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**Update for Argos FLS
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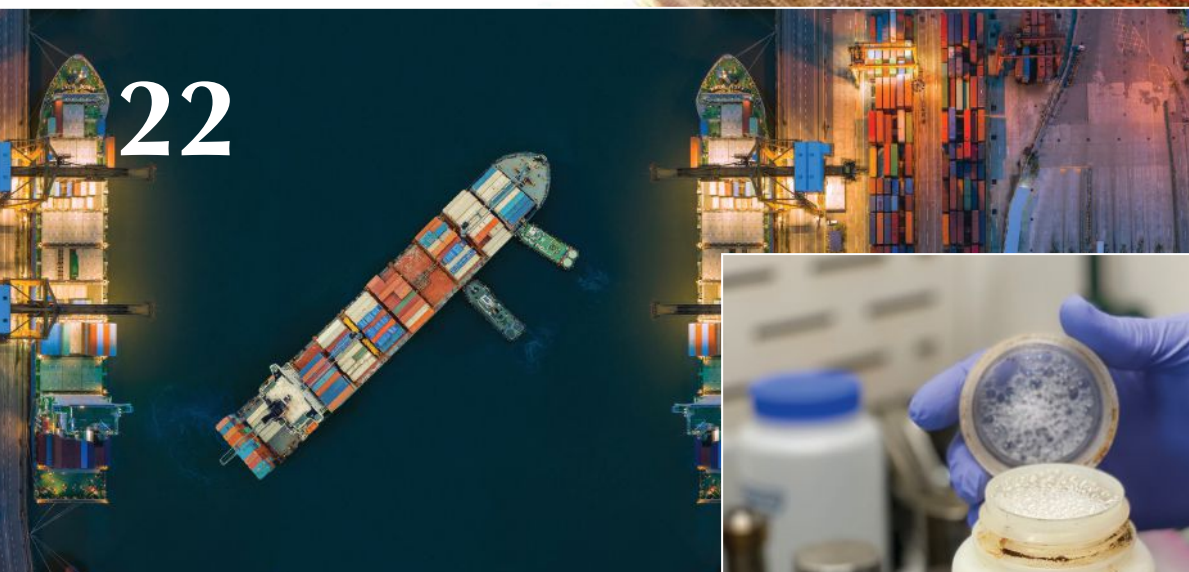
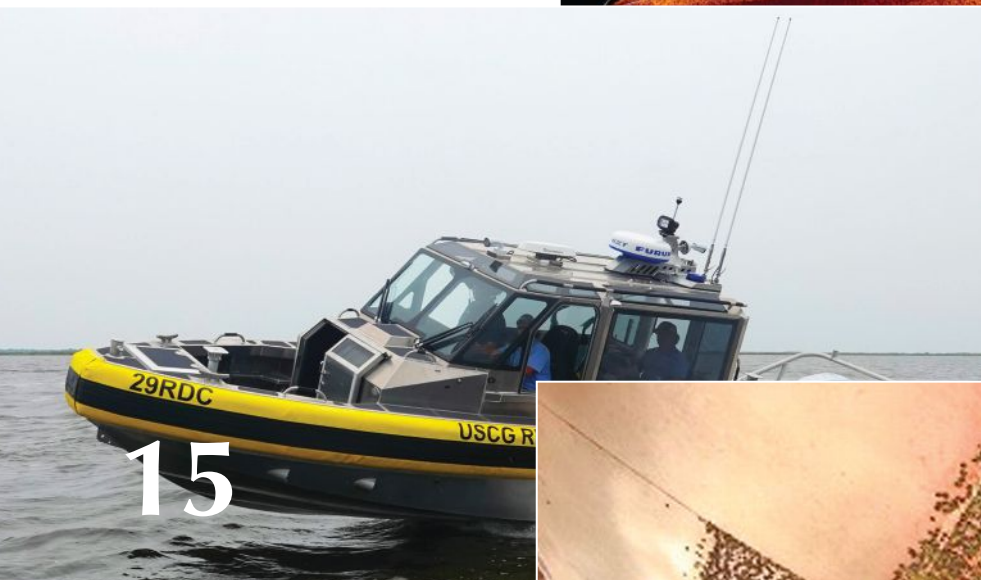
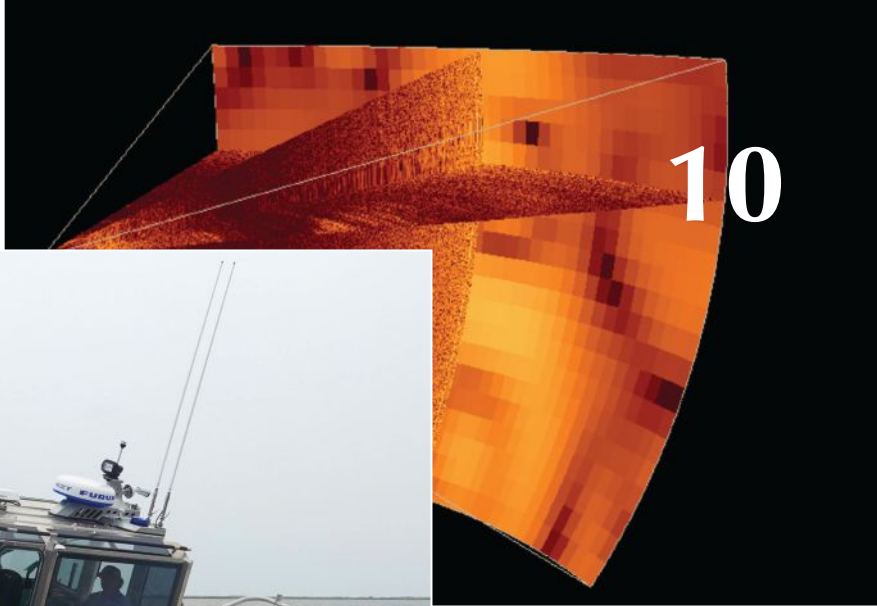
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COVER IMAGE

Advanced American Construction (AAC) performing marina dredging, dock pile driving and dock construction at the Port of Kalama in 2021, on the Columbia River between Oregon and Washington. Using a Trimble Marine Construction system, AAC was able to accelerate dredging to improve communication and achieve a more efficient daily burn rate. (Credit: Trimble Inc.)

NEXT MONTH

Low-impact alternative to hydropower-generated energy ... Web-based project management platform for Atlantic Shore offshore wind farm ... Unmanned systems for comprehensive ocean observation ... Fiber-optic monitoring for open-water aquaculture ... Direct Drive Electric.

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)) NOAA's 2021 US Climate Assessment. In NOAA's U.S. Climate Assessment for 2021, the average contiguous U.S. temperature was 54.5° F, 2.5° F above the 20th-century average and representing the fourth-warmest year in the 127-year period of record. The six warmest years on record have all occurred since 2012. The December contiguous U.S. temperature was 39.3° F, 6.7° F above average and exceeding the previous record set in December 2015. There were 20 separate billion-dollar weather and climate disasters in 2021, just two events shy of the record set in 2020. These events caused at least 688 fatalities and scores more injured. Two disasters occurred in December: the Southeast, Central Tornado Outbreak and the Midwest Derecho and Tornado Outbreak. The annual precipitation total for the contiguous U.S. was 30.48 in., 0.54 in. above average, ranking in the middle third of the historical record. However, 2021 saw an above-average monsoon season across the Southwest and several atmospheric river events along the Pacific Coast. Drought remained extensive across much of the western U.S. throughout 2021. That year was the third most-active Atlantic hurricane season on record. Above-average tropical activity across the Atlantic Basin occurred for the sixth year in a row. It was an active wildfire year across the western U.S., with more than 7.1 million acres consumed, 96 percent of the 10-year average. The U.S. Climate Extremes Index (USCEI) for 2021 was 115 percent above average and ranked third highest in the 112-year record, second highest when taking the tropical cyclone indicator into consideration. Warm extremes in both maximum and minimum temperature across much of the U.S. contributed to this elevated USCEI value. NOAA provides this annual U.S. climate assessment to government, business, academia and the public to support informed decision making: www.ncdc.noaa.gov/sotc/national/202113.

)) Singapore Retains Top Spot in Leading Maritime Cities Report. The 2022 Leading Maritime Cities (LMC) report provides fresh insights into which global hubs offer the best infrastructure, technology, finance and world-class talent to help the maritime community connect and prosper. Since the last edition of the LMC report was published in 2019, two years of fluctuating COVID pandemic-related restrictions have caused severe trade and travel upsets; extreme weather events have highlighted the climate crisis, another major driver of change; shipowners, charterers, cargo owners and lenders are gearing up for a decarbonized future, with rapid adoption of zero-carbon fuels expected over the next decade; and ongoing digitalization, including ports and the supply chain, will drive efficiency in support of this transition. The LMC report, compiled by DNV and Menon Economics, benchmarks each maritime city based on five key pillars: shipping, maritime finance and law, maritime technology, ports and logistics, and attractiveness and competitiveness. Singapore retains its number one spot overall in the latest report, followed by Rotterdam, London, Shanghai and Tokyo, respectively. Subjective indicators reveal the perceptions and assessments of 280 invited business executives, mostly shipowners and managers, from around the world. Looking five years ahead, they predict that Singapore will remain number one, with Shanghai coming in second. London, Oslo and Rotterdam are seen as leading the field in Europe, with Dubai and Abu Dhabi competing hard in the Middle East, India and Africa region. Dubai is predicted to grab sixth place overall by 2027. The experts see Singapore, Oslo, Shanghai and Copenhagen as best prepared for digital transformation, while Oslo tops the list for sustainable technologies and solutions for the oceans, followed by Singapore and Copenhagen. Download the report at: <https://tinyurl.com/yc2k3722>.

