZ, as do accumulations, which on average range from 15 – 20 kgs of nodules per m2. Estimates differ, but the numbers are staggering—in terms of tonnage, we are talking in the tens of billions.

ON&T: What provisions are in place to safeguard against some of the well documented environmental concerns?

TB: This where the ISA plays such an important role, which came into power in 1994, upon the entry into force of the 1982 United Nations Convention for the Law of the Sea (UNCLOS). The ISA is responsible for regulating seabed activities beyond the limits of national jurisdiction, in waters defined as the Area. This is why the Mining Code is so important; without it there will be no mining at all.

In terms of specific provisions, the ISA has approved a number of initiatives to ensure that marine environments are protected from any harmful effects that could arise from mining-related activities. In 2012, the ISA introduced the Environmental Management Plan for the CCZ, which established Areas of Particular Environmental Interest (APEIs) within the CCZ to preserve the region's full range of habitats and communities, including those native to abyssal plains, abyssal hills, seamounts and fracture zones. There are currently nine 400 km2 APEIs, which together represent more than 30% of the total CCZ management area. There have been calls for additional APEIs, alongside other collaborative initiatives, such as designated 'no-take' fields within contractor zones, to promote further habitat protection.

ON&T: Is such collaboration among contractors likely?

TB: Collaboration and transparency is essential for ocean mining to prosper. Let's not forget, the environmental studies being conducted right now under these exploration contracts is of vital scientific importance. Our understanding of the CCZ's seafloor ecosystems and the oceanographic conditions that govern them has been vastly accelerated by environmental impact assessment (EIA) studies. We have identified new species, some clearly endemic, and now understand more about the role of hard substrates in such environments than ever before. It would be misleading to suggest that deep-sea mining operations are non-invasive, but we can at least work together to manage our actions responsibly. The ocean mining community's drive to contribute conscientiously is often overshadowed by some of the more polemic assertions made by the media and environmentalists.

ON&T: Sounds like ocean mining has an image problem?

TB: Mining is associated with drilling technologies. But the harvesting of nodules—which are essentially half submerged in sediment—relies on a collector system, not a drill head. The technical challenge, therefore, is to design a collector system that can perform efficiently within the confines of the mining code. The rest of the technology needed for deployment—drill ships with dynamic positioning and riser pipes—are borrowed straight out of the offshore oil and gas industry playbook.

ON&T: So, even amid mounting environmental concern, there is cause for optimism?

TB: Better yet, there is evidence to suggest that the long-term impacts of seabed disturbances—noise /vibration, light and sediment discharge—are less pronounced than once feared. The long-term monitoring survey of the Japan Deep-Sea Impact Experiment (JET), a series of Benthic Impact Experiments from 1994 – 1996 using an Okeanus (then SOSI) Benthic Disturber, has recently suggested that while the physical impacts of seabed disturbances remain, the marine life continues to prosper.

ON&T: Looking back at the collector system you tested back in 1978, would you do anything differently today in terms of design?

TB: Not much, no. OMI's drill ship, the SEDCO 445, was equipped with a derrick suspended by gimbals, which reduced the transmission of the ship's movements to the uptake pipe. Two lifting systems were tested: pumping with axial pumps implanted in the pipe at a depth of 1,000 m and lifting by injection of compressed air between 1,500 and 2,500 m (airlift). Two collecting devices were towed behind the pipe: a hydraulic suction dredge with water jets and a mechanical collector with an inverse conveyor belt. We were able to collect about 1,000 tons of polymetallic nodules from depths of 5,400 m.

» *Metal alloys can be derived from polymetallic nodules, which, in addition to manganese (c.30%), contain nickel (1.5%), cobalt (.25%) and copper (1.25%). (Photo credit: DeepGreen)*

ON&T: What advice would you offer engineers looking to refine their extraction methods and equipment?

TB: Keep. It. Simple. Stupid. This fabled U.S. Navy engineering principle served us well. Our system proved capable of harvesting 40 tons of nodules per hour, with a 20 HP collector. The temptation today, especially given the recent advances in subsea engineering and tooling, might be to "overengineer" a system in the interests of stretching yield. But operating at depths of up to 6,000 m comes with inherent challenges. You need to mitigate risks of equipment failure as delays are likely to cripple you financially when working in remote locations like the CCZ.

For a test collector, I would propose a modular system that allows you to test various configurations. Where possible, as we did in 1978, I would prioritize a hydraulic design to ensure that the water does the heavy lifting, sorting and cleaning of the nodules. Eliminating the sediment as early as possible is critical to optimizing nodule capacity in the riser pipe. The collector's modular design would allow you to identify the optimal configuration using a passively towed collector, a tracked collector, and one that uses an Archimedes screw.

ON&T: What other in-situ testing considerations are important?

TB: Efficiency is not exclusively defined by the mechanical performance of your mining system, but rather the way you deploy it. For example, is it simply a case of "mowing the lawn," from one perimeter to another, or would a more random pattern of collection be beneficial? I suspect this is a growing deliberation. Either way, the only way you can delineate a mine site is to validate how your equipment works best at depth.

Also, the transparency of in-situ test results is important. Historically, mining companies have always been guarded about their technologies—we certainly were at OMI—but sharing such information would help abate environmental concerns and streamline monitoring and regulation.

DIAMOND OFFSHORE WIND, RWE RENEWABLES JOIN THE UNIVERSITY OF MAINE TO LEAD DEVELOPMENT OF MAINE FLOATING OFFSHORE WIND DEMONSTRATION PROJECT

» *Floating Wind: Diamond Offshore Wind and RWE Renewables, with years of collective offshore energy experience and success, will invest $100 million to build the project and help demonstrate the technology at full scale.*

The University of Maine will collaborate with New England Aqua Ventus, LLC (NEAV), a joint venture between Diamond Offshore Wind, a subsidiary of the Mitsubishi Corporation, and RWE Renewables, the second largest company in offshore wind globally, to develop UMaine's floating offshore wind technology demonstration project off the coast of Maine.

As the developer, NEAV will own and manage all aspects of permitting, construction and assembly, deployment and ongoing operations for the project. UMaine's Advanced Structures and Composites Center will continue with design and engineering, research and development and post-construction monitoring.

The project will consist of a single semisubmersible concrete floating platform that will support a commercial 10–12-megawatt wind turbine and will be deployed in a state-designated area 2 miles south of Monhegan Island and 14 miles from the Maine coast. The purpose of the demonstration project is to further evaluate the floating technology, monitor environmental factors and develop best practices for offshore wind to coexist with traditional marine activities. It will supply clean, renewable electricity to the Maine grid.

Construction, following all permitting, is expected to be completed in 2023.

Sens. Susan Collins and Angus King and Reps. Chellie Pingree and Jared Golden issued a joint statement on the partnership announcement: "For generations, Maine has been a national leader when it comes to using our natural resources sustainably to create jobs, protect our environment and power our economy. The University of Maine's floating deepwater offshore wind project carries on that tradition. We have strongly supported UMaine's development of the Aqua Ventus project. We are proud to see the project's progress and applaud the $100 million public-private partnership launched today, which will accelerate UMaine's development of its innovative technology and create jobs. Maine's offshore wind resource potential is 36 times greater than the state's electricity demand, making this project so significant for Maine's clean energy future."

An immediate priority for the new development team is to engage with the fishing industry, other maritime users, coastal communities and other interested parties on how to ensure this new renewable energy source can optimally provide economic growth to Maine and work with maritime industries.

Since 2008, the University of Maine has researched floating offshore wind technology as a solution to Maine's overdependence on imported fossil fuels. After winning funding from the U.S. Department of Energy (DOE), the university worked with Maine-based construction firm Cianbro to build and deploy the first grid-connected offshore wind turbine in the U.S. in 2013, a one-eighth scale prototype of its VolturnUS floating hull technology. The success of the project led to additional funding from the DOE to further advance the VolturnUS technology, which has been issued 43 patents to date. The university and Cianbro sought to partner with a world-class offshore wind developer to further demonstrate this technology on a commercial scale. UMaine will continue to own its VolturnUS floating hull intellectual property and license it to NEAV for this project.

"Diamond Offshore Wind and RWE Renewables bring global expertise in offshore wind project development and construction, and we look forward to working with them to demonstrate UMaine's floating hull technology in Maine waters," says Habib Dagher, executive director of UMaine's Advanced Structures and Composites Center, where the VolturnUS hull technology was invented. "Our design is ideally suited for deepwater deployment anywhere and has the potential to play a significant role in global efforts to decrease dependence on fossil fuels."

Diamond Offshore Wind and RWE Renewables, with years of collective offshore energy experience and success, will invest $100 million to build the project and help demonstrate the technology at full scale. Combined, the two new partners are responsible for nearly a quarter of the world's offshore wind capacity.

"We are pleased to see the University of Maine continuing to make progress and that new private sector partners recognize the great potential of this project," says Daniel Simmons, assistant secretary of energy efficiency and renewable energy for the U.S. Department of Energy. "This complements the investment of research, development and demonstration funding from DOE to advance innovation in a floating design for offshore wind."

Under the Mills administration and with a long history of bipartisan support, Maine has moved boldly ahead on renewable energy and offshore wind development, including enacting legislation authorizing approval by the Maine Public Utilities Commission of the power purchase contract for Aqua Ventus, and initiating a study of the port at Searsport as a potential site to support and develop offshore wind. The governor also accepted the invitation for Maine to join the Bureau of Ocean Energy Management Gulf of Maine Intergovernmental Renewable Energy Task Force, along with New Hampshire and Massachusetts, which is charged with facilitating coordination related to renewable energy activities in federal waters in the Gulf of Maine.

"The strength of Maine's economy, the preservation of our natural resources, the long-term health and well-being of our communities and of future generations depend in great part on our transitioning to clean energy and tackling the threat of climate change," says Gov. Janet Mills. "This new public-private partnership joins world-class offshore wind developers and the University of Maine, and puts us on track to be home to the nation's first floating offshore wind project, reflecting the major economic growth opportunity of the clean energy economy. I am pleased this project is moving forward, and encouraged by the partners' strong commitment to work collaboratively with Maine fishermen to protect and support our traditional industries as we chart a greener future for our state."

"This is a significant milestone for the University of Maine, the offshore wind research team and the state of Maine," says UMaine President Joan Ferrini-Mundy. "As Maine's research university, UMaine is continually advancing its broad land grant, sea and space grant mission. The path from fundamental research to economic realization is complex, and success takes incredible innovation, persistence and strategic partnerships. Many faculty, staff and students have participated in the development of this technology, and will continue to support the energy and marine economy as this project transitions to the private sector. This collaboration exemplifies our role and commitment to creating and supporting the future of Maine."

NEAV will continue to involve Maine companies in permitting, construction and assembly, deployment, and ongoing operations and maintenance of the project. In addition, NEAV has committed to working with the University of Maine on research, development and design to take the technology elsewhere in the U.S. and the world. The concrete hulls are designed to be built in communities adjacent to potential projects, generating local construction jobs and other benefits during the building and assembly phase.

The project is projected to produce more than $150 million in total economic output and create hundreds of Maine-based jobs during the construction period.

"Cianbro has been a founding member of the Aqua Ventus team for over 10 years and we remain deeply supportive and committed to the development of offshore wind in Maine," says Pete Vigue, chair of The Cianbro Companies. "We look forward to working with the NEAV team and all related stakeholders to complete the initial demonstration unit."

The developers also will work with the University of Maine System, the Maine Community College System and Maine Maritime Academy to attract K–12 students to science, engineering and business programs, prepare college students and help to create a skilled workforce in Maine with the technical skills necessary to support offshore wind development and operation.

"We are pleased to partner with the university to bring its ideas for floating offshore wind to fruition," says Chris Wissemann of Diamond Offshore Wind. "This project south of Monhegan is a perfect opportunity to demonstrate a new technology that can be built in Maine, create jobs in Maine, and demonstrate how fishing and offshore wind can co-exist. Together with RWE, our engineers conducted an extensive due-diligence review of UMaine's VolturnUS floating wind technology, and believe it is a world leader in floating wind that reduces costs and creates local jobs. We are really focused on creating economic opportunities for Maine as this new carbon-free economy emerges."

"We see great potential for floating wind farms worldwide, especially in countries like the U.S., with deeper coastal waters," says Sven Utermöhlen, chief operating officer, Wind Offshore Global of RWE Renewables. "This innovative project combines the University of Maine's knowledge with the state's maritime heritage, allowing RWE Renewables to gain the experience that can help us provide future opportunities to grow local economies and produce clean, renewable power."

NREL FLOATS NEW OFFSHORE WIND COST OPTIMIZATION VISION

» *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)*

The United States' most plentiful offshore wind resource is found in waters so deep that floating platforms are needed to support the turbines—posing major challenges for offshore wind to deliver electricity at a commercial scale and competitive cost. In order for floating wind to become a viable marketplace technology, optimized designs, configurations, and operational practices need to be identified to achieve cost parity with fixed-bottom platform designs.

A recent study by the U.S. Department of Energy's (DOE's) National Renewable Energy Laboratory (NREL) unveils a new strategic vision for floating offshore wind. Researchers identify barriers that must be overcome to bring down the overall cost of energy produced, then outline a vision for an integrated systems approach with the potential to significantly improve the market feasibility of floating wind plants.

"While we've made great progress with innovations related to individual components and tools, only a comprehensive systems-based approach can allow floating wind technology to fully mature in commercial markets," said NREL Offshore Wind Platform Lead and study co-author Walt Musial. "A multidisciplinary effort makes it possible to simultaneously focus on a wide range of factors and then optimize designs to achieve a minimum system cost."

Choosing an Integrated vs. an Iterative Approach

Much of the 2,000 gigawatts of U.S. offshore wind domestic electricity-generating capacity is found near coastal population centers. More than 58% of this resource is located in water depths of 60 meters or greater, where the engineering challenges of fixed-bottom installations directly connected to the sea floor make them technically and/or economically infeasible.

Floating platforms are needed to most effectively harness wind energy in these locations.

Floating wind turbine substructure prototypes were initially adapted directly from proven offshore oil and gas platforms concepts. While this first wave of designs proved that the floating technology can meet durability and energy production demands, baseline cost analysis indicates further optimization, innovation, and upscaling to commercial plant sizes will be required to make floating wind energy systems economically viable.