)) Tacoma Tideflats 5G Network Feasibility Study. Washington Maritime Blue and 5G Open Innovation Lab (5G OI Lab), in collaboration with two of its founding partners, Avanade and Amdocs, have published the findings and recommendations from the Tacoma Tideflats 5G Network Feasibility Study, which highlights how a private 5G network would enable the Tideflats to accelerate current and future technology innovation and establish global leadership in the maritime industry. It also lays the foundations for the Tacoma Tideflats to build and launch a private enterprise 5G network before the end of 2022. Maritime Blue is a Build Back Better Regional Challenge award finalist and will dedicate funding from this recognition to make the Tacoma Tideflats one of the first commercial ports in the U.S. to be an innovation and sustainability trailblazer, fueling a growing maritime economy and establishing a blueprint for other ports worldwide. Less than 10 ports around the world currently offer the speed, stability, security and scalability of a private 5G network. The Tacoma Tideflats covers more than 5,000 acres and is the base of port and terminal operations, industrial and manufacturing hubs and a critical marine ecosystem. View the study at: <https://maritimeblue.org/joint-innovation-projects/5g-feasibility-study>.

)) Large, Deep Coral Reef Discovery. A giant coral reef has been found off the coast of Tahiti, French Polynesia, in the Pacific Ocean at 30-m depth, BBC reported. The reef system extends for 2 mi. and is supposedly one of the largest ever discovered at that depth. The reef is in good condition, most likely because of its location in deepwater. The marine explorers who discovered the reef were on a mission to map the seabed in the region and were surprised at their discovery. "We still associate corals with the shallowest tropical seas, but here we find a huge, previously unknown coral reef system," said Professor Murray Roberts, a marine scientist from the University of Edinburgh. Coral reefs around the world show evidence of vulnerability to climate change. This newly discovered reef offers some hope that if reefs can survive at this depth, they may be better protected from global warming. **ST**

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The Financial Impact Of Climate Disclosures

The maritime sector faces dual challenges in relation to climate change: the need to reduce contributions to global warming and the need to adapt to the physical impacts of climatic change.

As an industry highly reliant on fossil fuels, much of the focus in maritime to date has been on decarbonization. The challenges include the transboundary nature of international shipping, the lack of commercial availability of alternative fuels, the high costs of retrofitting ships to electrified and hybrid systems, and the lack of clarity of potential regulations and guidelines.

Until recently, pressure to improve environmental, social and governance (ESG) performance has largely come from boards and environmental regulators. Pressure is increasing with the expectation that companies include ESG performance in their financial reporting, moving ESG from a corporate sustainability initiative to an integral part of annual financial and corporate risk reporting. Financial regulators and stock exchanges worldwide are issuing guidance emphasizing the importance of considering climate change, and maritime companies need to ensure they have an in-depth and accurate understanding of their ESG performance.

As a global maritime hub, Singapore has recently taken significant steps to ensure the companies trading in its ports and waters are making solid efforts to drive ESG initiatives. Last year, the Singapore Exchange (SGX) announced a series of ESG disclosure proposals (<https://bit.ly/31yuC5t>), including mandatory climate reporting, due to come into effect for shipping this year. Going forward, financial institutions will be demanding access to relevant environmental impact data that is rigorous, comprehensive and clear, ensuring ESG performance can be accurately assessed.

While many maritime companies have ESG strategies in place, the approach to climate risks remains in its infancy. Of note is an absence of substantive reporting on the physical risks of climate change and more extreme weather. Climate trends likely to affect the Singapore region have been identified by the government (www.nccs.gov.sg/singapores-climate-action/impact-of-climate-change-in-singapore), yet very few companies have publicly reported on the physical risks to their assets, operations and workforces.

The new climate risk disclosure process provides the impetus to build organizational awareness of climate change and an appropriate response toward net-zero emissions, and the requirement to actually disclose climate risks to shareholders and the public requires real investment in analyzing the risks and developing practical solutions. There are several measures that can be put in place now to ensure companies can meet these new requirements. One is to ensure key staff are familiar with the requirements and have the necessary training to enable them to create frameworks to ensure compliance without negatively impacting operations. Another is for companies to carry out thorough risk assessments across their assets and operations, allowing operators to create decarbonization and physical risk adaptation strategies that best meet the needs of the business. A key to enabling this will be the use of supporting technology to accurately assess operations and make informed decisions to ensure compliance and transparency while protecting profitability.

ESG-related disclosures are under an intensifying spotlight. Maritime companies must take steps to empower themselves with better decision-making capabilities and solutions that drive more sustainable operations. They can seize the opportunity not only to achieve compliance but also deliver confidence to their stakeholders that they are making a demonstrable impact in addressing climate challenges while keeping an eye on the bottom line. **ST**

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Annual Review & Forecast

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Instrumentation: Measurement, Processing & Analysis

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

MARCH

Electronic Charting/Vessel Management/
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**AUVSI XPONENTIAL 2022, April 25-28, Orlando, FL

APRIL

Offshore Technology/Alternative Energy & Ocean Engineering

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

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Editorial Calendar

UE DATE

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Seafloor Mapping/Sonar Systems/Vessels

JULY

Deck Gear, Cable, Connectors, Power Systems & Salvage

AUGUST

Geophysical Exploration/Seafloor Engineering

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

SEPTEMBER

Ocean Resources Development & Coastal Zone Management

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

OCTOBER

Environmental Monitoring, Remote Sensing & Pollution Control

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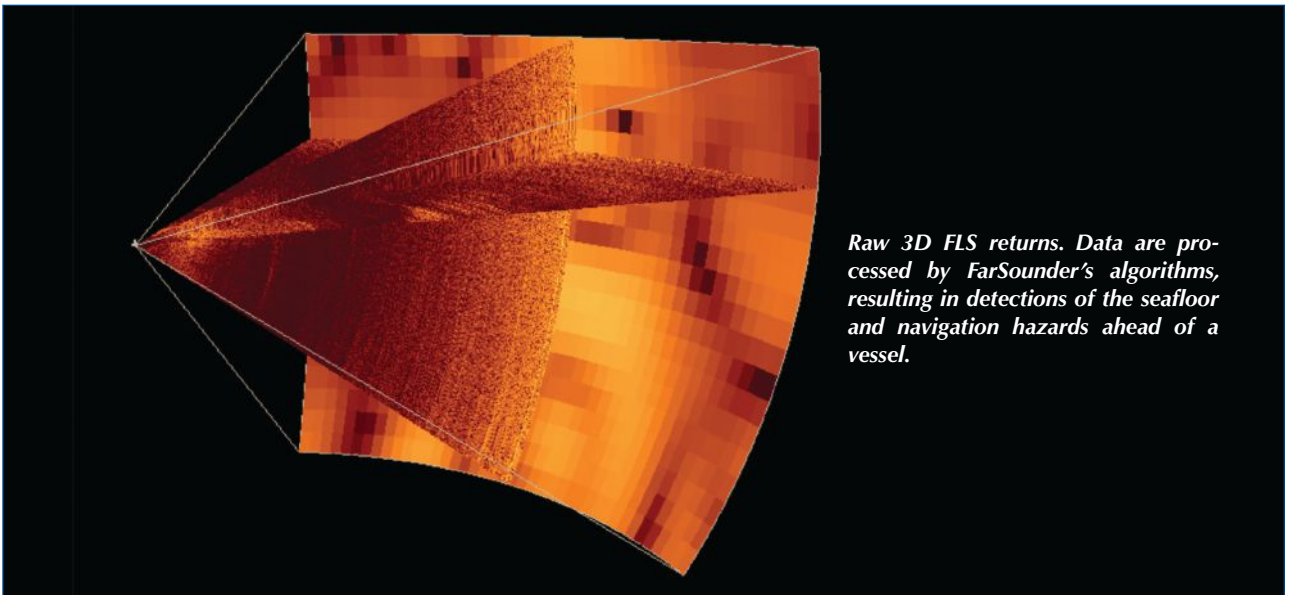
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Update for Argos

Software Collaboration Enhances Forward-Looking Sonar

By Dr. Heath Henley



On the evergoing journey to protect the ecosystem and keep vessels and passengers safe, FarSounder and Navtor are making an impact. They share the same core goals of improving ocean safety through innovation and technology while simultaneously keeping the focus on the customer.

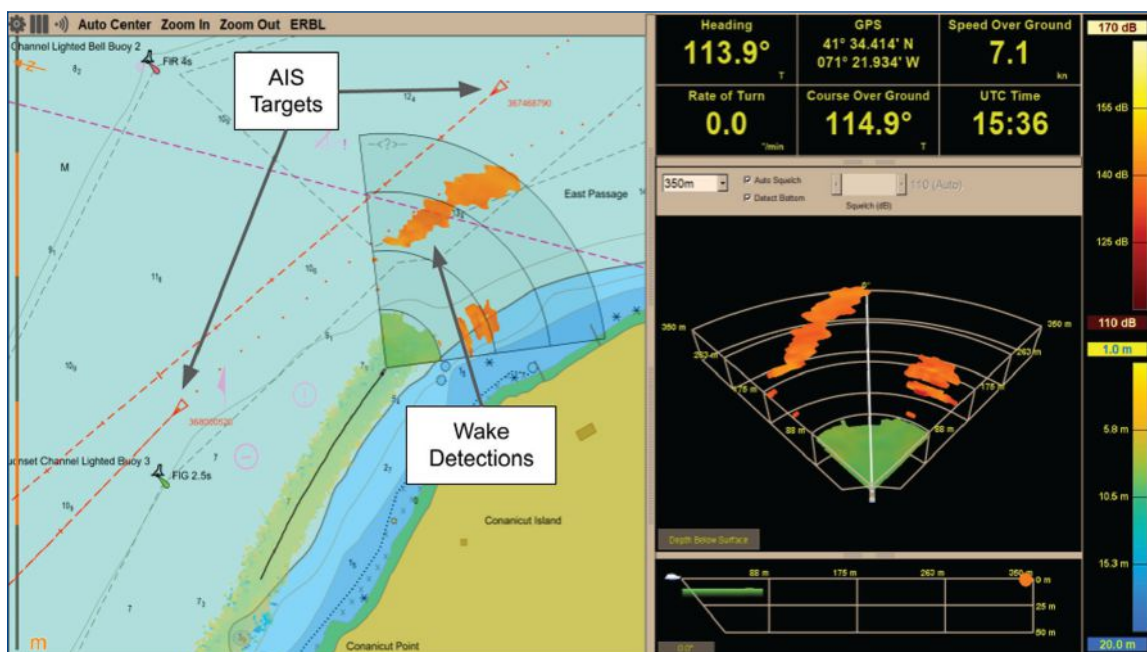
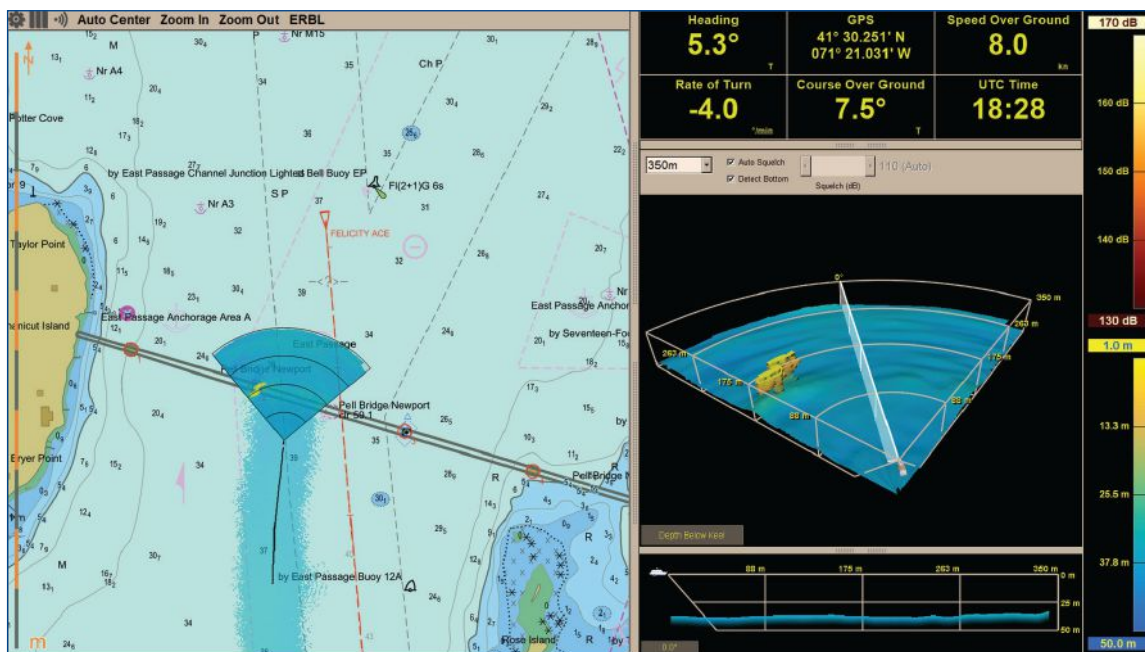
Navtor prides itself on creating e-navigation tools that are safe, simple and efficient. Similarly, FarSounder's Argos 3D forward-looking sonar (3D FLS) provides safe navigation by detecting many ocean obstacles via an easy to understand user interface. A partnership between the two companies brings an impactful software update for FarSounder's Argos FLS technology.

Argos FLS

For more than 20 years, FarSounder has been designing and manufacturing a 3D FLS for use in real-time navi-

gation. FarSounder's Argos 3D FLS improves the safety of everyday operations, enables users to explore less-traveled waters, and even allows users to contribute to global crowdsourced data initiatives. The Argos series of navigation sonars produced by FarSounder consists of three products, with the main differentiating factor between them being the maximum detection range. Argos 3D FLS systems can be found on expeditionary cruise ships, superyachts, and research and government vessels alike.

Argos sonars are typically installed at the bow, facing forward, at least 1 m below the waterline. They transmit acoustic signals ahead of the vessel and listen for the returned signal using an array of receivers. The returned signals can then be processed to determine the location of both the seafloor and any obstacles or navigation hazards in front of the vessel. The volume covered by the system, e.g., what the system can see, or its field of view,

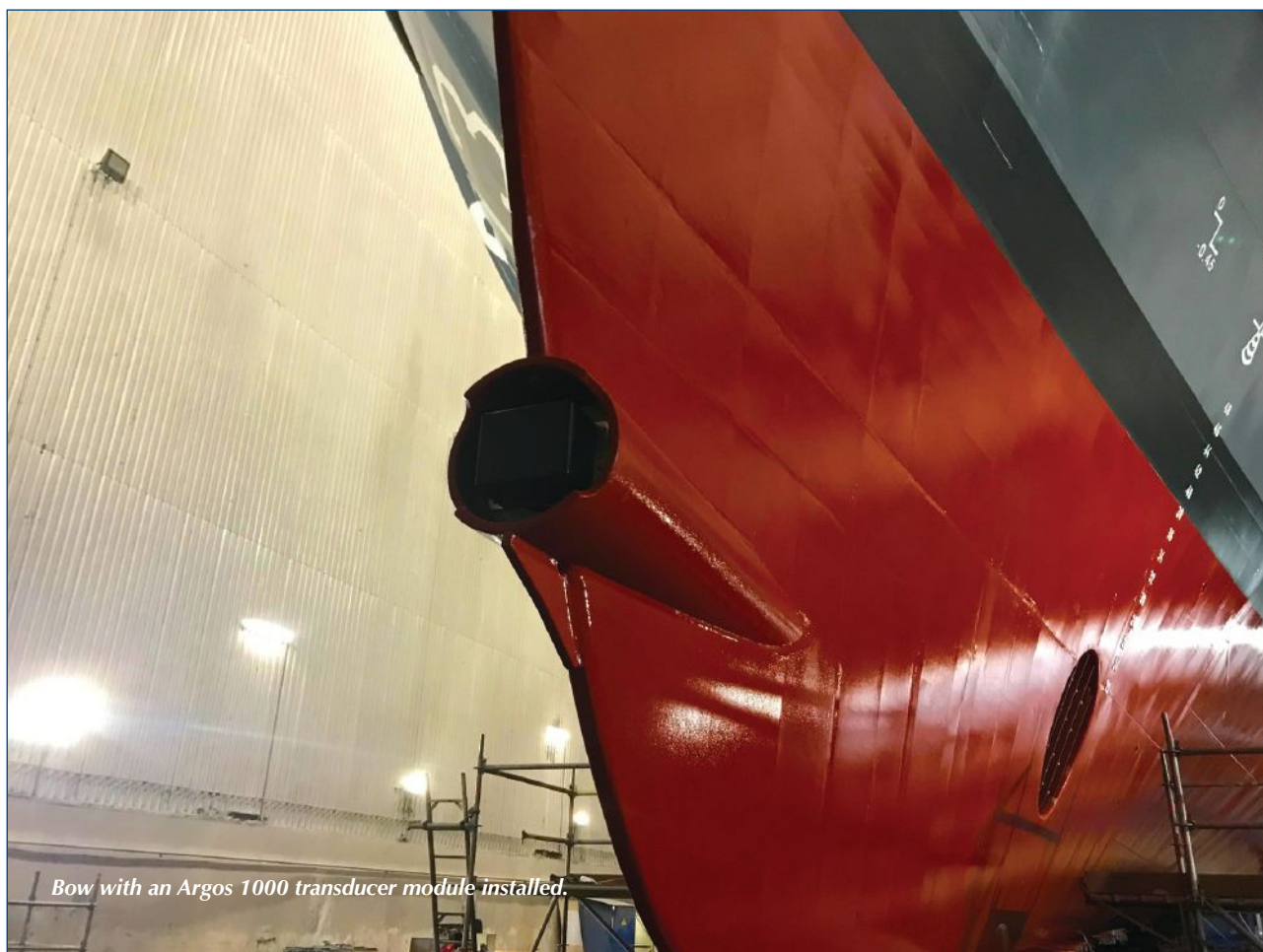


(Top) Chart View is on the left, 3D View on the right, depicting navigation past a bridge piling with an Argos 350 on a recent field test in Newport, Rhode Island. Another vessel approaching, the *Felicity Ace*, can be seen from the AIS target on the Chart Overlay. A number of detections can be seen corresponding to the pilings of the bridge and reflections from the seafloor. In this scenario, the chart agrees well with the Argos data. The Local History Mapping can be seen behind the vessel in the left-hand window of the figure. (Bottom) Operating near wakes with AIS in the Chart Display on a recent field test with an Argos 350 in Narragansett Bay, Rhode Island. In the example shown here, the operator is approaching a vessel's wake, which is detected as a line of in-water targets along the past track for the other vessel. Later on, as the wake was crossed, it degraded performance temporarily while the sonar was within the wake bubbles. Two AIS targets from nearby ves-

sels, including the AIS target and track corresponding to the vessel that produced the detected wake, are immediately and easily visible in the Chart Overlay. The vessel operator can immediately recognize and expect the response of the Argos system to a wake and adjust procedure accordingly.

varies a bit depending both on the operational mode and the model of the sonar. In general, it ranges vertically from about seafloor to surface, and horizontally either 60, 90 or 120°, depending on the operation mode and product model.