Detailed modeling by NREL researchers shows that needed cost reductions are unlikely to come from a single breakthrough invention, but will require the deliberate combination of design building blocks that span multiple disciplines—a complementary combination of innovations in technologies, design features, and installation and operational strategies.

To achieve this vision, the NREL approach uses a fully integrated systems-engineering and techno-economic design to capture the complex interactions among physics, manufacturing, installation, and operation of floating wind systems and identify optimal designs that dramatically reduce costs.

The current approach to offshore wind system design is iterative, with each company bringing to the table its own area of expertise and profit motive.

"One manufacturer designs the turbine and tower, another company designs the substructure, and sometimes a separate developer tackles array layout and logistics. The tremendous complexity of the physical environment for floating installations and interplay of design components make this divide-and-conquer approach quite costly and less effective in identifying workable solutions," said NREL Senior Research Engineer and study lead author Garrett Barter.

Building on Experience and Filling Gaps

The NREL study examines the current state of floating offshore wind technology and highlights gaps in development and areas that could benefit from additional tools and innovation. Researchers looked at system

components including turbines, platforms, moorings, and controls. They also reviewed plant-level factors, such as wake and array effects; manufacturing, installation, operation, and maintenance; grid integration; and environmental impact.

"While the promise of new systems engineering design tools capable of tackling the challenges of floating wind sounds tantalizing, to be successful and more than just an academic exercise, they must incorporate prior lessons learned," said NREL Senior Research Engineer and study co-author Amy Robertson. "Experience from oil and gas and fixed-bottom projects can quickly steer a new tool towards solutions that are most likely to provide the greatest performance and cost reductions."

The study itemizes important experience-based engineering and operational considerations and describes the advantages of factoring them into design decisions to narrow the options for cost-effective designs. For instance, structures that can be towed to deep water locations for deployment and to shore for maintenance offer both logistic and economic benefits to operators. Designs that use this know-how and can be standardized for use in a wide range of ocean environments and ports promise greater economies of scale for manufacturers and more widespread adoption by industry.

Developing New Tools

Researchers also perceive that existing engineering-focused tools do not adequately factor in cost and systems design considerations, while systems engineering tools lack sufficient fidelity of the physics to capture all critical design drivers. To bridge this gap, DOE's Advanced Research Projects Agency-Energy (ARPA-E) recently initiated a new program, Aerodynamic Turbines Lighter and Afloat with Nautical Technologies and Integrated Servo-control (ATLANTIS), to revolutionize floating offshore wind turbine design and design tools. NREL and its ATLANTIS collaborators from the University of Illinois Urbana-Champaign and Colorado State University are pursuing the vision put forth in the paper by creating the open source Wind Energy with Integrated Servo-control (WEIS) toolset to optimize floating offshore wind turbines.

Targeting Cost-Effective Floating Wind by 2030

Once system optimization tools are developed, they can be used to quantify the cost-benefit trade-offs of individual technologies and different system or industrial strategies. Researchers envision the study eventually feeding into a research program that includes optimization of whole systems—including entire wind plants and their supporting logistics—as well as trade-off and sensitivity studies related to substructure, anchoring, turbine, rotor, generator, controls, and materials innovations.

NREL's proposed integrated systems design approach aims to help industry deploy cost-effective floating turbine systems by 2030.

Read the full study here: *https://www.sciencedirect.com/science/article/pii/S1755008420300132*

XODUS LAUNCHES MAJOR FLOATING OFFSHORE WIND STUDY

Global energy consultancy Xodus Group has launched a three-year collaborative research project on the costs around floating offshore wind.

The study, led by Xodus through the IDCORE programme, is a collaborative partnership between the Universities of Edinburgh, Strathclyde and Exeter as well as the Scottish Association for Marine Science (SAMS). To enable the best industry outcomes, Xodus is issuing an open call to developers and technology suppliers to engage with the study from the outset.

The project will be key to ensuring floating wind can be a serious contender in the energy mix going forward and will result in a tool designed to assist in key decision making for floating offshore wind projects. It will also create guidance to assist with project finance decision making and to reduce uncertainties in floating offshore wind energy yield assessments.

Titled 'Improving the Bankability of Floating Offshore Wind Projects', the study will tackle the challenges and risks that project developers have in acquiring finance for floating wind projects and develop a methodology to use floating LiDAR data for bankable energy yield assessments.

The study will explore the impacts of floating structures on modelling wind resource and incorporating the impact of met ocean conditions on site considerations.

Scott Hamilton, Renewables Division Manager at Xodus said: "We have a strong track record of engaging with leading academic research and are proud to be leading this collaborative project in floating offshore wind. It's important for us to be investing in future skills that the industry needs.

"We are openly inviting developers to engage with us on this project from the outset, and we expect the outcomes to provide much needed innovative research in this area and deliver benefits to the wider wind industry."

» *Ben Smith, University College London*

» *Bcott Hamilton, Xodus, Renewables Division Manager*

The IDCORE programme addresses future challenges to develop leading technologies and train world-class scientists and engineers essential for the UK to sustain its global status in the ORE sector.

Xodus is already invested in IDCORE, with two of its consultants having already gained their doctorates through the scheme. With support from Xodus' technical team, the research will be carried out by Ben Smith, a graduate from University College London.

Companies interested in participating in the research should contact: *renewables@xodusgroup.com*

OCEAN ENERGY INDUSTRY CALLS FOR EUROPEAN TARGET OF 100MW BY 2025

The new EU Strategy on Offshore Renewable Energy must include a target of 100MW of ocean energy installed in Europe by 2025. This would be enough to power 100,000 European homes a year, and would pave the way for installing 3GW by 2030 and 100GW by 2050. This target would provide the political impetus and incentives needed to maintain Europe's position as the global leader in ocean energy and create a new industry for Europe.

Four priority actions are needed to achieve this, according to Ocean Energy Europe. First on the list is the formation of a pan-European alliance of EU decision-makers, national governments and industry representatives. The alliance would be tasked with accelerating the sector's development by providing access to national revenue support and making it easier to secure project sites.

Secondly, earmarking €300 million for ocean energy research and innovation over the next five years will support the EU's green recovery objectives, cut technology costs and get planned projects into the water.

The third action, setting up a European insurance & guarantee fund, will also reduce project risks and make it easier for developers to access private finance.

The final recommendation is to develop an export strategy for offshore renewable technologies. A blend of European Investment Bank financing and guarantees for export-ready projects will make sure that Europe holds onto its world-leading position in ocean energy.

The importance of public support in kick-starting projects and encouraging private investment to create a truly commercial industry cannot be overstated. Since 2007, every €1 of EU & national public funding for ocean energy has leveraged €2.9 of private investments in the sector.

» *Remi Gruet, CEO of Ocean Energy Europe*

Remi Gruet, CEO of Ocean Energy Europe said: "This target is entirely achievable. There is a strong pipeline of projects lined up along Europe's coasts – all that's needed now is the right policy and market environment to deliver them. The new EU Strategy on Offshore Renewable Energy is a huge opportunity for Europe to achieve a recovery that is both green and just."

SAIPEM, PROTAGONIST IN OFFSHORE WIND, WILL DEVELOP A WIND FARM IN ITALY

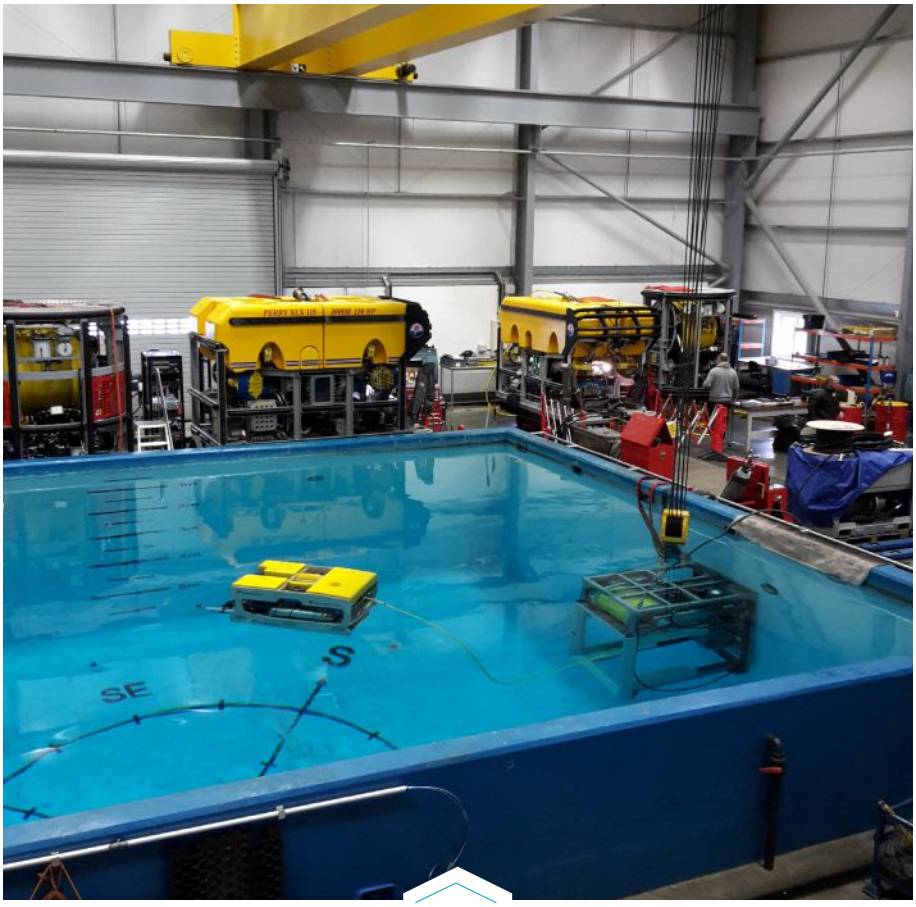
Saipem will co-develop a wind farm in the Adriatic Sea off the coast of Ravenna. The company thus confirms its increasingly active presence in the field of initiatives linked to the development of offshore wind and its presence in the sector also in Italy. To this end, it has recently signed a Memorandum of Understanding with AGNES, a company that develops renewable energy projects in the Adriatic Sea, in particular offshore and nearshore wind farms, floating solar panels at sea, energy storage systems and hydrogen production from renewable sources, and QINT'X, an Italian company specialising in renewable energy, specifically solar, wind and hydroelectric energy and e-mobility.

This project will involve the installation of approximately 56 turbines on fixed foundations on the seabed at two different sites: one located more than 8 nautical miles from the shore, and the other more than 12 miles from the shore. As part of this project, innovative technologies will also be used such as floating solar technology based on the proprietary technology of Moss Maritime, which is part of Saipem's XSIGHT division dedicated to developing innovative solutions to speed up decarbonisation process in the energy sector. In this respect, the XSIGHT division has already begun developing integrated solutions for using renewable energy. The Agnes project will be the first project to develop such integrated solutions, offering the opportunity to find an alternative solution to decommissioning O&G platforms in the Adriatic Sea.

Mauro Piasere, Chief Operating Officer of the XSIGHT Division, commented: "Saipem has long launched a process to strengthen its presence in the renewable energy sector. In particular, through the XSIGHT division, the company's new role as developer of offshore wind farms is being defined and the Memorandum of Understanding signed with AGNES and QINT'X constitutes a new important opportunity in this direction. This agreement is consistent with the new business model adopted by the company, which is increasingly becoming a leader in the field of energy transition, and introduced in 2019 as part of the agreement with Plambeck to develop wind farms with floating foundations in the Red Sea off the coast of Saudi Arabia. Through the XSIGHT division, Saipem is planning to launch similar projects in Sicily and Sardinia as well, using floating foundations for wind turbines, thus supporting the Italian shipbuilding industry".

Alberto Bernabini, Chief Executive Officer of QINT'X, commented: "This agreement marks another important step towards the realization of an ambitious project. Our vision is to create a new green energy hub in the Adriatic Sea, integrating multiple technologies to generate clean energy from the wind, sun and hydrogen. We are very proud and pleased to count on Saipem as a partner, a global leader in Offshore solutions, which is now set to be a main actor in the much-needed energy transition. This collaboration will allow us to harness many synergies transform Agnes Project into a reality".

FORUM DEVELOPS REMOTE PILOTING CAPABILITY FOR ROVs



» *Forum's test pool at Kirkbymoorside, Yorkshire, UK. (Photo credit: Forum)*

Forum Energy Technologies recently revealed it has developed and demonstrated the ability to remotely operate Work-Class and Observation Class (Perry and Sub-Atlantic) ROV systems between an offshore vessel and a remote location.

This new capability brings major opportunities to adapt operational practices in response to the latest industry drives as cost savings and reductions in HSE risks can be realized through reducing offshore crew sizes.

The concept of remote piloting was proven by Forum 2010 when the company successfully operated its TXLX Work-Class ROV in its test pool at Kirkbymoorside, UK, from a TXLX Console located in Florida, USA. Remote Control capabilities demonstrated were camera and light controls, manifold power on/off, depth and gyro power, pan and tilt controls, manipulator controls, ROV thruster controls, auto heading controls. At that time, internet speeds were much slower than today resulting in high latency telemetry which the control system software was not equipped to counter.

However, continued development in software efficiencies which reduce the effect of network latency coupled with increased availability and reliability of the global 4G network has now allowed Forum to offer remote operations on its full range of ROV systems. Forum's ICE™ & subCAN™ remote operations suites provide a robust means of piloting vessel or platform-based systems from an onshore control facility via a wired, 4G or satellite connection.

The onshore hardware replicates the offshore HMI hardware and GUI so controls will be immediately familiar to operators. The Onshore Control Module provides a local hub for power and data connections.

Existing offshore control station hardware can be upgraded to allow remote control and monitoring of power systems. The Offshore Control Module interfaces with the upgraded hardware providing control and monitoring via the existing ICE/subCAN network. A key-switch, in conjunction with the software, ensures secure control of hand-over between offshore and onshore stations.

The ICE™ & subCAN™ control software applies enhanced position control when a compatible DVL and gyro are fitted to the ROV.

The system upgrade components are manufactured and delivered from Forum's UK facility in Kirkbymoorside, Yorkshire.