These sonars generate a lot of data. While the data do contain valuable information about the environment, they also require work to interpret. Instead of relying on



Bow with an Argos 1000 transducer module installed.

the user to interpret this raw information, FarSounder has developed algorithms to detect the seafloor and any navigation hazards, or in-water targets, so that they can be displayed in a way that is more intuitive and can be quickly put to use on the bridge.

The 3D Viewer is one of the ways processed sonar data are displayed in FarSounder's SonaSoft software: Seafloor and in-water target detections are drawn in 3D relative to the vessel.

Data can also be overlaid on a nautical chart, as can be seen in the Chart Viewer in FarSounder's SonaSoft software. This view is, perhaps, the more intuitive one due to its similarity with a radar overlay. The vessel is drawn at its current position on the nautical chart while the seafloor and hazards detected by the sonar are shown relative to the vessel, overlaid on the chart. With Navtor support, NMEA message types associated with AIS and automatic radar plotting aid (ARPA) targets are also displayed on the FarSounder standalone system. With this additional information, customers have a more complete understanding of their surroundings on one screen.

Chart Overlay may be the most useful tool, as it enables users to check their confidence in their current charts. For example, in areas where charted features are in agreement with the sonar data, that is a good indicator that the quality of the chart data is good. However, in situations where they do not agree, users should downgrade their confidence in the chart data and pro-

ceed accordingly. Given the value that the Chart Overlay display adds for Argos customers, it has been a focus of improvements and features for the development team at FarSounder.

New Features

Argos sonars heighten the user's situational awareness and understanding of the operating environment. Overlaying Argos sonar data intuitively on top of a nautical chart enables users to quickly identify situations where the charts they are using may differ from reality, for any number of reasons.

While real-time navigation is the focus of the Argos series of products, they are also capable of retaining some historical data. In particular, FarSounder's Local History Mapping feature stores up to 1 hour's worth of seafloor measurements as a vessel transits.

Because Chart Overlay is an important and useful tool for Argos users, FarSounder chose to partner with Navtor to provide the latest features and capabilities. This partnership provides an impactful, feature-filled update to the Chart Overlay for Argos users that will increase ease of use, enhance customer experience and, most importantly, improve navigation safety.

Of course, integrating the Navtor ECS kernel into SonaSoft added new features and performance improvements. The most notable to end-users are support for the display of NMEA AIS and ARPA targets in the Chart

“Overlaying Argos sonar data intuitively on top of a nautical chart enables users to quickly identify situations where the charts they are using may differ from reality”

Overlay, and more convenient import of standard S57/S63 data. The added support for AIS and ARPA targets improves situational awareness and provides a more cohesive experience for operators using the system on the bridge. Importing S57/S63 ENC charts is now faster, and no hardware USB dongle is required. In addition, importing S57/S63 charts is now available by default and gratis. So, it's now easier than ever for customers to import their chart data and synchronize the Argos display with their ECDIS and/or other bridge displays.

Finally, a number of smaller updates were realized, such as support for subscribing to NMEA sentence streams over ethernet (UDP and TCP), in addition to via serial communication lines, and the support for additional NMEA sentence types.

AIS/ARPA

The FarSounder team is most excited about the increased situational awareness and understanding of the

environment that comes from adding AIS and ARPA support to the Argos sonar system.

Other vessels operating nearby produce wakes, and wake bubbles are a challenge for any sonar system. The problem with wakes is two-fold. From a distance, a trail of wake will be detected as a long line of in-water targets. On the other hand, when the sonar is actually within a wake, the bubbles absorb the transmitted acoustic energy, resulting in poor quality or fewer returns and detections. Therefore, all Argos systems are equipped with a signal quality indicator to alert the operator to this situation. This tool is analogous to a mobile phone signal indicator; more “bars” indicate better signal quality and higher reliability of the sonar's returns. Given that wakes are something to keep an eye on when using an FLS, knowing where vessels have recently been in the area is useful.

ARPA targets can be similarly useful. Targets displayed by the radar system that also correspond to sonar targets



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“While real-time navigation is the focus of the Argos series of products, they are also capable of retaining some historical data.”

are all overlaid on the chart in the Argos display. This will provide the operator better access to more information in one spot and facilitate decision making.

FarSounder is continually working to add new features and improvements to improve user experience and navigation safety.

Plans for the Future

FarSounder has some big improvements planned for the near future, for the Chart Overlay and more. The updates to come will enhance user experience and even allow customers to contribute depth measurements to a crowdsourced database of ocean data.

Local History Mapping is getting an update soon to support more than an hour of rolling history, and to allow users to save some of their data for recall at another time. In addition to being able to use the data locally, long-range plans include the capability to share recorded bathymetric history between a fleet of vessels.

FarSounder has been a participant in the International Hydrographic Organization (IHO) Crowdsourced Bathymetry Working Group (CSBWG) since 2017. This is a group of hydrographic professionals and industry representatives focused on establishing guidelines and a data pipeline for mariners to contribute bathymetry measurements to an open-source database. Shortly after joining the CSBWG, FarSounder began to offer some customers the capability to collect data while underway and submit them to the bathymetry database for the benefit of the community.

One ambition of the working group is that crowdsourcing bathymetric data collection will contribute to achieving the goal of the Seabed 2030 initiative to create a unified and accessible map of the world's oceans by 2030 (*Sea Technology*, January 2022). Ideally, through future software updates, Argos users will be able to opt in to contribute data to the bathymetry database automatically.

This is just a peek into what's to come for FarSounder. To receive updates about the latest FarSounder news, or to get in contact with us, reach out on social media (Instagram, LinkedIn, Facebook, Twitter) at [@farsounder](https://www.farsounder.com) or via our website: www.farsounder.com. **ST**

Dr. Heath Henley is a FarSounder software engineer and hydrographic and advanced solutions specialist.

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Autonomous Perception Technologies

Continuing Advancement Creates Competitive Advantage

By Amelia Smith

Today's available autonomy systems enable active waypoint-based transit autonomy, as well as other automated behaviors that allow crews to intelligently manage voyages from start to finish. Leading systems consume real-time situational awareness data from multiple onboard technologies, including, radar, AIS, GPS, cameras and depth transducers, and fuse them into an active electronic nautical chart platform. They manage path planning and dynamic replanning for obstacle avoidance or other course changes.

Some systems, like those of Sea Machines Robotics, take all aspects of a voyage into account, including sea-keeping that regulates vessel motions in higher sea states for the protection and comfort of cargo and passengers. The company's SM300 autonomy system also provides a remote-user experience that includes augmented charts, dynamic domain information, real-time video and direct control of vessel systems, and gives remote commanders the ability to switch between autonomous and direct remote control.

In 2020, Sea Machines Robotics partnered with shipbuilder Metal Shark Boats to supply the U.S. Coast Guard's Research and Development Center with a Sharktech 29 Defiant vessel for the purposes of testing and evaluating the capabilities of available autonomous vessel technology. (Credit: Metal Shark)





(Top) In August 2021, the Department of Defense's Defense Innovation Unit secured a \$3.1 million multiphase agreement with Sea Machines to develop full-scale, ocean-going VTOL replenishment platforms to enable autonomy in supply logistics. (Middle) Early autonomy adopter Rolls-Royce collaborated with Sea Machines in 2021 to deliver comprehensive remote command, autonomous control and intelligent crew support systems to customers and to complement Rolls-Royce's mtu NautIQ marine automation portfolio. Left: Denise Kurtulus, vice president, Global Marine, Rolls-Royce Power Systems; right: Michael G. Johnson, CEO, Sea Machines. (Bottom) Sea Machines is helping the U.S. Army Corps of Engineers conduct survey missions with a limited crew during emergencies, or when it's not safe to deploy a manned vessel.



The next wave of technology will additionally incorporate camera vision targets, artificial intelligence (AI) and other proprietary technologies to provide advanced perception and situational awareness. Specifically, Sea Machines will utilize a robust sensor-fusion approach that allows the “brain” of the vessel to process huge data sets and swiftly transmit information to and from the environment. AI enables machine learning, meaning the technology will become “smarter” and more useful over time.

Computer vision can process and detect objects quicker than humans can, even in perfect conditions, and provide a redundant set of eyes for those in the

bridge—helping to mitigate fatigue, distraction and poor visibility due to low light or weather. For illegal vessels that are hidden from radar and AIS, on-boat cameras can still offer reliable detection and identification.