Kevin Taylor, Forum's vice president - subsea vehicles, said: "Forum has a strong reputation globally for manufacturing high quality, robust ROVs and associated auxiliary products for a number of industries ranging from oil and gas to renewables, defense, mining and telecommunications. This additional and important feature is part of our continued product support and development across the entire range.

"Remote operations can reduce the number of personnel offshore, particularly during complex processes or technical procedures which may require a specialist to be deployed. The capability also aligns strongly with industry drives to reduce carbon footprint and deliver safe, efficient operations."

FORUM ENERGY TECHNOLOGIES

COMMERCIALIZING TECHNOLOGY TO GROW THE GLOBAL BLUE ECONOMY

The UK has an unrivalled track record of technological innovation, but ideas frequently fail between invention and commercialization. To help cross this chasm, the National Subsea Research Institute (NSRI) has developed a tool which provides a clear indication of the potential commercial viability of early stage technology in the subsea industry, supporting technology and innovation developers, funding organizations and investors.

By measuring the viability of a technical concept through analysis of various factors including market conditions and funding requirements, the tool provides a systematic approach and helps identify exactly where pioneering companies should be focusing their efforts.

This in turn will help the UK subsea industry capitalize on its world leading expertise to foster and develop the blue economy.

Current annual global spend across the blue economy is around £20bn, with a forecast rise to £140bn by 2035. The UK is in a dominant position with a 40% share of almost £8bn.

NSRI is the focal point for subsea research and development in the UK. Tony Laing, Director – Research and Market Acceleration at NSRI, says: "As an enabling organization, we are dedicated to understanding demand-led technology gaps and supporting supplier-led technology solutions. With our unique combination of deep domain knowledge and impartiality, we are in prime position to take a lateral approach to cross-industry challenges and priorities in terms of technology requirements. In the current precarious economic climate, technology development and innovation has never been more important, but it must be underpinned with a sound business case.

"Companies regularly come to us with strong engineering-based innovations, however establishing robust commercial viability is often not considered by businesses early enough in the idea generation process.

"With meaningful outputs in dashboard format, our commercialization tool visualizes uncertainties and shows companies exactly where they should focus their efforts to drive maximum business value and return on investment. That could be towards internal resources, delivering the technology or external market-led factors. The outputs are also incredibly valuable for allowing investors and stakeholders to understand the existence of customer-led demand.

"The energy landscape is changing at an incredible rate, and the UK's subsea industry is well-placed to capitalize on the many opportunities surrounding the blue economy, energy transition and digitalization. However, capturing opportunities and implementing robust commercial thinking is going to be key for success."

One company which has directly benefited from support provided by NSRI, is SMS. Established in 2004, SMS provides sensory data analysis and visualization for the oil and gas industry.

SMS development director, Alistair Moncur, says: "NSRI has helped shape our strategic growth and diversification planning in the UK and internationally through their comprehensive commercialization approach. This has included exploring the wider energy transition and other aspects of the blue economy, such as defense. By enabling us to understand the commercial advantages of incorporating a digital AI system into our core technology, we have created significant growth opportunity and the potential to quadruple the size of our market over the short to medium term.

"During these challenging times, dealing with the impact of COVID-19 and volatility in hydrocarbon prices, building opportunities in a low carbon future has been pivotal for SMS."

» *Tony Laing, Director – Research and Market Acceleration at NSRI. (Photo credit: NSRI)*

FUGRO TO DELIVER GEOTECHNICAL SITE INVESTIGATION FOR CROSSWIND PROJECT

The CrossWind consortium, a joint venture between Shell in the Netherlands and Eneco, has awarded Fugro a contract to deliver comprehensive geotechnical site investigation solutions to support development of the Hollandse Kust (noord) offshore wind farm.

The CrossWind consortium, a joint venture between Shell in the Netherlands and Eneco, has awarded Fugro a contract to deliver comprehensive geotechnical site investigation solutions to support development of the Hollandse Kust (noord) offshore wind farm. The site investigation solutions will comprise an unexploded ordnance (UXO) site clearance survey followed by a seabed cone penetration test (CPT) investigation.

After clearing the sites with the Fugro vessel Atlantis Dweller, Fugro will mobilize their seabed SEACALF® Mk V DeepDrive CPT system for the fieldwork, which is scheduled to begin this month and should complete by the end of September. The SEACALF acquires high-quality data over the full foundation depth of wind turbines and has already been successfully deployed on a series of North Sea projects.

Tjalling de Bruin, Project Director for CrossWind, said: 'We are looking forward to working with Fugro to execute our first offshore activities safely and in good health during these extraordinary times. With a signed contract in place and the site investigation team mobilizing, the work is progressing well to deliver clean energy by 2023."

Sven Plasman, Commercial Manager at Fugro, added: "We are pleased that our proven track record on previous projects for Shell and Eneco, and our deep knowledge of offshore wind farm developments have led to another major contract award using the efficiency and safety of our seabed site investigation solutions such as the SEACALF Mk V DeepDrive CPT system."

The CrossWind consortium plans to have Hollandse Kust (noord) operational by 2023 with an installed capacity of 759 MW, generating at least 3.3 TWh per year. The wind farm will be located 18.5 km off the Dutch coast near the town of Egmond aan Zee.

» *Fugro's Atlantis Dweller will be mobilized for the unexploded ordnance (UXO) site clearance survey as part of their new CrossWind project for the Hollandse Kust (noord) offshore wind farm. (Photo credit: Fugro)*

» *The active heave compensated umbilical winch and skid mounted A-Frame style LARS was deployed on two separate deep-sea mining missions to successfully recover cobalt crust core samples. (Photo credit: Okeanus)*

OKEANUS DELIVERS GROUNDBREAKING WINCH AND LARS TO NiGK

Okeanus Science & Technology, LLC (Okeanus), an established provider of marine engineering services and oceanographic equipment, has released further details of an active heave compensated umbilical winch and skid mounted A-Frame style LARS that was delivered to Japan's NiGK Corporation (NIGK) earlier this year. The system underwent strict factory acceptance tests and sea trials and, following its delivery to NiGK's end customer, the Japan Oil, Gas and Metals National Corporation (JOGMEC), was then deployed on two separate deep-sea mining missions to successfully recover cobalt crust core samples using NiGK's new state-of-the-art seabed drill.

Mounted to a vessel of opportunity, the 10-ton SWL winch and LARS proved instrumental in the handling of the tethered drill. The Okeanus team were responsible for the engineering development of the skid-mounted umbilical winch and LARS, from concept through to production, and it was manufactured at Okeanus' facility on FM-529 in Houston, TX.

The active heave compensated LARS incorporates a number of exclusive features and modes of operation, such as: a custom telescoping docking head design and assembly (with failsafe latches); full rotation maneuverability; oversized dual groove over-boarding sheave, for use with the umbilical and positively buoyant strain relief; and an operator-adjustable motion damping feature that allows for safe and efficient shipboard launch and recovery operations, even in high sea states.

"We worked in close and ongoing collaboration with our customer, NiGK, on this cutting-edge system and incorporated a number of new and exciting design features," according to Okeanus managing director Benton LeBlanc. "The umbilical winch and LARS were successfully tested dockside in Japan earlier this year and, on the successful completion of sea trials, the system was deployed on deep-sea mining expeditions."

This is the latest in a series of specialized engineering projects on which Okeanus was able to custom design solutions for safe and reliable deployment in the Deep Sea. Okeanus' ability to work in phased partnership with clients from a range of industries and international markets to define fit-for-purpose equipment is further testament to the firm's reputation for manufacturing robust, mission-critical handing systems, as well offering a leading portfolio of rental oceanic hardware.

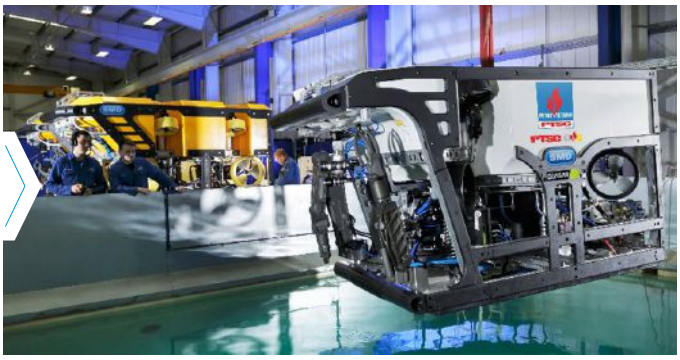
SMD TO SUPPLY QUASAR II ROV TO PTSC G&S IN VIETNAM

Soil Machine Dynamics Limited (SMD) has won a multi-million-dollar contract to supply a Quasar II, medium-sized Work-Class ROV to PTSC GEOS & SUBSEA SERVICES CO., LTD., (PTSC G&S), a subsidiary of Petrovietnam Technical Services Corporation (PTSC). The Quasar is the second of its kind to be ordered by PTSC G&S, nearly a decade after the first ROV was purchased.

Quasar II is a versatile all-around performer capable of survey, construction, and drill support operations. Once delivered to the oil fields in South East Asia, it will work alongside the existing SMD ROV, performing a range of operations, at depths of up to 2,500 meters.

PTSC G&S has commissioned a high specification of options to compliment the Quasar II, including the most powerful tooling capabilities, a survey pod, and the latest instruments. The vehicle offers class-leading performance, tooling, instrument space and easy access for maintenance. The machine will also be mated with an SMD compact Tether Management System (TMS).

The team at SMD will also provide training and mobilization support. The training will employ the use of SMD's simulator to allow ROV operators to train and rehearse for a range of subsea scenarios before launching and piloting the ROV for real.

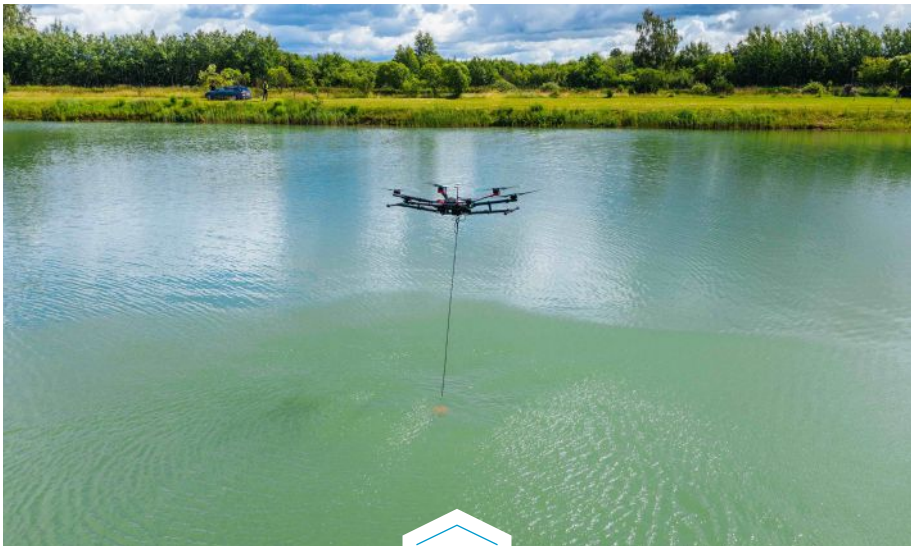


» *The Quasar II, versatile all-around Work-Class ROV capable of survey, construction, and drill support operations, is due for delivery in February 2021. (Photo caption: SMD)*

Mark Collins, Business Development Director, Remote and Autonomous Systems at SMD said, "PTSC G&S has successfully operating our existing Quasar in oil fields in Vietnam and South East Asia for nearly a decade. It's always a pleasure when long-standing customers come back to us for new equipment and we're delighted to be working with PTSC G&S again.

"Our technology has developed significantly over the past decade as have the markets we operate within, but our core vehicles remain the best in their class, and this new contract is testament to that. Our medium-sized Work-Class ROV is a real workhorse and represents exceptional value. It has high powered capabilities and the capacity to partner with a range of tools and technologies, it's versatile and built to last."

SPH ENGINEERING AND EYE4SOFTWARE PARTNER TO ADVANCE BATHYMETRIC AND HYDROLOGICAL DATA COLLECTION



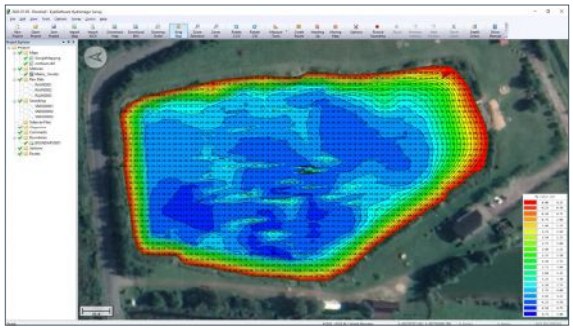
» *SPH Engineering bathymetric-drone*

SPH Engineering, the world's premier UgCS software developer and integration services provider for unmanned aerial systems, and Eye4Software, a leading developer of hydrographic software, recently announced a partnership agreement to synchronize the UgCS solution for bathymetry and the Hydromagic Survey software package. The cooperation is expected to advance the methods of bathymetric and hydrological data collection with drones.

The integrated drone system for bathymetry consists of an Unmanned Aerial Vehicle (UAV) drone with a single or dual-frequency echo sounder. The full integration is ensured with the flight planning and control software UgCS and a special onboard software by SPH Engineering. Hydromagic, a professional hydrographic survey package by Eye4Software, is applied to data processing gathered using an echo sounder attached to the drone.

Experts from both SPH Engineering and Eye4Software worked hard to ensure compatibility of data files generated by onboard drone software with Hydromagic. NMEA 0183 with bathymetric data and SEG-Y files with full echo sounder data can be processed with Hydromagic to produce output results (depth maps, contour maps, 3D models) according to the requirements of the industry.

"Thanks to our professional partnership with Eye4Software we can provide complete solutions and support from a single source - everything from bathymetric data collection using drones to data processing with a state-of-the-art software package. I am proud to see that our brand new drone-based solution with an integrated echo sounder for bathymetric surveys has been well-received by the market and we have already made our first product shipments to meet clients' demands" - Alexey Dobrovolskiy, CTO of SPH Engineering, comments.



» *PP SPH colored depth map UgCS Industrial Solutions*

"With the improved SEG-Y import function in our Hydromagic Survey package, SPH Engineering's customers can now use our hydrographic processing software which has been in use by many USV operators for years. Combining our and SPH Engineering's technologies, it is now even possible to survey areas even an USV can't operate" - Leon Steijger, CEO at Eye4Software B.V., adds.

Earlier this year SPH Engineering announced the launch of a UAV drone integrated with an echo sounder, a new product for bathymetric surveys of inland and coastal waters. This method of data collection is time- & cost-efficient and suitable for mapping, measuring, and inspections, as well as environmental monitoring.

A video presentation of the bathymetric survey of a lake (near SPH's HQ in Riga, Latvia) using a UAV drone equipped with an echo sounder: *https://youtu.be/Xq3CfSbj65o*

SUBSEA EXPO 2021 CONFIRMED FOR FEBRUARY 2021 AS CALL FOR PAPERS OPENS

» *A third of the exhibition spaced has already been booked for the expo to be held at Aberdeen's P&J Live venue from February 23. (Photo credit: Subsea Expo)*

Europe's largest underwater engineering event, Subsea Expo, is shaping up to what could be the sector's first post-pandemic, large scale event where delegates will be able to meet and network in person.

More than a third of the exhibition floor space has already been booked for Subsea UK's annual three-day exhibition, conference and awards dinner.

The show will be held for a second time at Aberdeen's P&J Live venue from February 23. Earlier this year, 185 companies exhibited with visitor numbers in excess of 6,600.

The 2021 event will focus on the resilience being demonstrated by organizations as they emerge from the double impact of COVID-19 and the low oil price and accelerate their energy transition strategies by embracing a green recovery to support a lower carbon future.

Neil Gordon, chief executive of Subsea UK, said: "The economic repercussions of the global pandemic have pushed companies to re-evaluate priorities and pivot their capabilities to safeguard their future. As well as examining their own sustainability credentials to support the race to net-zero, firms are redirecting their technologies and expertise towards the growing renewables market and the wider Blue Economy.

"As the offshore energy industry extends its reach into offshore wind, hydrogen and the development of carbon capture, utilization and storage, sharing knowledge and identifying opportunities will be key to future success. Subsea Expo 2021 offers a platform for companies to find out about opportunities in new and emerging markets, showcase their capabilities to existing and potential customers and network with their peers."

The call for speakers has officially opened with presentations being sought for four key themes: net-zero and energy transition; the digital age – speed and efficiency; subsea production systems and pipelines; and offshore renewables.

The deadline for submitting abstracts to present at Subsea Expo is October 9.

Entries for the Subsea UK Awards will also be accepted up to this date.

Details about the award categories, booking exhibition space and sponsorship opportunities are available on the Subsea Expo website. *www.subseaexpo.com*

JAN DE NUL REACHES MILESTONE FOR TAIWAN WIND FARM

» *Jan De Nul Group completed the installation of four medium-voltage export cables connecting the offshore wind farm to the shore, as well as the upgrade of the onshore substation in Changhua County. (Image credit: Jan De Nul)*

Jan De Nul Group reaches another significant milestone by completing the installation of four medium-voltage export cables connecting the offshore wind farm to the shore, as well as the upgrade of the onshore substation in Changhua County. This substation upgrade was essential for the connection of the first state-owned wind farm 'Taiwan Power Company Offshore Windfarm Phase 1 Project – Demonstration' to the Taiwanese power grid.

Jan De Nul's Cable-Laying Vessel *Willem de Vlamingh* successfully installed the four subsea export cables from the offshore wind farm site, 10 km off the coast, to the shore where they were connected at the landfall area near Fangyuan.

For the complex beach pull-in operations including passing over a shallow water sandbank, Jan De Nul Group teamed up with its Taiwanese partner Hung Hua Construction who provided essential marine equipment, including a jack-up barge.

Due to the presence of a nearshore oyster farm and an important shipping lane for fishermen on the subsea export cables route, the cables had to be pulled through 1-km-long underground ducts, which had previously been installed by horizontal directional drilling (HDD) up to 21 m below the seabed.

"Originally, the HDD's were stipulated in the contract to be 300 m long, but Jan De Nul decided to extend them in order to prevent any damage to the sensitive coastal zone and fish farms. As such, we demonstrate once more Jan De Nul's global care for the environment. Our offshore cable team did an amazing job, as did our onshore civil construction team who worked on the HDD together with Taiwanese companies Hung Hua and Magitech," says Jan Kop, Project Director at Jan De Nul Group.

In-House Developed Equipment Perform Trenching Works

After the cable installation, trenching works started. For the nearshore trenching works, Jan De Nul's Starfish excavators used an in-house developed plough-skid and jet-skid. For the offshore trenching operations, the Cable-Laying *Vessel Willem de Vlamingh* also acted as a Trenching Support Vessel.

Upgraded Substation In Da Cheng Is Ready To Receive Power

Together with its Taiwanese subcontractor Chung-Hsien Chen, Jan De Nul Group completed the installation and commissioning of new electrical equipment, including high voltage transformers, high-voltage and medium-voltage switchgear, a new SCADA control room and emergency power supply, inside the onshore substation in Da Cheng. This custom designed upgrade was essential for the substation to be able to receive power generated by the new offshore wind farm.

After passing a 24-hour energization test, the upgraded substation was successfully connected to the national grid for the first time in this new configuration.

Offshore Works Progress

In the meantime, the offshore foundation installation of 84 pin piles and 21 jackets is making steady progress and Jan De Nul Group's consortium partner Hitachi Ltd. continues preparing the wind turbines in the Taichung marshalling port. The turbine installation campaign, due to start in August, will feature Jan De Nul's Offshore Jack-Up Installation vessel *Taillevent*.

About 'Taiwan Power Company Offshore Windfarm Phase 1 Project – Demonstration'

The 'Taiwan Power Company Offshore Windfarm Phase 1 Project – Demonstration' was awarded to the Consortium Jan De Nul–Hitachi in February 2018.

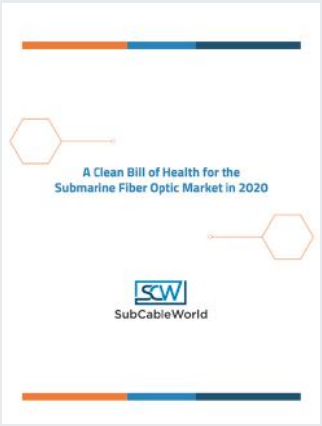
Jan De Nul Group is responsible for the full balance of plant, including design, fabrication and installation of the foundations, and the provision of the offshore vessel for the installation of the wind turbines. Also included is significant electrical scope, including the supply and installation of the cables both onshore and offshore, as well as upgrading an electrical substation.

Hitachi Ltd. is in charge of manufacturing, assembly, installation and other works related to the 21 Typhoon certified offshore wind turbines using a downwind rotor, each with a capacity of 5.2MW.

The Jan De Nul–Hitachi consortium is responsible for the first five years operation and maintenance (O&M) of the TPC Changhua offshore wind farm Phase 1.

» *For the complex beach pull-in operations including passing over a shallow water sandbank, Jan De Nul Group teamed up with its Taiwanese partner Hung Hua Construction who provided essential marine equipment, including a jack-up barge. (Image credit: Jan De Nul)*

» *Jan De Nul's Cable-Laying Vessel Willem de Vlamingh was used to connect the export cables to a landfall area near Fangyuan. (Image credit: Jan De Nul)*



SUBCABLEWORLD RELEASES UPDATED 2020 MARKET STUDY OF THE SUBSEA FIBER OPTIC CABLE MARKET

Report cites unprecedented band-width demand as key driver for growth amid the COVID-19 pandemic

SubCableWorld (SCW), a market intelligence resource for the global submarine cable industry, revealed details of an exclusive market report that forecasts continued growth for the submarine fiber optic cable industry amid the COVID-19 pandemic. According to the report, A Clean Bill of Health for the Submarine Fiber Optic Market in 2020, the industry shows no appreciable negative impact from the current global economic uncertainty, and 2020 will be the seventh consecutive year of dynamic growth for the industry, an unusually long period of consistency for a market known for its rapid boom and bust cycles.

Projections suggest that 2020 will be the third-highest yearly demand (kilometers of cable going to contract) since the current boom period began in 2014. Only the record-breaking years of 2014 and 2018 saw higher totals and those will only exceed SubCableWorld's 2020 forecast by 4% and 10%, respectively. The revised forecast for 2020 is 30% higher than the average demand over the previous six.

For more information visit: *https://tscstrategic.com/2020-fiber-optic-market-report*.

BALMORAL DEVELOPS OFFSHORE WIND CABLE PROTECTION SOLUTION

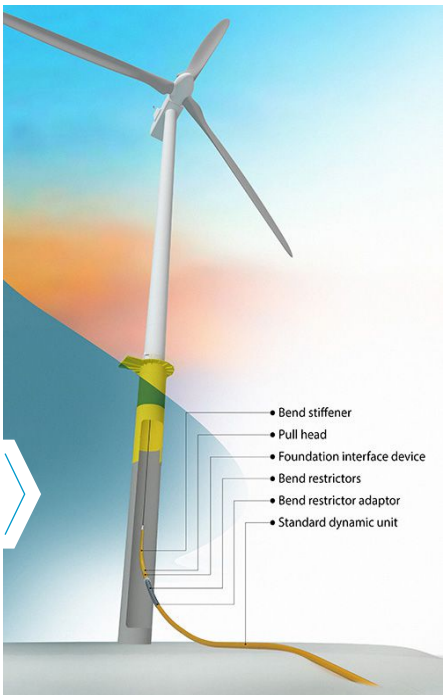
Multi-discipline engineering outfit Balmoral offers a range of cable protection systems (CPS) for inter array and export cables for fixed and floating offshore wind installations. The independent company's in-house Discovery Unit, a combination of product R&D, materials and testing specialists, has created an integrated CPS, which the company reports is unique.

The patented system, which is available in three standard sizes, includes a combination of bend restrictors and a bend stiffener, foundation interface device, standard dynamic unit and a detachable pull head, all of which is designed, manufactured and brought together in-house before being tested on the company's test rig.

Solutions for varying apertures on monopile installations are available as well as J-tube and I-tube options for jacket structures.

Dr. Aneel Gill, product R&D manager, says: "Our systems are designed based on the fatigue limit state (FLS) and offer something different because of their unique diverless removal feature and the ability to account for free span caused by scour development. Our patented fibre reinforced technology adds stiffness to the system controlling the curvature during the project lifespan. This reduces the amount of movement experienced by the cable, improving fatigue performance and greatly reducing the risk of failure through the life of field. The low weight components of the system permit efficient transportation, handling and assembly on deck. The system also allows for diverless removal of the CPS should cable maintenance be required."

» *Balmoral Patented Cable Protection System*



» *Balmoral CPS Test Rig*

Balmoral says it is totally committed to the renewables sector and has invested heavily in its engineering, manufacturing and testing services. It said the company's 40-year engineering and technical background was critical in creating the new CPS system.

Ian Milne, sales manager, comments: "With over 300 employees at our Aberdeen facility we retain an impressive complement of design engineers, project managers, R&D, laboratory and testing per-sonnel helping us maintain and strengthen our position as a leading subsea solutions provider for the energy sector."

Through an established global network, Balmoral is ready to bring the benefits of its system to the worldwide industry.

Milne continued: "From what we read in the press and glean from the available data, the scale of global opportunity is quite staggering. Considering what is already happening in Europe and the Far East, to the potential that lies off the coasts of North and South America, the industry offers great prospects for companies that are willing to invest in new technology and innovative solutions – something we've been doing at Balmoral for many years."

SUBMARINE NETWORKS WORLD CONFIRMS VIRTUAL EVENT IN NOVEMBER

With connectivity and bandwidth needs growing exponentially, demand for low latency, greater capacity and more flexible networks continues to escalate. Meeting this challenge will require agility, scalability and innovation. With global submarine cable capacity forecast to grow by 143% by 2022, the role of the undersea network as mission-critical infrastructure is clearly instrumental in supporting today's fast-paced global economy.

Unpacking what all this means for the subsea cable industry will be central to discussions at Submarine Networks World, the world's leading annual submarine communications gathering, which is set to take place from November 3-5. The two-day virtual event will stream exclusive live keynote speeches, presentations, panel debates and virtual roundtables via a series of topic specific channels. Over 120 speakers from leading cable owners and operators, consortium members, investors, financiers and technology providers across the world are scheduled to participate.

To find out more about the event agenda, visit *https://www.terrapinn.com/conference/submarine-networks-world/index.stm*

ARCTIC TELECOM CABLE PROJECT SET TO LAUNCH SEABED SURVEYS

Cinia Ltd, as part of the Cinia Alliance and in collaboration with MegaFon, are working on the preparations for the development project for the Arctic submarine cable project.

The objective of the multinational collaboration is to pave the way for a completely new telecommunications link to complement and secure other global connections. At the moment the Cinia Alliance involves partners from the Nordics and Japan.

The global economy increasingly depends on international telecom networks and logistics systems. The Arctic cable will increase the redundancy of the global networks significantly by providing a new route. Once complete, the Arctic cable will also offer the lowest-latency sea route between Europe and Asia.

Seabed surveys are an important part of the project works and these surveys are planned to be executed in different phases. In the first phase the preparations of the Arctic survey in the joint project are led by MegaFon, which has commissioned a research vessel that will now start transiting to the area. This seabed survey will begin in August and it is estimated to last three months.

Today, over 99 percent of international telecommunications runs through global submarine networks. The new over 10,000 km Arctic cable will provide high capacity and low latency in addition to increased network resilience to complement and secure existing connections. Currently, the global network backbone is lacking an optical submarine cable that connects Europe, the coastal regions of eastern and northern Russia, Japan and North America. The new cable route also supports the development of the Arctic region.

"Cinia has constructed 1,200 km of C-Lion1 submarine cable from Germany to Finland, which was launched in 2016. It proved our ability to lead and execute demanding multinational submarine projects. The Arctic cable is a sustainable and climate-conscious solution that will drive global, regional as well as local development," says Ari-Jussi Knaapila, CEO, Cinia Ltd.