“In the near future, operators will consider data coming from [on-boat] cameras as the primary sensors,” explained Sea Machines’ Fiona Hua, director of perception engineering. “We are working now on fusing data from cameras with that of other established sensors—GPS, radar, AIS, etc.—to reliably provide a detected object’s classification, vessel name, heading, speed, purpose and

Huntington Ingalls Industries debuted the Proteus USV for testing and development of autonomy capabilities. The 27-ft. Proteus, outfitted with Sea Machines Robotics' SM300 autonomy system, completed a successful demonstration off the coast of Panama City, Florida, in May 2021.



appearance. This will provide crews with richer situational awareness at sea."

For operators looking for alternatives to radar and LiDAR, camera vision is an excellent option.

"Computer vision is made possible in part by passive, onboard cameras. This offers military and government operators another technology to enhance situational awareness at sea," said Hua.

"Computer vision is going to be the enabler that provides new capabilities to the Department of Homeland Security, and specifically the U.S. Coast Guard, missions," said Sea Machines' Phil Bourque, senior director of global sales.

Use Cases for Autonomy

Defense, Surveillance and Security. For branches charged with defense, marine autonomy enables a single, shore-based operator to command and control an entire unmanned fleet of vessels. These automated fleets can work collaboratively to cover large surveillance areas in less time than previously possible.

Escorting ships carrying high-value cargo is also made more efficient and effective with autonomous security boats that can be programmed to match the speed and course of the assets to which they're assigned.

Because autonomous marine technology integrates with common situational awareness sensors, autonomous defense vessels can execute missions with little to no human intervention, and with increased situational awareness. Sensor fusion offers advantages in the identification of friend or foe (IFF) because recognized objects are paired with marine traffic data. In the case of an encroaching vessel, this matchup provides a target's name and flag, speed, course and more to an operator, enabling faster classification of the approaching object as safe, suspicious or a threat.

"If a surveillance team knows what size or type of vessels they are looking for at sea, then we can program the system with a sensitivity for that type of target," explained Hua. "Even in night and foggy conditions, thermal cameras can detect many targets that the human eye cannot."

"A passive system like computer vision can operate in a contested environment and not be subject to directional finding [DF] equipment—ideal for covert operations," added Bourque.

Remote payload control allows an off-site operator command of onboard equipment, such as cameras, cranes, launch stations, anti-piracy tools and more. Remotely operated sensors and cameras can be used to detect aerial, surface-level and subsea threats, critical for antisubmarine warfare (ASW); interdiction operations; mine hunting; heat, chemical or nuclear detection; drug and human trafficking prevention; and more. From nearly any location, an operator can access payload data and engage equipment to safely and successfully complete missions.

ISR and Communications. Autonomous surface vessels can play a critical role in command, control, communications, computer, intelligence, surveillance and reconnaissance (C4ISR) work conducted by the government. USVs can be used in ocean surveillance systems, which can include reconnaissance satellites, surveillance subsea vessels, underwater sensors and maritime patrol aircraft. As a vital link to the assets above and below them, USVs can be stationed long term at sea to feed branches critical and encrypted data. Autonomous boats do this more predictably and cost effectively without a crew.

Another challenge USVs can help to solve is energy reserves at sea. Autonomous vessels can be equipped to serve as a "floating battery," providing enough power to connect stand-off vessels to satcoms.

In September 2021, Sea Machines proved that the world's waterways are primed and ready for autonomy by undertaking the longest autonomous journey at sea: 1,027 nautical mi. On October 15, in the waterways of Denmark, the company's remotely commanded, autonomous Nellie Bly USV crossed over the company's ambitious goal line, claiming success and setting a world record while collecting significant data at sea.



In situations where traditional communications or GPS data have been compromised, unmanned vessels can serve as low-frequency positioning navigation and timing (PNTs) instruments, providing situational awareness and stealth to other aerial, surface-level and underwater assets. For scenarios where GPS has been denied or jammed, USVs can act as a pseudo-satellite for precision navigation reference.

Offshore Operations. Autonomous offshore support boats can work longer hours, even in periods of low light or poor visibility, with greater precision and predictability. USVs can operate in very poor weather conditions that would otherwise put mariners at risk and compromise tasks.

Broad coverage areas or long transits to an offshore site can now be executed autonomously. USVs can adjust direction in fractions of a second without human intervention to maximize efficiency. If an unexpected object appears in the path, cameras and other sensors will detect it far sooner than the human eye, and the USV will reroute safely before resuming the mission.

For users conducting offshore security missions, USVs enable more data to be gathered with fewer resources and less time. Manned motherships paired with smaller unmanned daughter craft can collect data at all hours of the day and night, as uncrewed workboats don't require stops for low-light conditions, breaks or shift changes. A fleet of USVs can operate collaboratively for force-multiplication that maximizes coverage and reduces the time required to collect data.

For offshore jobs in extreme locations or those with toxic conditions, USVs eliminate the need to expose

crews to hazards. An operator-in-the-loop can program a vessel to collect data or spilled oil, deploy payloads and monitor surroundings in real time, all from a safe location.

Rescue and Relief. Autonomous assets can support rescue operations, expeditionary logistics and humanitarian relief efforts because they can deliver cargo, ammunition and personnel faster and more cost-effectively. Entire fleets can collaboratively execute sweeping patterns to more productively search for downed planes or people and vessels in water.

"Near-future advanced perception systems, like ours, will use on-boat cameras to scan large swaths of ocean for very small objects, like swimmers or life vests, that are hard for humans to detect. This will significantly aid search-and-rescue missions," said Hua.

Following disasters near coastal areas, a USV stationed nearshore can provide a signal to restore communications and connectivity. Autonomous surface vessels can also offer medical support by acting as efficient "floating hospitals."

The Latest Applications

In the past year, the industry has seen several significant applications of autonomy in real-world missions.

In April 2021, Sea Machines supported the U.S. Army Engineer Research and Development Center to deploy the research vessel *Martin*, the first full-size, semiautonomous craft in the U.S. Army Corps of Engineers, in Vicksburg, Mississippi.

Martin now offers the team the ability to conduct survey missions with a limited crew during emergencies or



in post-disaster areas where it's not safe to send a manned vessel.

In May 2021, Huntington Ingalls Industries (HII) outfitted the 27-ft. Proteus USV with the SM300 system from Sea Machines and completed a successful demonstration in Florida. Proteus was equipped with commercial perception sensors, including GPS, automatic identification system, depth transducer, radar and a camera enabling a 360° field of view. HII deployed a separate 51-ft. boat during the demonstration to illustrate the SM300 system's obstacle avoidance capability and adherence to the Convention on the International Regulations for Preventing Collisions at Sea (COLREGs). Proteus will enable HII's continued development of autonomy capabilities and sensor fusion to meet the needs of both government and commercial customers.

In the summer of 2021, Sea Machines and Viasat Government Systems, a leading provider of integrated defense satellite communications, partnered for live autonomy demonstrations held virtually during the Navy League's Sea-Air-Space Expo to showcase the reliability of communications for autonomous vessels operating both within and outside the range of cell towers. One coastal application included remote monitoring of a large harbor or port; an unmanned patrol boat outfitted with cameras could conduct a search pattern to detect people entering or leaving, relaying information in real time. Another application included autonomy for remote operations. Already covering much of North America, the U.S. Gulf of Mexico, the Caribbean and routes between the U.S. and Europe, Viasat will expand its satcom network in the coming months. This will offer global coverage to enable communication with, and connectivity to, unmanned ships sailing almost anywhere in the world, including remote sites.

"We see numerous applications for how autonomous vessels could benefit U.S. defense and allied nation operations," said Joe Johnson, business area director for rotary and maritime broadband services for Viasat. "Sea Machines' autonomous robotics capabilities and Viasat's resilient, assured satcom expands the potential for beyond-line-of-sight autonomous vessel connectivity and how it could support defense customers executing maritime missions."

"Viasat and similar communications technologies give Sea Machines' users reliable real-time connectivity at sea, even in distant or remote areas," said Bourque. "This is greatly important for over-the-horizon, remote-command operations and enables the advantages people expect from our human-in-the-loop autonomous technologies."

This past summer, Sea Machines also advanced its existing multi-year agreement with the Department of Defense's (DOD) Defense Innovation Unit (DIU) to successfully deploy autonomous control kits on multiple barges and increase DOD's agility in deploying and replenish-

ing assets around the world. The original agreement, established in October 2020, charged Sea Machines with engineering, building and demonstrating ready-to-deploy system kits that transform existing commercial barges to platforms capable of landing and replenishing military aircraft. Now the DOD is funneling an additional \$3.1 million into the project to transition it from proof-of-concept to the design and trial stages.

"Sea Machines is bringing innovation and modern design to the DOD," said Bourque. "Our extended contract represents the confidence the DOD has in our technology and ability to deliver."

In September 2021, Sea Machines publicly proved that the world's waterways are primed and ready for autonomy by undertaking the longest at-sea autonomous journey. After 13 operational days, on October 15, the company's remotely commanded, autonomous Nellie Bly USV achieved its goal of traversing 1,027 nautical mi. During the journey, the vessel operated autonomously 96.89 percent of the time, enacted 31 automated collision avoidance maneuvers and captured 3.8 TB of data to enhance Sea Machines' industry-leading computer vision library. The mission was conducted in real time online, allowing viewers to follow along the record-setting journey live, effectively showcasing that autonomous technology is ready and available now for remote, long-distance missions at sea.

Early Adoption Is a Competitive Advantage

The number of early adopters for this type of technology is rapidly accelerating. In the past year alone, several industry leaders have committed to offering autonomous solutions to customers, including Rolls-Royce, Hamilton-Jet and Damen Shipyards Group.