» *Map of Arctic Connect*

» *C-Lion1 Cable Installation*

JDR TO CONDUCT ARRAY CABLE TERMINATION AND TESTING ON MORAY EAST OFFSHORE WIND FARM

» *Moray East - image from JDR cables*

JDR, the global subsea cable supplier and servicer owned by the TFKable Group, has agreed a contract with Boskalis to provide the termination and testing of 100 array cables and two offshore substation interconnector cables for the Moray East offshore wind farm off the coast of Scotland.

This award secures further UK content for the project and comes in addition to the supply of the 200 km of 66kV array cable and a range of termination accessories, which are currently being manufactured by JDR in its state-of-the-art facility in Hartlepool, UK. The scope of work includes the provision of technicians, tooling, and test equipment. JDR will perform procedures for the stripping of the armour protection, fitment of the permanent hang-offs, routing, cleating, electrical and fibre termination, including testing of the cables. As part of this contract JDR will also carry out Damped AC testing of the substation interconnector cables.

With the contracting of JDR for both the cable supply and the termination and testing works Boskalis will benefit from the continuity from production to installation, ensuring the integrity of the cables through final commissioning until energisation. The reduction in interfaces will also ensure a slicker operation and clearer scope demarcation.

Located 22 km off the coast of Scotland in the Moray Firth, Moray East, is a 950MW offshore windfarm that covers an area of 520 square km in water depths ranging from 37 m to 57 m. The project is being developed by Moray Offshore Windfarm (East) Ltd, a consortium of EDP Renewables (EDPR), Diamond Generating Europe (DGE) and Engie. This consortium contracted Boskalis for the supply and installation of the wind farm's inter-array cables.

Neil Brown, Head of Services at JDR, commented, "We're delighted to announce this contract win as this is our first-time providing termination and testing to Boskalis. This project win continues our increasing track record in the offshore installation market which is very important to us. It's a testament to the sheer hard work and diligence of our offshore teams who continue to produce high service levels for offshore projects such as this one."

The termination and testing works are due to commence in November 2020 and continue until mid-2021.

ROYAL NAVY TO USE DRONE TECHNOLOGY FOR FUTURE OPERATIONS

» *Autonomous and crewless technology from different companies was on show on board HMS Prince of Wales. (Photo credit: LPhot Dan Shepard)*

HMS Prince of Wales provided an impressive setting for the Future Maritime Aviation Force Accelerator Day this week, bringing together experts from the navy, MOD and industry to meet and discuss the vision for drone operations.

It comes as the navy seeks to develop and invest in the latest technology, bringing new, world-beating equipment to the frontline quicker.

Brigadier Dan Cheesman, Chief Technology Officer for the Royal Navy, co-hosted the event with Commodore Nick Walker, Deputy Director Naval Aviation, calling on attendees to consider how technology and innovation could transform the way the navy operates in the skies now and into the future.

The Future Maritime Aviation Force, Brig Cheesman said, was also about seeing how the Royal Navy could build-on and gain advantage from the pace of technological development already underway in the commercial sector.

"The aim is to transition rapidly from what we have now to whatever we want in the future.

"We live in an exponential world of technological change and if we can integrate the latest and get it on operations, it will deliver battle-winning advantage. Specifically, getting that technology onto ships like *HMS Prince of Wales* would be a game-changer.

"We are working in collaboration with companies like the ones here today to understand how they can help us move faster.".

Brig Cheesman added it should be the Royal Navy's goal that these new capabilities should be delivered in weeks and months, not years and decades as is currently accepted.

The work of the Royal Navy's NELSON digital acceleration lab supports this idea. They have continued the development the "plug in and play" MAPLE system that, when integrated onto Royal Navy ships, will simplify the process of accessing and using autonomous and un-crewed technology.

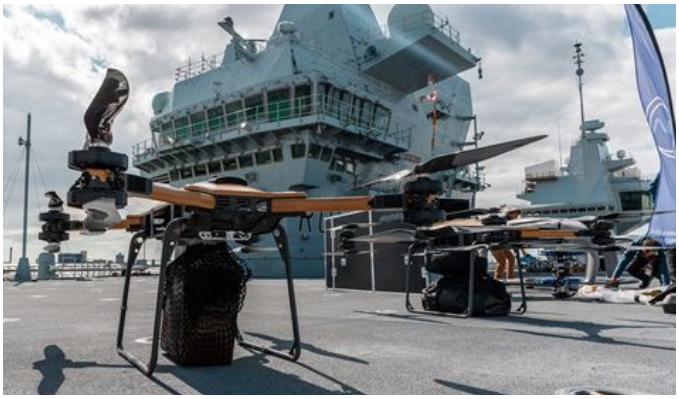
Trials earlier this year in Norway saw this system used on *HMS Albion* and last year on *HMS Argyll*. Going forward, all Royal Navy ships will possess open architecture, fully-networked, organic crewless aviation systems with *Prince of Wales* being at the forefront of a series of trials.

As previously announced by First Sea Lord Admiral Tony Radakin, this will see the aircraft carrier being used as a testbed for un-crewed aerial vehicles.

Commodore Nick Walker, Deputy Director of Navy Aviation, supported the importance of the speed of introducing new technology. Speaking onboard *HMS Prince of Wales*, he said: "When we have drones and other equipment routinely embarked on ships, that's when we really start to understand what they can do and get an idea of what we can achieve.

"We have to do it safely, in the right way and coherently, but I want to see the type of kit on display today on frontline operations within the year."

» *The event invited attendees to consider how technology and innovation could transform the way the Royal Navy operates in the skies. (Photo credit: LPhot Dan Shepard)*



» *The conference addressed the concept of using unmanned aerial vehicles on warships of the Royal Navy of Great Britain (Photo credit: LPhot Dan Shepard)*

» *MUSV boat (Image credit: L3Harris)*

L3HARRIS TECHNOLOGIES AWARDED MEDIUM UNMANNED SURFACE VEHICLE PROGRAM

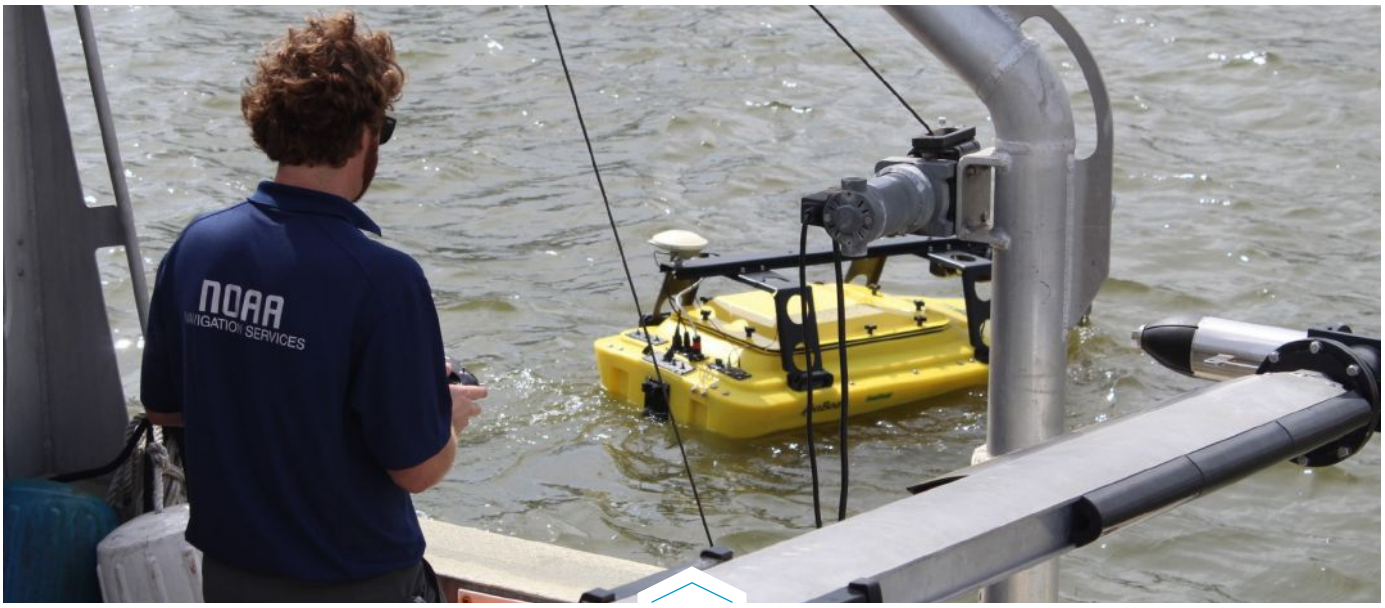
L3Harris Technologies has won a contract from the U.S. Navy for the Medium Unmanned Surface Vehicle (MUSV) program. This is the Navy's first program for an unmanned surface vehicle to support the Navy's Distributed Maritime Operations strategy.

The $35 million initial award is part of a $281 million program that includes a prototype and options for a total of nine MUSVs. L3Harris will integrate the company's ASView™ autonomy technology into a purpose-built 195-foot commercially derived vehicle from a facility along the Gulf Coast of Louisiana. The MUSV will provide intelligence, surveillance and reconnaissance to the fleet while maneuvering autonomously and complying with international Collision Regulations, even in operational environments.

"The MUSV program award reinforces our investments in the unmanned market and demonstrates our ongoing commitment to bring mission-critical capabilities to our warfighters," said Sean Stackley, President, Integrated Mission Systems, L3Harris. "L3Harris is continuing to develop a full range of highly reliable and affordable autonomous maritime capabilities to enable distributed maritime operations in support of the National Defense Strategy."

L3Harris will be the systems integrator and provide the mission autonomy and perception technology as the prime contractor on the program. The program team includes Gibbs & Cox and Incat Crowther who will provide the ship design and Swiftships will complete the construction of the vehicle.

L3Harris is a world leader in actively powered Unmanned Surface Vehicle (USV) systems, with over 115 USVs delivered worldwide. L3Harris' USVs are actively serving the Navy, universities, research institutions and commercial businesses.



» *New agreement seeks to expand the development and operations of unmanned maritime systems in the nation's coastal and world's ocean waters. (Photo credit: NOAA).*

NOAA AND U.S. NAVY TO EXPAND DEVELOPMENT OF UNMANNED MARITIME SYSTEMS

NOAA and the United States Navy have signed a new agreement to jointly expand the development and operations of unmanned maritime systems in the nation's coastal and world's ocean waters. This will enable NOAA to leverage the Navy's expertise, infrastructure, best practices and training to accelerate its science, service and stewardship mission.

"With the strengthening of our ongoing partnership with the Navy, NOAA will be better positioned to transition unmanned maritime technologies into operational platforms that will gather critical environmental data that will help grow the American Blue Economy," said retired Navy Rear Adm. Tim Gallaudet, Ph.D., assistant secretary of commerce for oceans and atmosphere and deputy NOAA administrator.

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

The Naval Meteorology and Oceanography Command's mission is to define the physical environment from the bottom of the ocean to the stars to ensure the U.S. Navy has freedom of action to deter aggression, maintain freedom of the seas and win wars. For over twenty years, Naval Oceanography has been a global pioneer in the development and use of unmanned systems.

"This agreement lays the foundation for collaboration, engagement, and coordination between NOAA and the U.S. Navy that our nation has never seen before," said RDML John Okon, Commander Naval Meteorology and Oceanography Command. "It will help us take advantage of each other's strengths to advance each of our strategic and operational mission priorities."

The new arrangement corresponds with rapid expansion and innovation in the use of unmanned systems across the government, academia and private enterprise. A timely example of how NOAA and the Navy are working together with unmanned systems is the ocean unmanned glider project to improve hurricane prediction. For the third year, NOAA, the Navy, academia and private industry are deploying unmanned ocean gliders from the Caribbean Sea to the eastern seaboard that demonstrate unmanned maritime system's observations can improve hurricane intensity forecasts.

The new pact formalizes the Commercial Engagement Through Ocean Technology Act of 2018, that directs NOAA to coordinate with the Navy on a wide range of functions including research of emerging unmanned technologies, protocols for acquisition of these systems, and sharing facilities for testing and evaluation. It is an annex to the broader NOAA and Navy Memorandum of Agreement signed in 2013.

Additionally, this agreement is among NOAA's follow up actions from the November 2019 White House Summit on Partnerships in Ocean Science and Technology and is an outcome of the NOAA Unmanned Systems Strategy. It also aligns with the Executive Order on Maintaining American Leadership in Artificial Intelligence.

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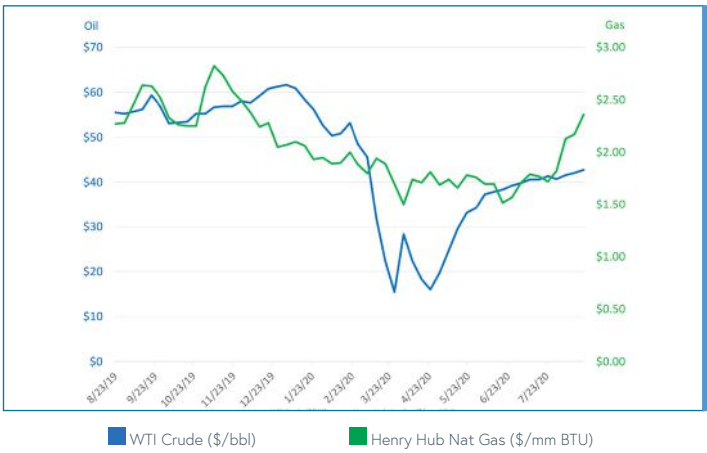
CRUDE & NATURAL GAS Spot Prices

PRICES IN US DOLLARS AS OF AUGUST 21, 2020

Oil prices continued their slow upward trend in the past month, with the West Texas Intermediate spot prices increasing by just under $2.00 per barrel. As of press time, the impact of hurricanes in the Gulf of Mexico is not yet clear, however. Reuters reported that prices moved upwards following indications that OPEC nations are keeping up their efforts to cut productions, but the increase has been slowed by concerns over weak demand.

The WTI spot price closed at $42.73 per barrel on August 21. Prices moved upwards in all but one of the previous eight weeks, but the overall change during that period was less than $3.00 per barrel.

Meanwhile, natural gas prices finally began moving upward after reaching historic lows. The Henry Hub spot price moved passed $2.00 per million British thermal units (MMBtu) for the first time since January. In the past month, the Henry Hub spot pricing moved upwards by more than $0.50 MMBtu, the biggest monthly increase this year. According to CNBC, greater demand for cooling counteracted the continued downward push of high supply levels.



WEEKLY WTI CRUDE & NATURAL GAS SPOT PRICES

Last 52 Weeks

WTI Spot Price

$42.73

$40.56 previous month

TRENDING UP

Henry Hub Spot Price

$2.36

$1.79 previous month

TRENDING UP

KEY EQUITY Indexes

PRICES IN US DOLLARS AS OF AUGUST 24, 2020

The Dow Jones Industrial Average (DJIA) and S&P 500 continued to push upward in the past month, nearing or surpassing levels from before the COVID-19 pandemic. The DJIA moved past the 28,000-point mark in late August and is less than 1,000 points from the record levels it was seeing in early February. The S&P moved into record territory during the same period, nearing the 3,500-point mark. CNN reported that the Fed's indications that it will keep interest rates low attributed to the recent surge in both indexes.

The Philadelphia Oil Services Index (OSX) continued its moving slowly upward in the past month to close at 35.58 points on August 24. It has generally trended upward since a low point in the low 20s in March, but is still well below the mid-60s that it was seeing at the start of the year.

SELECTED EQUITY INDEXES

CUMULATIVE PERCENTAGE CHANGE

Last 52 Weeks

28,492.27

Up **1,849.68** from previous month

TRENDING UP

DJIA

35.58

Up **2.78** from previous month

TRENDING UP

OSX

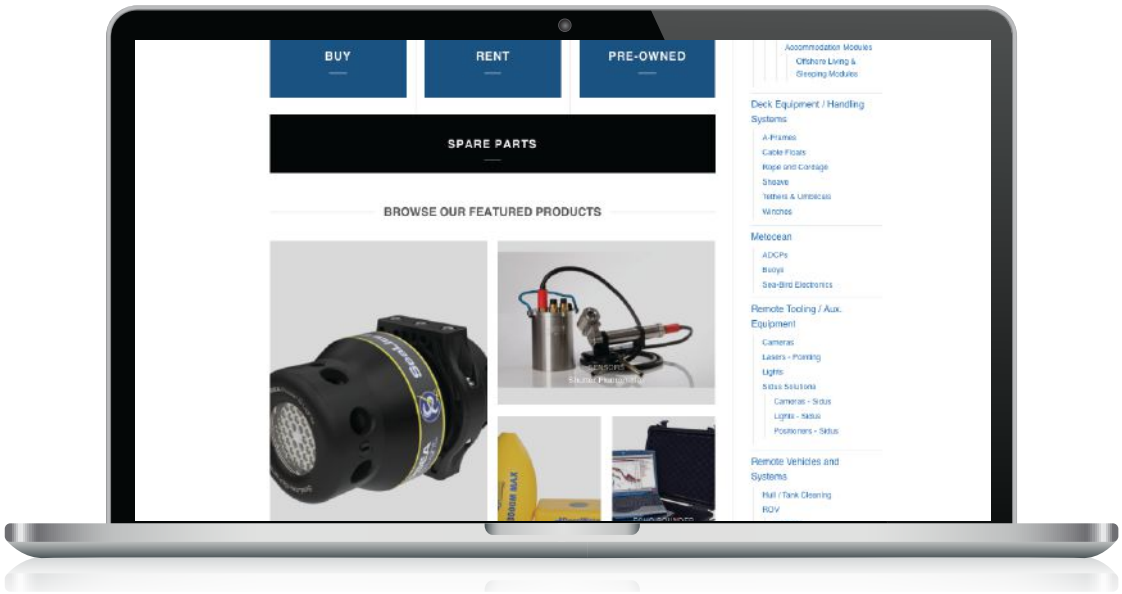
3,484.55

Up **287.03** from previous month

TRENDING UP

S&P 500

SeaCatalog



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SUMMER IS PRODUCING DIVERGENT ENERGY TRENDS

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

CRUDE OIL:

The forces driving crude oil prices are certainly confusing. As we pointed out last month, the reopening of the U.S. economy continues, albeit bumpy. Numerous states that reopened and whose economies were trending upward, were forced to retreat when coronavirus outbreaks emerged. The number of new cases has climbed nationally, partly due to increased testing, but also because people failed to practice social distancing. These backward steps have hurt the trajectory of oil demand, although air travel surprisingly seems to be steadily increasing. Around the world, various countries that were early in facing the COVID-19 virus, and beat it down, are now experiencing upticks in cases, raising concerns about a second wave of infections. Their governments are responding by reinstituting partial lockdowns, which will not help oil demand's recovery.

While demand remains uncertain, the trajectory is higher. This increases the pressure on successfully managing crude oil supply. Oil prices remain in a narrow range just over $40 a barrel. Price stability has been helped by OPEC members adhering to their reduced output quotas. As the organization debates increasing its output further, it remains frustrated by the continued cheating of several members. Stories of U.S. producers restarting shut-in wells from March and April further frustrates OPEC seeking to lift oil prices to help members meet their budgetary needs. OPEC's frustration over producers' willingness to restart production at such a low oil price reflects their failure to appreciate how low operating expenses for these wells are, making them profitable at current prices. What we haven't witnessed is an uptick in new oil well drilling, which is highly sensitive to current oil prices, and importantly, projections for future prices.

Saudi Arabia has recently said it expects global oil demand to reach 97 percent of pre-COVID-19 levels, or only a 3-million-barrel shortfall by December. However, other energy researchers predict the slowing of economic activity will hold demand 7-9 million barrels below last January's level. A 4-6-million-barrel demand gap could be the difference between prices in the $40s or maybe $60s. We likely need another month of data before having confidence in which outcome will prevail.

NATURAL GAS:

The optimism for higher gas prices that emerged last month seems to be in control of the market now. In the past month, helped by a heat wave that swept across the U.S., natural gas futures prices jumped by roughly 45 percent. Moreover, this momentum continues, as reflected in the natural gas futures price curve. The price for January 2021 gas, in the height of winter's heating demand, points to a further 35 percent gain. If we view the futures price a year from now, they are trading around $2.80 per thousand cubic feet, nearly 16 percent higher than now. Although 12 months away, the tone of the gas market is encouraging for producers.

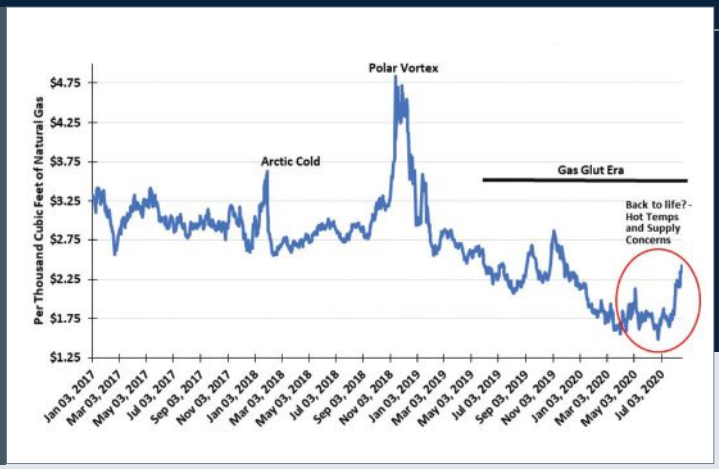
Has something fundamentally changed to drive gas prices up? Or, is it merely speculation? The answer to both questions is yes. After years of dismal gas prices due to surging supplies, market fundamentals are changing. Lower crude oil prices, and the prospect they remain low well into 2021, is taking a toll on associated natural gas output from oil wells.

The old mantra that the cure for low commodity prices is low commodity prices seems to be working. Low gas prices discourage explorers from seeking new supplies. However, the significance of associated natural gas output, which is tied to crude oil production and crude oil prices, cannot be underestimated. The growth of that supply distorted the commodity mantra, at least as it was applied to natural gas. Now that crude oil prices are low, discouraging new oil well drilling, the production decline curve is causing oil output to fall, along with associated natural gas volumes.

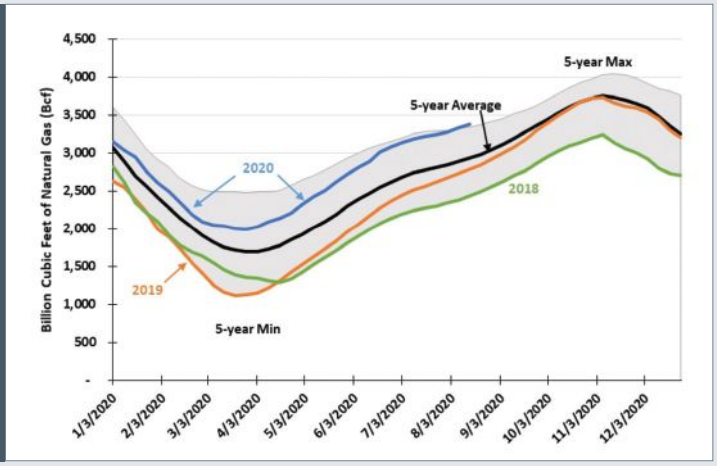
Contributing to the perception of a tighter natural gas market has been the combination of lower weekly gas storage injections at the same time LNG shipments fell. Weak international gas prices this spring, in addition to high storage volumes abroad, due to economic lockdowns and warm winters, caused gas customers to cut back LNG shipments. They are ramping up now, in anticipation of increased gas use in Europe and Asia, as economic activity improves and winter demand looms. More LNG shipments, coupled with increased gas use from greater air conditioning during hot weather, is boosting demand at the same time gas supply is shrinking.

The gas market is signaling it anticipates associated natural gas supply being limited this winter. Higher prices signal more supply (increased gas drilling) and a slowdown in consumption are needed. How high gas prices go depends on a myriad of factors. Will shale drilling rebound, adding more associated natural gas supply? Will hurricanes cause supply and/or demand disruptions? What happens to international gas prices and LNG shipments? How much of the recent price rise has been driven by speculators counting on the perception of an ever-tightening gas market? But the key question is: When will speculators decide they've made enough money?

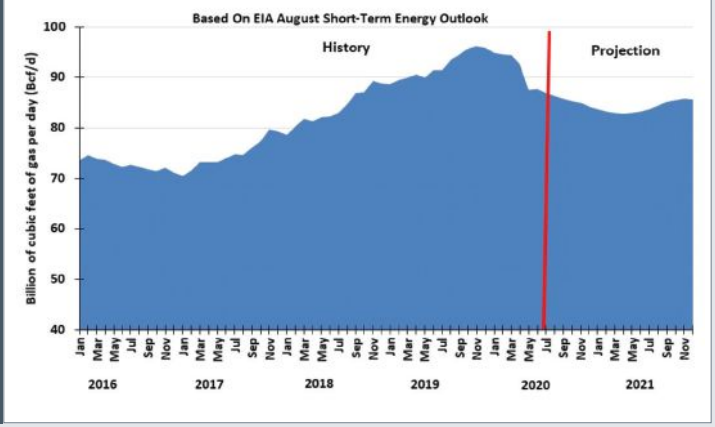
2020 Natural Gas Prices: They Are Now Heading Higher



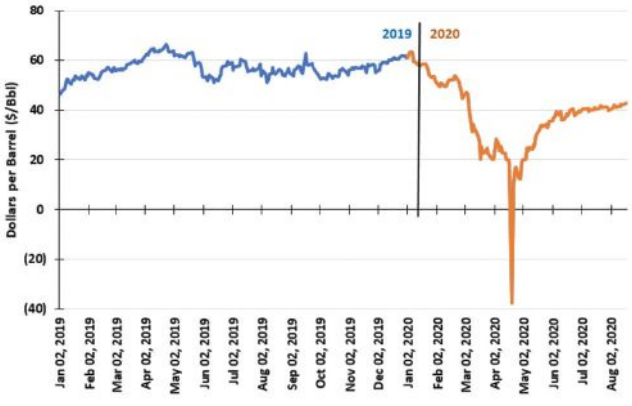
Low Prices and High Output Rebuilt Gas Storage



Dry Natural Gas Production Monthly 2016-2021



How Oil Prices Have Trended in 2019 and 2020



AMERICAS

Underwater Mining Conference
St. Petersburg, FL » Sept. 27 - Oct. 2
www.underwatermining.org

AUVSI XPONENTIAL
Virtual » Oct. 5-8
www.xponential.org/xponential2020

AWEA Offshore WINDPOWER
Virtual » Oct. 13-14
www.awea.org/conferences/awea-offshore-windpower-conference

Global OCEANS 2020
Virtual » Oct. 5-30
global20.oceansconference.org

BlueTech Week
Virtual » Nov. 16-20
www.tmabluetech.org/bluetech-week

PTC
Honolulu, HI » Jan. 17-20, 2021
www.ptc.org/ptc21

Oceanology International Americas
San Diego, CA » Feb. 15-17, 2021
www.oceanologyinternationalamericas.com

Floating Wind Solutions
Houston, TX » Feb. 25-26, 2021
https://floatingwindsolutions.com

Offshore Wind Executive Summit
Galveston, TX » March 2, 2021
www.offshorewindsummit.com

EUROPE

Offshore Energy
Amsterdam, The Netherlands » Oct. 27-29
www.offshore-energy.biz/offshore-energy-2020/

All-Energy
Glasgow, UK » Nov. 4-5
www.all-energy.co.uk

Ocean Energy Europe
Brussels, Belgium » Dec. 1-2
www.oceanenergy-europe.eu/annual-event/oee2020

Oceanology Int'l
London, UK » Dec. 1-3
www.oceanologyinternational.com

Deep Sea Mining Summit
London, UK » Dec. 7-8
www.deepsea-mining-summit.com

UDT
Rotterdam Ahoy, The Netherlands » Dec. 8-10
www.udt-global.com

SMM
Hamburg, Germany » Feb. 2-5, 2021
www.smm-hamburg.com

Upstream Digital Transformation Europe
London, UK » Feb. 10-11, 2021
www.offsnet.com/udt-eu

Submarine Networks EMEA
London, UK » Feb. 16-17, 2021
www.terrapinn.com/conference/submarine-networks-world-europe/index.stm

Subsea Expo
Aberdeen, UK » Feb. 23-25, 2021
www.subseaexpo.com

OTHER REGIONS

Telecoms World Middle East
Virtual » Oct. 13-14
www.terrapinn.com/conference/telecoms-world-middle-east