Whether operators choose to use intelligent technologies to support onboard mariners or to execute remote and/or unmanned autonomous missions, it's clear that proven autonomy leads to better decision making and greater predictability. For situations when speed matters, having accurate, redundant data immediately accessible could be the difference between a near-miss and an incident.

"Remotely commanded autonomous vessels provide the marine industries with the platform necessary to be competitive. This is delivering significant increases in productivity and operational safety, digitized ultraefficiency and response speed, and is providing a new world of actionable operational data for improved planning and business practices," said Bourque.

These competitive advantages are significant for all marine operators, but especially critical for government and military fleets that secure our land and marine borders. Those who get on board early will reap the most benefits. **ST**

As the owner of A.WordSmith Communications, Amelia P. Smith supports the marketing and communications activities of Sea Machines Robotics, a leading developer of autonomous-control and advanced-perception technologies for commercial marine surface vessels. With more than 15 years of experience, more than half of which have been dedicated to maritime industries, Smith specializes in content production, public relations, social media management and other types of targeted marketing.

Biotech for Sustainability

Marine Coatings Support Vessel Efficiency, Battle Invasive Species

By Philip Chaabane

As shipping gets to grips with the scale of the decarbonization challenge, anti-fouling paints and coatings will play a vital role in improving the sustainability and efficiency of vessel operations. While there is still much uncertainty on the exact route to net zero, as low- and zero-carbon fuels are still far away from being widely available at scale, tackling fouling is a useful starting point because all vessels must be coated, and coatings that effectively prevent and/or slow the process of bio-fouling can support vessel efficiency.

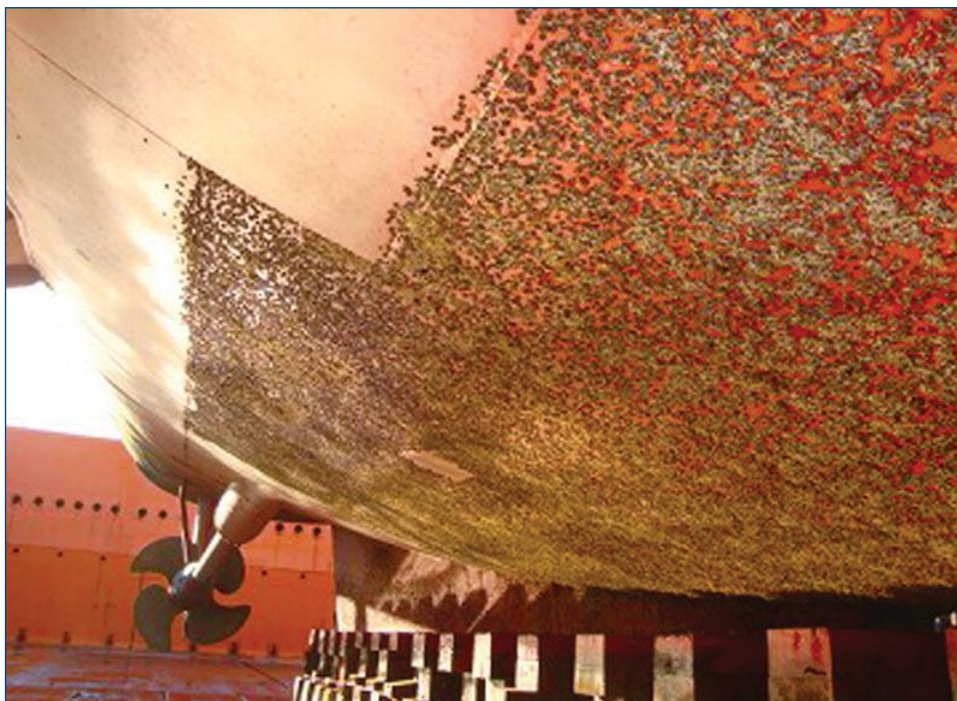
The challenges posed by biofouling, from “hard” fouling caused by shelled species such as barnacles and “soft” fouling from plant species, are multiple and complex, with impacts that present a range of environmental risks, such as the biosecurity threat of invasive species.

The need to tackle fouling was already urgent before the COVID-19 pandemic hit. In a study from 2015 to 2019 that I-Tech conducted with coating consultants Safinah Group, we found that nearly every vessel surveyed, 249 vessels in total, had a degree of underwater hull hard fouling. On 44 percent of vessels surveyed, over 10 percent of the underwater hull surface was significantly covered with hard fouling to a level that is deemed to cause an “unacceptable” impact on performance by experts. Approximately 25 percent of vessels displayed hard fouling coverage between 10 to 30 percent, and the remaining percentage of vessels suffered much higher levels. Levels of fouling have likely only increased as many vessels in the global fleet remain idle for far longer than usual during the pandemic.

Fouling’s Impact

Hard fouling, particularly from shell-forming marine life such as barnacles, incurs significant performance penalties for vessels because it increases hydrodynamic drag. Studies show that a vessel with just 10 percent barnacle coverage requires an increase in shaft power of 36 percent in order to maintain the same speed through the water, compared to a vessel free of hard fouling. This, in turn, can result in higher fuel costs and higher emissions.

Both soft and hard fouling of “niche” areas, the more hidden parts of a vessel that are often difficult to maintain, can compromise the operational health and efficiency of a vessel, as well as pose a biosecurity threat to marine ecosystems through the transportation of invasive



aquatic species. By unknowingly transporting live fouling agents to regions where they are not native, vessels can seriously contaminate global ecosystems.

'Zero Barnacle Growth'

Owners and operators looking to meet emerging Energy Efficiency Existing Ship Index (EEXI) and Carbon Intensity Indicator (CII) regulations may turn to tactics such as slower speeds to help them do so. However, the slower a vessel travels, the easier it is for organisms to foul the hull and niche areas, particularly in fouling hotspots. Certain coatings technologies also perform less well at low speeds.

Selektope, I-Tech's proprietary anti-fouling technology, is a comparatively new active agent on the market but nevertheless an increasingly integral one. Its unique ability to repel fouling species/organisms (rather than terminate, like many other biocides) marks a novel approach to the challenge facing the shipping industry. Because the active agent is so effective in small concentrations, it reduces the overall biocidal load of any coating it's added to.

In a case study, I-Tech followed a five-year operation involving MT *Calypso*, a Team Tankers-operated vessel, coated with paint that used Selektope. Following 63 months in operation, the vessel demonstrated zero barnacle growth across the vertical sides and bottom of the hull, where it was coated.

These results are significant because the tanker's long operating period significantly increased the risk of high levels of biofouling on the vessel's hull, yet examinations at multiple stages of the study period showed no signs or impact of barnacle growth.

Furthermore, MT *Calypso* traveled through heavy fouling areas known as "hotspots" across global routes. Hotspots are regions where typically warmer waters make fouling much more prevalent—and challenging to manage. In addition, the tanker spent long periods at anchor, further increasing the risk of fouling because bar-

nacle larvae can only attach to the hull when the vessel is at anchor or moving at slow speeds of up to 6 kt. For example, the vessel laid at anchor continuously for one month while waiting for drydock and wasn't cleaned at any time during the coating's service life, but the study found no indications of barnacle growth.

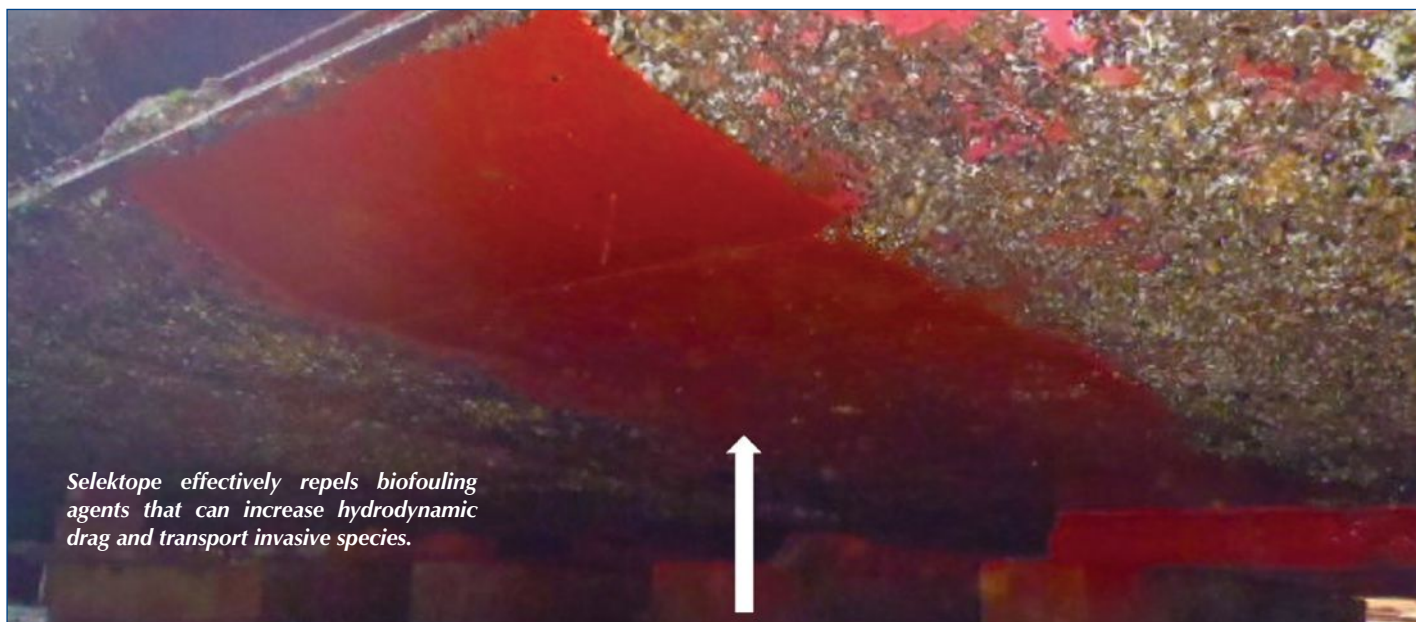
During the study period, MT *Calypso* displayed an average weighted speed loss of only 0.5 percent and demonstrated only a normal amount of wear. The five-year coating, which was developed by Chugoku Marine Paints (CMP), was the first 60-month paint system containing Selektope, making it a landmark venture for both CMP and I-Tech.