Telecoms World Asia
Virtual » Oct. 28-29
www.terrapinn.com/conference/telecoms-world-asia

Submarine Networks World
Virtual » Nov. 3-4
www.terrapinn.com/conference/submarine-networks-world

ADIPEC
Virtual » Nov. 9-12
www.adipec.com/virtual

MAST Asia
Tokyo, Japan » Nov. 9-11
www.mastconfex.com/asia2020

Offshore Well Intervention Australia
Perth, Australia » Feb. 9-10, 2021
https://offsnet.com/owi-aus

Underwater Technology (UT)
Tokyo, Japan » March 1-4, 2021
www.ut2021.org

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» Submersibles	Cranes & Winches; LARS & Control Systems; Sensors, Profilers & Measurement; Thrusters; Umbilical, Tether, Cables & Connectors	AUVSI XPONENTIAL » October 5-8
SEPTEMBER		
» Marine Renewables	Current Meters / ADCP, Wave / Metocean Buoys, Bottom Survey Equipment, Cable Protection Equipment, Inspection Services and Equipment, Service Vessels, Materials and Coatings, Installation Equipment	AWEA Offshore WINDPOWER » October 13-14 Offshore Energy » October 27-29 Ocean Energy Europe » December 1-2
OCTOBER		
» Ocean Science & Technology	Acoustic Modems; Acoustic Releases, Transponders, Command & Control Systems; Oil Spill Prevention; Oceanography Tools, UW Video Cameras	Global OCEANS 2020 » October 5-30
NOVEMBER		
» Maritime » Tracking and Positioning	Transponders / AIS; S/P Power Systems; Workboats & Supply Vessels	UDT » December 8-10
DECEMBER		
» Future of Ocean Technology	Ocean Technology	TBD

SeaState

THE ON&T PODCAST

SEASON 1 / EPISODE 4

OCEAN MAPPING:
A LOOK AT MAPPING THE SEAFLOOR

In ON&T's next episode of SeaState we chat with Dr. Larry Mayer, who is a professor and director of the Center for Coastal and Ocean Mapping at the University of New Hampshire. He graduated magna cum laude with an Honors degree in Geology from the University of Rhode Island in 1973 and received a Ph.D. from the Scripps Institution of Oceanography in Marine Geophysics in 1979. At Scripps, he worked with the Marine Physical Laboratory's Deep-Tow Geophysical package, applying this sophisticated acoustic sensor to problems of deep-sea mapping and the history of climate. After being selected as an astronaut candidate finalist for NASA's first class of mission specialists, Larry went on to a Post-Doc at the School of Oceanography at the University of Rhode Island where he worked on the early development of the Chirp Sonar and problems of deep-sea sediment transport and paleoceanography. In 1982, he became an assistant professor in the Dept. of Oceanography at Dalhousie University and in 1991 moved to the University of New Brunswick to take up the NSERC Industrial Research Chair in Ocean Mapping. In 2000, Larry became the founding director of the Center for Coastal and Ocean Mapping at the University of New Hampshire and the co-director of the NOAA/UNH Joint Hydrographic Center.

Larry has participated in more than 90 cruises (over 70 months at sea!) during the last 35 years, and has been chief or co-chief scientist of numerous expeditions, including two legs of the Ocean Drilling Program and eight mapping expeditions in the ice-covered regions of the high Arctic. He has served on, or chaired, far too many international panels and committees to mention here, and has the requisite large number of publications on a variety of topics in marine geology and geophysics. He is the recipient of the Keen Medal for Marine Geology and an Honorary Doctorate from the University of Stockholm. He was a member of the President's Panel on Ocean Exploration, National Science Foundation's Advisory Committee for the Geosciences, and chaired a National Academy of Science Committee on national needs for coastal mapping and charting as well as the National Academies report on the impact of the Deepwater Horizon Spill on ecosystem services in the Gulf of Mexico. He was the co-chair of the NOAA's Ocean Exploration Advisory Working Group, and the vice-chair of the Consortium of Ocean Leadership's Board of Trustees, and is currently the Chair of the National Academies of Science's Oceans Studies Board, a member of the State Dept.'s Extended Continental Shelf Task Force and the Navy's SCICEX Advisory Committee. In 2016, Larry was appointed by President Obama to be a member of the Arctic Research Commission; in 2017, he was elected to the Hydrographic Society of America Hall of Fame; in 2018, he was elected as a member of the National Academy of Engineering; and in 2019 he was elected as a foreign member in the Royal Swedish Academy of Sciences.

Larry's current research deals with sonar imaging and remote characterization of the seafloor as well as advanced applications of 3-D visualization to ocean mapping problems and applications of mapping to Law of the Sea issues, particularly in the Arctic. *www.oceannews.com/seastate*

» *Dr. Larry Mayer is the founding director of the Center for Coastal and Ocean Mapping at the University of New Hampshire and the co-director of the NOAA/UNH Joint Hydrographic Center.*

» *In 2016, Larry was appointed by President Obama to be a member of the Arctic Research Commission.*

2G ROBOTICS ANNOUNCES CEO LEADERSHIP TRANSITION

Jason Gillham, founding CEO of underwater laser scanner and imaging systems specialist, 2G Robotics, is stepping down from his role at the company as of August 2020.

He will remain available to the board of directors and to parent company Sonardyne Group during the leadership transition period. Chris Gilson, 2G Robotics' Product Development Manager, will take over as Acting General Manager.

Founded in 2007 and headquartered in Ontario, Canada, 2G Robotics is a leader in mobile scanning and imaging technologies that improve the speed and accuracy of subsea inspection using remotely operated vehicles (ROVs), autonomous underwater vehicles (AUVs) and manned submersibles.

Under Gillham's leadership, the company pioneered the use of lasers to generate high-density point clouds that help identify small features, defects and collect precision measurements for a variety of survey tasks. The company counts amongst its global user base those working within offshore survey and structural monitoring, marine archaeology, and mine detection and classification.

Gillham says, "I am incredibly proud of the market and technology leadership we have undertaken and what the 2G Robotics team has accomplished. With the company now as part of Sonardyne Group, I look forward to seeing new leadership build on what we have created. I would like to thank the staff, customers and partners who have been part of the journey so far and trust they will continue to drive the company forward."

Stephen Fasham, 2G Robotics' chairman and Sonardyne Group's Chief Operating Officer, says, "Jason has put 2G Robotics on a great course for the future and he leaves behind a strong and empowered management team. We all owe him tremendous gratitude for the vision that started the company and his contribution to delivering a fantastic technology success story. We're working with the 2G Robotics team to deliver the next chapter and want to thank Chris for providing strong leadership during this transition."

» *Jason Gillham (left) and Chris Gilson with one of 2G Robotics' latest RECON line of payloads for light, modular AUVs. (Photo credit: 2G Robotics)*

2G Robotics was acquired by Sonardyne Group in early 2020. The acquisition was the latest step in Sonardyne Group's long-term growth strategy to build a family of companies with complementary products and services for the marine sector. As part of Sonardyne Group, 2G Robotics' product and service offering is already benefitting from its relationship with other group companies, which include Chelsea Technologies, EIVA, Sonardyne International Ltd. and Wavefront Systems.

WWW.2GROBOTICS.COM
WWW.SONARDYNE.GROUP

OCEAN SCIENTIFIC INTERNATIONAL LTD REACHES EXPORT MILESTONE

UK-based manufacturer of marine monitoring Systems Ocean Scientific International Ltd (OSIL) has achieved an export milestone for global sales. Now exporting to over 100 countries, OSIL's global customer base is ever expanding despite a challenging climate.

The 105th export country was Georgia with an order for Niskin Bottles and a Marine Nutrient Standards Kit shipped to an oceanographic laboratory for water quality monitoring. Other recent export sales include a 30 m Giant Piston Corer system to Korean Institute of Ocean Science & Technology (KIOST) for their on-going sediment sampling program; P-Series IAPSO Standard Seawater for precise salinity measurement and high-end instrument calibrations to Morocco; two 0.6 m Inshore Monitoring Buoys for remote collection of tide data to a survey company in Singapore and Nutrient Standards to a laboratory supply company in Trinidad for aquaculture purposes.

As global experts in the provision of tailored integrated systems for over 30 years OSIL produce scientific data collection systems for environmental monitoring in all marine situations, from shallow coastal waters to full ocean depth, but specialise in instrumented MetOcean data buoys, unique single or multi- parameter monitoring platforms, water column sampling equipment and seabed sampling equipment (complete with Launch and Recovery Systems (LARS)).

OSIL are also the world leading authorities in the field of salinity measurement, operating the IAPSO Standard Seawater Service, supplying industry standard Guildline salinometers, and producing a range of other calibration and nutrient standards.

PARADIGM LEAP DEVELOPS *THE PATHWAY TO DIVERSIFICATION* PROGRAM

Paradigm Leap have developed a bespoke program designed to initiate change in the Oil and Gas and Energy sectors. The innovative program has been formulated by industry experts for senior business executives who want to broaden their company's horizons. In these unprecedented times, Paradigm Leap believe that opportunity exists but requires harnessing through hard work, dedication and strategic thought. The team are passionate about leading the change and supporting companies to achieve their full potential.

The newly developed program will guide businesses through the Pathway to Diversification focusing on people, planet and profit. These three pillars of the program will underpin the process throughout, ensuring untapped potential is identified whilst positioning companies for successful change and sustainable clean growth. Diversification is about small significant changes that can be sustained in the market and bring stability to businesses.

At Paradigm Leap we believe strategic diversification comes in multiple forms. It can become overwhelming to hear Net Zero or Carbon Neutral messages associated with big investment by large companies. Initiatives like offshore platform electrification, wind farms, green hydrogen plants are relevant and the target of well-deserved attention, however, big investment does not fit the majority of the energy businesses. It does have a place, but is not fitting in the day-to-day activities of most UK businesses. Paradigm Leap recognize this and have developed a programme tailored to small and medium companies.

The Pathway to Diversification will take place over a structured two-week program, and will be presented and managed by leading oil and gas professionals with real experience of diversification. The first stage will be to identify opportunities through understanding the business, its capabilities and the target goals. Thereafter, the Paradigm Leap team will work with the company through a carefully developed process which will screen the opportunities and evaluate the viable options. A strategy will then be developed with a clear path for diversification. The outcome of the program will deliver clearly defined actions to achieve the goals and to identify the tools required to support the business.

» *The Pathway to Diversification will take place over a structured two-week program, and will be presented and managed by leading oil and gas professionals with real experience of diversification. (Image credit: Paradigm Leap)*

» *The newly developed program will guide businesses through the Pathway to Diversification focusing on people, planet and profit. (Image credit: Paradigm Leap)*

The time is now to implement targeted and sustainable change. Paradigm Leap's program will make sure that happens.

"The North Sea is at an inflexion point, combined with the global desire to combat climate change and the UK's ambition to achieve Net Zero by 2050. Now is the time to unlock opportunities. Key to this will be diversification into other sectors which will provide long term prosperity. This is the ideal time for the oil and gas supply chain and its technology innovators to identify, plan and deliver a diversification strategy," says Jakaria Rahman, Project Director for Paradigm Leap.

GENERAL DYNAMICS NASSCO "MOVER AND SHAKER" AWARD FOR PHOENIX MANAGER

Phoenix International Holdings Inc. West Coast Program Manager, Travis Niederhauser, has received the "Mover and Shaker" award from General Dynamics NASSCO for his involvement with the USNS Miguel Keith (ESB-5) temporary refloat and caisson salvage project.

This project was successfully completed over the span of one month from mid-July to mid-August of 2018 and included nearly 30 Phoenix diving and engineering professionals working side by side with teams from multiple companies.

Commenting on the award, Patrick Keenan, Phoenix President, stated, "The Phoenix family takes great pride in Travis' receipt of this award. He is a valuable employee whose leadership, work ethic, and expertise were instrumental in the success of the Miguel Keith refloat." He continued, "Dedicated professionals like Travis ensure that Phoenix remains an underwater solutions leader in the maritime industry."

» *Travis Niederhauser (left) with Mr. David Carver, President of General Dynamics NASSCO*

CSA OCEAN SCIENCES LAUNCHES RESEARCH VESSEL (R/V) DOLPHIN

CSA Ocean Sciences Inc. (CSA), a US-based marine environmental consulting firm, has revealed the latest addition to its coastal survey fleet, the R/V *Dolphin*. The 15 m multipurpose vessel has been specially configured to support marine geophysical survey. Building upon the capabilities of CSA's existing nearshore fleet, the R/V *Dolphin's* layout includes a large aft working deck, a raised wheelhouse with 360° viewing windows, and a spacious multi-use salon area below decks.

The vessel is powered by twin Detroit Diesel 8-71 motors and a 20 kW generator. On deck are two high speed integrated research winches, each with 6-pass slip rings to support custom instrument interfacing. Each winch is capable up to 1,500 lbs pull with electronic controls for local or remote operation. A 1,500 safe working load (SWL) articulating A-frame is located on the vessel's transom. The legs are spaced 3 m wide for the launch and recovery of large towed instruments. Two modular J-frames are incorporated on the outboard side of each cross member to provide additional tow points and wider spread for the simultaneous deployment of towed gear. The R/V *Dolphin* is currently configured to simultaneously tow a Transverse Marine Gradiometer (TVG) and side-scan sonar, with an additional magnetometer concurrently operating multi-beam, single-beam, and sub-bottom profilers, and an ultra-short baseline (USBL) transceiver.

The survey salon features an enclosed, climate-controlled cabin 7 m long by 3.5 m wide, and survey desks with three dedicated workstations. The port side has a small galley with full size refrigerator and the starboard side head is complete with shower. A server rack contains data acquisition computers, uninterrupted power supplies, and rack-mounted instrument accessories. Forward, two workstations are dedicated for protected species observers and/or client representatives. A cellular-based WIFI network supplies high speed internet throughout the entire salon deck. The vessel is complete with all mandated Health, Safety, Security, and Environment (HSSE) gear such as an emergency position-indicating radio-beacon (EPIRB), automatic identification system (AIS), search and rescue transponder (SART), life raft, immersion suits, and personnel locator beacons.