Conclusion

No single technology can decarbonize shipping. But as regulations and environmental, social and governance (ESG) finance continue to evolve and encourage ship-owners and operators to start reducing emissions now, they need to make the most of the tools and technologies currently available. Anti-fouling marine coatings should be at the top of the list to support vessel efficiency and shipping's sustainability.

I-Tech's Selektope supports the industry's sustainability efforts by decreasing the threat of invasive species and, thus, lowering hydrodynamic drag on vessels, as well as futureproofing coatings against upcoming environmental regulations. **ST**

Philip Chaabane has been the CEO of I-Tech since 2014. He has a unique combination of experience in senior positions at global technology companies, both large and small. Prior to I-Tech, he worked at the fuel cell company PowerCell Sweden AB, where he was responsible for business and customer development. Chaabane has also had various operational roles at Volvo Aero Corp. (now GKN Aerospace). He has an M.S. in international materials engineering from the Luleå University of Technology and EEIGM in France.



Selektope effectively repels biofouling agents that can increase hydrodynamic drag and transport invasive species.

Arriving at Decarbonization

Generating Methanol-to-Hydrogen On Vessel, On Demand

By Bryan Reid

Change is on the horizon for shipping operators, with environmental mandates driving global commitments for greater sustainability and less pollution. Industry wide, the goal is a 40 percent cut in carbon emissions by 2030 and, at minimum, 50 percent by 2050. It's a high bar, yet understanding fuel choices that deliver clean, green propulsion is only part of the challenge.

This industry shift also has direct bearing on ship architecture, engineering and design; ship operations and longevity; and even support facilities in ports and inland waterways.

Hydrogen offers potential; however, it is a complex

substance with unique challenges for storage, transportation and safety protocols.

For example, to enable its use, shipping operators are faced with managing storage at cryogenic temperatures or maintaining extremely high-pressure tanks with a large onboard footprint.

Methanol-to-hydrogen reforming is providing a real-world option that solves these complexities. It's a process that enables practical consideration of hydrogen as a clean and commercially viable source of propulsion and operating energy, while eliminating the challenges outlined above.

The shipping industry is playing a global role in facilitating a healthier planet and strong worldwide economy. Mandates from the IMO, a United Nations entity, has shipbuilders tasked with reducing carbon emissions by at least 50 percent by 2050 and eventually fully eliminating the industry's carbon impact. It's a monumental goal likely to drive new or significantly modernized ships, engines and fuel. Hydrogen power is proving to be an ideal sustainable energy option, with the challenge of the inherent complexities of its safe transportation, storage and onboard management. (Credit: RIX Industries)



Onboard Hydrogen Without Storage

For hydrogen to become a truly viable energy source for cleaner propulsion, ship operators must be able to eliminate its related operational challenges of onboard storage and management. Consider that propulsion would require a massive amount of hydrogen available, stored in either liquid or gas form. Because hydrogen is approximately 11 times lighter than air, incredibly dense amounts of the substance would be required if used as an energy source for ship propulsion and operations. The greater the density of hydrogen, the larger the containment unit—infrastructure demands on ship architecture would be immense and complex. Liquid hydrogen requires storage at -253°C , a temperature that must be maintained during its transportation between a hydrogen source and a supply tank. Hydrogen stored in gas form demands high-pressure tanks that consume large amounts of precious deck space and require careful ongoing attention to safety and management. Neither option is realistic or ideal for utilization on board seafaring vessels or workboats.

But what if hydrogen could be brought on board without these storage issues? What if it could be created when and where needed, instead of stockpiled on board under difficult and dangerous conditions? Methanol enables these options and is playing a new role as a safe and manageable means to generate hydrogen on board and on demand. By converting methanol to hydrogen in a self-contained power system, such as a fuel cell, ship operators can generate a consistent source of pure hydrogen just as if it were being pulled from a large onboard storage tank. These conversion systems are highly energy efficient (greater than 80 percent) and operate in sharp contrast to the heavy footprint of traditional hydrogen

storage. Commercially available and designed as cabinet or container-based units, they offer a scalable, modular approach in handling diverse power demands, ranging from 10 kW to MW+ applications.

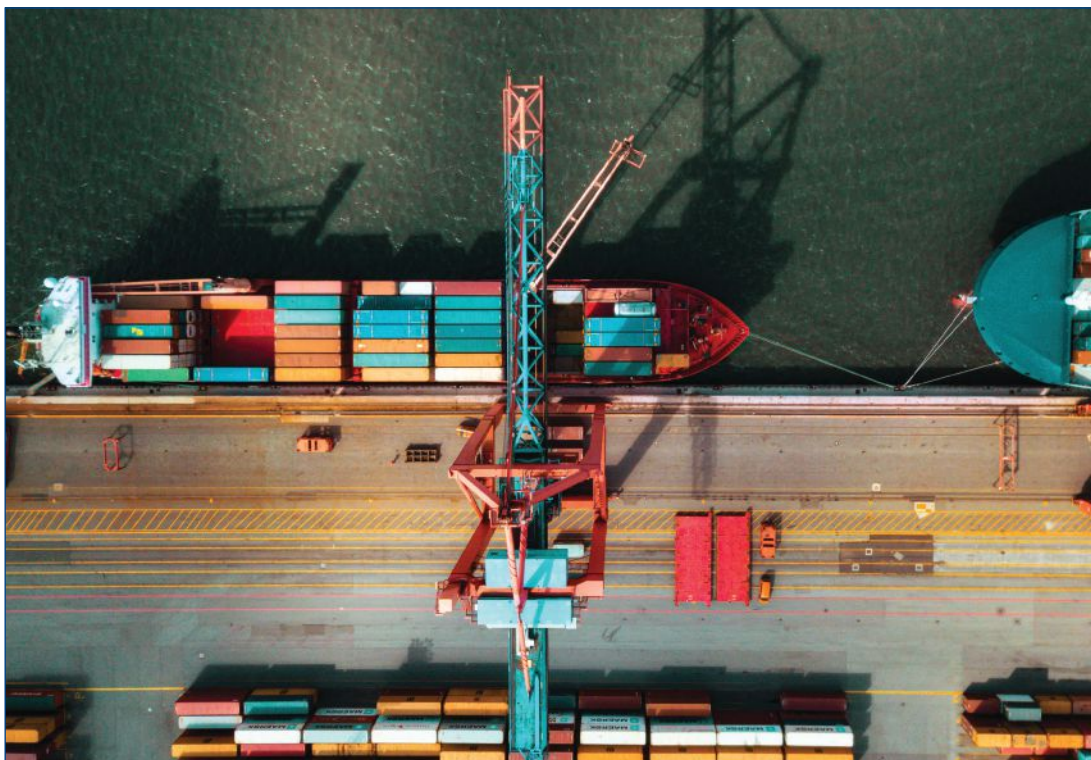
Methanol's Impact on Ship Design

Pressurized tanks must be cylindrical, a shape that is integral to their safety and ability to maintain contents under pressure. Nonpressurized tanks do not face this limitation, so they can be more flexible in their design. Because methanol is stored as a liquid at ambient conditions, custom-fit methanol tanks can be designed for use in any available shipboard space. This is a new frontier for naval architects and engineers, who can now capitalize on unique or unused onboard space that was once lost to real purpose and value. Premium deck and cargo space can also be visualized anew, as the ship's power system can ultimately be distributed across the entire vessel. In contrast to the traditional engine room, newly designed vessels might feature a reformer area holding the primary cabinet-based system for methanol-to-hydrogen conversion. Additional reformers and methanol tanks can then be integrated ship wide for greater capacity.

Existing vessel infrastructure can also handle hydrogen on demand without significant retrofit. By executing proper maintenance and cleaning of tanks used for diesel storage, a working vessel can readily switch its application to storage of liquid methanol. Ambient temperatures are suitable for methanol, so cryogenic complexity is simply absent.

Methanol Versus Ammonia

While ammonia and methanol both provide a path to hydrogen, they are vastly different in terms of cost,



convenience and safety. Methanol is common in marine industries; its handling requirements are similar to those for other types of fuels, and it maintains liquidity at ambient temperatures. The substance is biodegradable and miscible in water. It is also relatively low cost, based on its common availability in seaports around the world.

In contrast, ammonia is a much more complex substance for use as a hydrogen feedstock. It is less widely obtainable and comes only from central outlets in the shipping world. As such, ammonia is not easily accessed or dispensed and is inherently more costly. Ammonia is also highly toxic, recognized as a dangerous substance that requires advanced safety standards for careful handling, storage and logistics. This is a crucial limitation, as a safety infrastructure for ammonia handling would need global improvement to enable mainstream acceptance. The sharp contrast between methanol and ammonia is reflected in the International Maritime Organization's (IMO) view of each substance: Methanol is approved for bunkering and other maritime applications by the IMO, while ammonia has yet to receive approval.