» *R/V Dolphin*

"The R/V *Dolphin* gives CSA the capability to perform surveys in coastal and nearshore environments to the highest specifications with a fully integrated vessel," stated Kevin Peterson, CEO of CSA. "This is a rugged, long range vessel that has been designed and outfitted with the latest technology and equipment to ensure safe and reliable operations in water depths ranging from hundreds of meters to shallow nearshore sites."

marine technology SOCIETY
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IEEE Oceanic Engineering Society
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ACOUSTIC SYSTEMS

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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.

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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.

Listen Now. The Ocean Sonics Way.

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Website: www.teledynemarine.com/reson/
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

NORTEK AS

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E-mail: inquiry@nortek.no
Website: www.nortekgroup.com

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.

BUOYS

METOCEAN TELEMATICS

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Fax: +1 902 468 4442
E-mail: emily@metocean.com
Website: www.metocean.com
Contact: Emily MacPherson

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, is one of the few drifter 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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Phone: +1 207 502 1400
Fax: +1 207 221 5718
E-mail: sales@deepwb.com
Website: www.DeepWaterBuoyancy.com
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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E-mail: info@nautilus-gmbh.com
Website: www.vitrovex.com
Contact name: Steffen Pausch

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.

Simple, reliable and affordable.

SUBSALVE USA
P.O. Box 2030
North Kingstown, RI 02852
Phone: 401 884 8801
Fax: 401 884 8868
E-mail: richard@subsalve.com
Website: www.subsalve.com
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
382 Chicopee Row
Groton, MA 01450
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E-mail: lee@articrays.com
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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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Kildare W91F780
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E-mail: apastor@cathxocean.com
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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Fax: 858 576 0219
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Website: www.deepsea.com

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
7352 Trade Street
San Diego, CA 92121
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E-mail: info@sidus-solutions.com
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

SOUTH BAY CABLE CORP
54125 Maranatha Drive
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Idyllwild, CA 92549
Phone: 951 659 2183
Fax: 951 659 3958
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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Fax: +1 805 487 0427
USA: +1 888 BIRNS 88 (+1 888 247 6788)
E-mail: service@birns.com
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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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E-mail: sales@birnsaquamate.com
Website: www.birnsaquamate.com
Contact: Michelle DeTerra

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.

SOURIAU - SUNBANK | CONNECTION TECHNOLOGIES

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Website: www.souriau.com
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.

DESIGN & ENGINEERING

HYDRO LEDUC NA, INC.

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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

DIGITAL EDGE SUBSEA, LTD

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Phone: +44 (0) 1229 206456
E-mail: john@digitaledgesubsea.com
Website: www.digitaledgesubsea.com
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.

Our version 5 software is currently in development and full details will be released soon...

EQUIPMENT RENTAL

OKEANUS SCIENCE & TECHNOLOGY, LLC

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Phone: 985 346 4666
Fax: 985 346 8444
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Website: www.okeanus.com
Contact: Benton LeBlanc

Okeanus is the premier rental provider for oceanographic and marine scientific research equipment utilized in nearshore and offshore projects around the world. Focused on providing industry-leading customer service, Okeanus offers advanced, high-quality technology coupled with knowledgeable and experienced staff that can deliver dedicated support regardless of a project's location.

SeaCatalog Vendor

FIBER OPTIC PRODUCTS/SERVICES

OCEAN SPECIALISTS, INC.

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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.

GYRO COMPASSES

KONGSBERG SEATEX AS

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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.

LIQUID STORAGE

AERO TEC LABORATORIES, INC. (ATL)

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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.

MARINE ENVIRONMENTAL CONSULTING SERVICES

CSA OCEAN SCIENCES INC.

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Contact: Gordon Stevens

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.

MARINE VENTURES INTERNATIONAL, INC. (MVI)

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Marine Ventures International, Inc. (MVI) provides high quality, marine environmental and technical experts to conduct coastal and offshore field operations worldwide. We leverage our wealth of talent and resources to bring you a customized team of independent contractors, subject matter experts and specialized equipment to get the job done. Our professionals work in a variety of sectors from submarine cable projects and engineering services to protected species observation and environmental consulting.

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

ADVANCED NAVIGATION
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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.

EVOLOGICS GMBH
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E-mail: sales@evologics.de
Website: www.evologics.de

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.

KEARFOTT CORPORATION
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Kearfott is a leader in the design, manufacture, and support of guidance, navigation, and motion-control products for the aerospace, defense, energy exploration, and unmanned system markets. For over 100 years, Kearfott has been committed to delivering the best, most innovative technology for guidance, navigation, and motion-control products. Its products guide spacecraft and strategic missiles, navigate autonomously undersea, provide navigation and fire control for ground vehicles, and control motion aboard aircraft. Kearfott is a subsidiary of Astronautics Corporation of America, a global leader in the design, development, and manufacture of avionics equipment and systems for the commercial and military aerospace industry.

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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.

RJE INTERNATIONAL, INC.
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Contact: Bruce O'Bannon

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

ASL ENVIRONMENTAL SCIENCES, INC.
Victoria, BC, Canada
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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.

RBR
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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.

ROMOR OCEAN SOLUTIONS
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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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Phone: +1 425 643 9866
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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.

ROPE

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Website: www.cortlandcompany.com
Contact: Slobodan Nikolic

Cortland designs, manufactures, and supplies technologically advanced synthetic fiber ropes, slings and synthetic fiber strength members. For example, we offer deep water synthetic fiber rope solutions, oceanographic mooring systems, synthetic reinforcing over braids, hair fairing to reduce drag / strumming, and in-line attachments or lifting points (cable grips).

Collaborating with customers, our team uses its experience in high performance materials and market knowledge to transform ideas into proven products. We continue to innovate fit-for-purpose synthetic solutions for the ocean sciences. Cortland is a part of the Enerpac Tool Group (NYSE: EPAC), a diversified industrial company. Visit us online at cortlandcompany.com.

SONAR SYSTEMS

EDGETECH
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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.

KLEIN MARINE SYSTEMS, INC.
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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!

SOUND VELOCITY PROBES/CTDS

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Fax: +47 56 11 30 69
E-mail: info@saivas.com
Website: www.saivas.no
Contact: Gunnar Sagstad

- STD/CTD, Sound Velocity probes/recorder with optional multi-parameter facilities; Turbidity, Fluorescence, Oxygen etc. The new CTD/STD model SD208 with wireless communication and high accuracy: 0.002 mS/cm, 0.002 °C.
- Precision pressure /depth (0.01% accuracy) and temperature sensors/recorders. Applications: hydrographic profilings, installation on ROVs and towed systems, etc. Robust and compact designs are combined with accuracy and "plug and play" compatibility. Output format for sonar equipment, e.g. EM1002, EM3000, SSP, HiPAP and Reson 8125.

SUBSEA FABRICATION

NEW INDUSTRIES
6032 Railroad Avenue
Morgan City, LA 70380
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Website: www.newindustries.com
Contact: Bill New

New Industries provides quality fabrication services to the offshore oil & gas and marine industries focusing on large diameter pressure vessels, suction piles, DNV buildings and deepwater subsea production equipment such as jumpers, PLETs, PLEMs and manifolds.

SUBSEA TECHNOLOGY

SUBCTECH GMBH
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Germany
Phone: +49 0 431 22039 880
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Safe and reliable Li-ion subsea batteries made in Germany for subsea oil & gas applications, measurement systems and vehicles (AUV/ROV). Marine measurement and monitoring technologies, such as high precision pCO2 gas analyzer and autonomous underway systems (FerryBox). SubCtech provides customized solutions to high industrial standards such as IPC-A-6xx class 3 and qualifications according to MIL-STD, ISO 13628-6 and API 17f.

UNMANNED MARITIME VEHICLES

GENERAL DYNAMICS MISSION SYSTEMS' BLUEFIN ROBOTICS PRODUCTS

553 South Street
Quincy, MA 02169
Phone: +1 617 715 7000
E-mail: adam.mara@gd-ms.com
Website: gdmissionsystems.com/underwater-vehicles/bluefin-robotics
Contact: Adam Mara

General Dynamics Mission Systems' Bluefin Robotics products provide undersea capabilities for defense, scientific and maritime customers worldwide. Bluefin Robotics products offer a range of systems and configurations that can operate in the open ocean and in constrained waterways. Our core autonomous product line includes Bluefin SandShark, Bluefin-9, Bluefin-12, and Bluefin-21, Hovering Autonomous Underwater Vehicle (HAUV), and Subsea Power technologies.

The Bluefin Robotics AUV family shares a free-flooded, modular, and open architecture backbone that has enabled the integration of 70+ sensors. We have developed and delivered AUVS worldwide to research institutes and industry and have provided AUVS to the United States' and International Navies.

INTERNATIONAL SUBMARINE ENGINEERING LTD. (ISE)

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International Submarine Engineering Ltd. (ISE) is a world leader in the design and integration of autonomous and remotely operated robotic vehicles and terrestrial robotics. Over our 40+ years in business, we have accumulated a great deal of expertise in the design, manufacture, and maintenance of:

- Autonomous Underwater Vehicles (AUVs)
- Remotely Operated Vehicles (ROVs) for subsea operation
- Human Occupied (HO) submersibles
- Customized systems for the offshore oil industry
- Customized systems for the Military-Naval sector
- Hydraulic, pneumatic, and electric robotic manipulators
- Teleoperated and autonomous robotic systems
- Robotic systems for nuclear Industry applications
- Communications and real-time control system

L3 HARRIS (OCEANSERVER)

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L3Harris Technologies is an agile global aerospace and defense technology innovator, delivering end-to-end solutions that meet customers' mission-critical needs. The company provides advanced defense and commercial technologies across air, land, sea, space and cyber domains.

L3Harris OceanServer develops autonomous, lightweight Unmanned Undersea Vehicles. L3Harris OceanServer has established itself as the leader in man portable UUVs, providing highly capable vehicles to a wide array of military, commercial and research customers. With over 15 years experience in the underwater field, our engineers have developed a reliable and easy to use platform that is trusted to complete marine missions all around the world.

MARISCOPE MEERESTECHNIK

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Website: www.mariscope.de
Contact: Niklas Becker

With more than 25 years of experience in the design, development and manufacture of ROV's and towed systems, Mariscope is one of the very few companies that can offer you really customized underwater solutions with actual integration. Instead of just adding accessories or instruments to our vehicles, we design, develop and manufacture the completely integrated solution to the client´s needs.

Mariscope offers from small towed systems or compact Observation Class ROVs up to complete multifunction units. The company also provides other solutions such as antifouling devices, side-scan sonars, oceanographic instruments for ports and offshore platforms (current/wave meters), or even manned submarines.

OUTLAND TECHNOLOGY

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Contact: Jeff Mayfield

Offering the most rugged equipment and unsurpassed customer service, Outland Technology has been the world's leading manufacturer of underwater video, lighting and ROV equipment for over 30 years. We recognize that no two jobs are the same and specialize in products that are customizable for your specific applications.

SEAMOR MARINE LTD.

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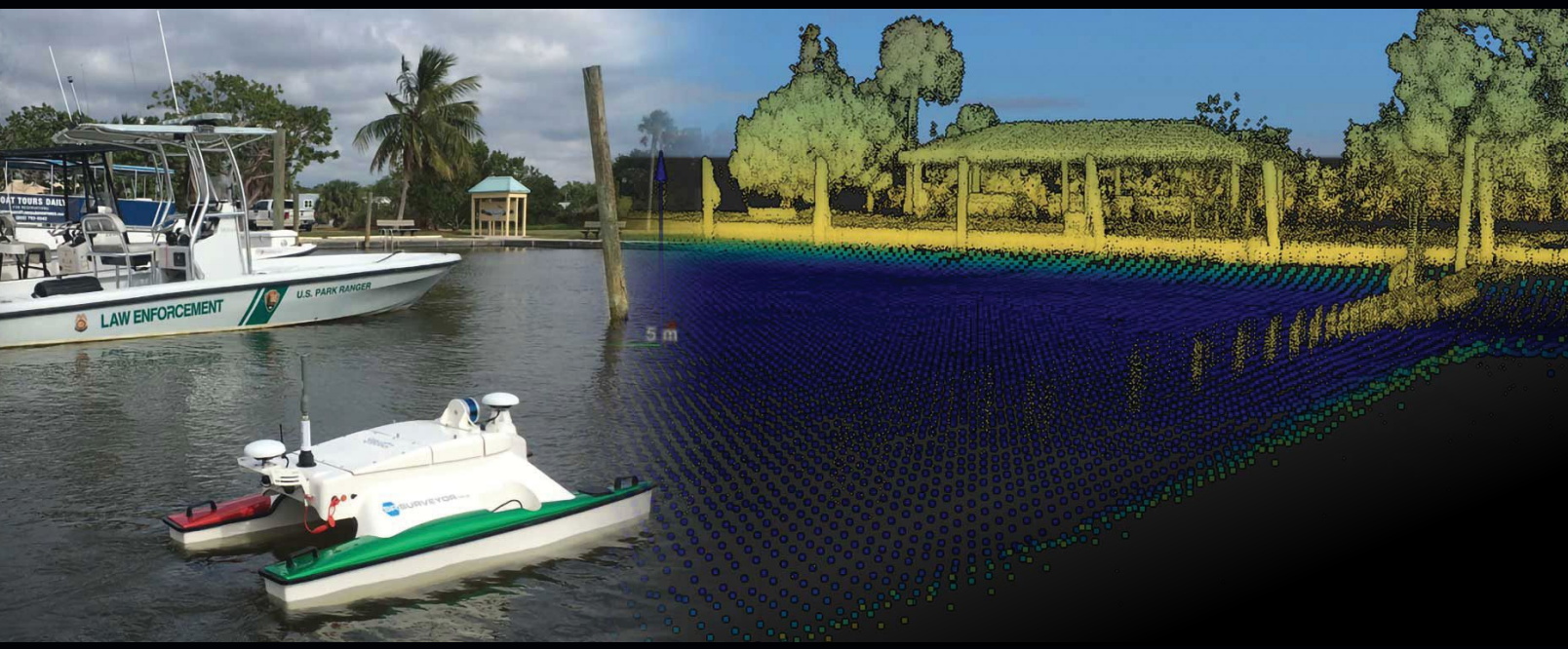

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