Shades of Methanol in Hydrogen Reforming

In methanol-to-hydrogen reforming, methanol is mixed at an approximately 2:1 ratio with deionized water. The mixture is then heated and pressurized within the system. As it evaporates into steam, the heat and pressure force the chemicals to separate into individual molecules of carbon monoxide, carbon dioxide and hydrogen. When the hydrogen is consumed by a fuel cell, its only byproduct is water.

In the reforming process, methanol can be gray or green, which refers to the level of carbon impact resulting from the production of the methanol itself. This can be a point of confusion as ship operators evaluate options and take steps toward meeting industry mandates for reduced pollution. Gray methanol is produced with natural gas as its feedstock and is available now. Using gray methanol, the methanol-to-hydrogen process eliminates NOx, SOx and particulate matter. When compared to a standard diesel engine, this option results in 23 to 25 percent less CO₂. Green methanol, or methanol that is sustainably produced, results in net-zero carbon output.

Mandates for reduced emissions warrant immediate action, although shipping operators may be hesitant as they await further evolution and availability of green methanol. However, in methanol-to-hydrogen reforming, the methanol can be both gray and green, simultaneously mixed in the reformer as more sustainable options unfold. This advantage provides a head start when net-zero advances do arrive, regardless of the timeline. As the industry anticipates new fuels, vessels with re-



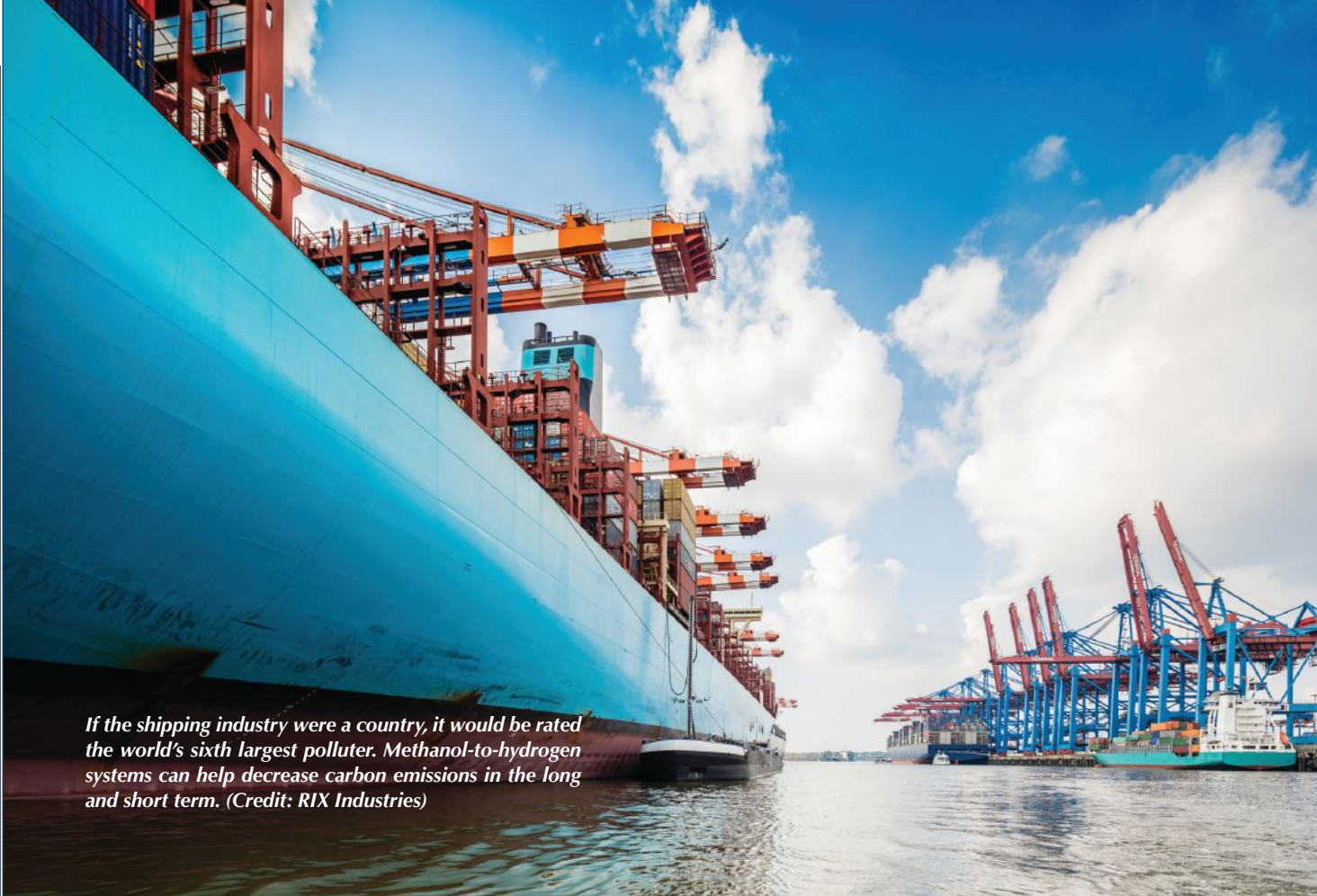
Hydrogen-on-demand is enabled by RIX's M2H2 system. (Credit: RIX Industries)

forming technology will also be well on their way to avoiding the carbon levies on the horizon for 2023. Ship operators will have taken strong steps in futureproofing their fleets.

Examples of hydrogen-on-demand systems include RIX's S Series and M Series. The S Series is market ready, and the M series is in the design-for-cost cycle and, in parallel, going through a certification process for use in marine applications.

Both product lines integrate technology licensed from Element 1 (dba e1), a developer of clean energy products, processes and technologies. Combined with PEM (proton-exchange membrane) fuel cells, M Series systems produce power with no NOx, SOx or particulate matter. These systems deliver high efficiency, minimal vibration/noise and low emissions for power-critical applications. They achieve net-zero CO₂ emissions when paired with renewable methanol. M Series systems support 30- to 120-kW fuel cell solutions and can be combined to support megawatt applications and facilitate flexibility for operations such as ship propulsion, auxiliary power systems, reefer container power, and cold ironing.

The S Series and M Series systems have been tested and continue to be deployed for integration with various fuel cells. Results to date have been excellent, with efficiencies of greater than 80 percent demonstrated. Reformers have been testing with fuel cells from companies such as Ballard, Cummins and Intelligent Energy, and testing with additional fuel cells should be conducted in the first quarter of 2022. The M Series should be ready to deploy for demonstration/trials with full production configuration in the third quarter of 2022.



If the shipping industry were a country, it would be rated the world's sixth largest polluter. Methanol-to-hydrogen systems can help decrease carbon emissions in the long and short term. (Credit: RIX Industries)

Decarbonization Now for a Net-Zero Future

If the shipping industry were a country, it would be rated the world's sixth largest polluter. Oceana, an international oceanic research organization, estimates that "more than 3 percent of global carbon dioxide emissions can be attributed to ocean-going ships," or the approximately 90,000 marine vessels that ferry more than 90 percent of the world's trade.

The IMO's most recent milestone for reduced emissions (a 2020 mandate met through the use of a less polluting variety of diesel fuel) demonstrates the urgency to shift away from diesel. A global partnership of diverse public and private sector entities is making headway, but also highlights the challenges of evolution faced by shipbuilders and operators. Globally, a well-defined regulatory framework is developing, with standards and policies pointing to the critical importance of reducing carbon impact in this decade.

At the same time, a stored hydrogen solution to propulsion is implausible for the shipping industry. Barring any new science or magic, the chemical characteristics of hydrogen are not apt to change. Liquid storage requires cryogenic temperatures and gas storage requires high-pressure tanks with a high-volume footprint. Tank filling is risky and requires a precise, consistent speed that is neither too fast nor too slow. These and other safety logistics can only be handled by certain port facilities at great cost. Under these conditions, which apply across

the hydrogen supply chain, transport costs can increase to \$16 per kilogram from \$1 per kilogram by the time hydrogen arrives for pumping. In contrast, methanol is simple to transport, widely available and does not need freezing temperatures to stay safe at any point in its supply chain journey.

Hydrogen infrastructure has always been the hurdle for shipping operators—adding cost and complexity, creating safety concerns, and wasting valuable deck space. In an industry where cargo is king and vessels are assets designed to last for decades, solutions must be both sustainable and optimized for the realities of ship operations. Hydrogen on demand is making a difference, unlocking the path to flexible, clean performance that meets mandates, reduces carbon penalties and positions shippers for a net-zero future today. **ST**

Bryan Reid is the chief sales officer at RIX Industries. You can connect with him at: breid@rixindustries.com or www.linkedin.com/in/bryan-reid-194470a.



Ending ‘Forever Chemicals’

Why the Maritime Industry Needs to Start Thinking About PFAS

By Dr. Brian Pinkard

For anyone working in the water, wastewater or environmental remediation industry, hearing that PFAS (per- and polyfluoroalkyl substances) “forever chemicals” have been found at a new site is a bit like hearing that corruption has been found in government—if you go looking for it, you will find it. However, it still came as a shock to see a recent study from *Environmental Science & Technology* that showed sea spray was a significant mechanism for transporting PFAS from the ocean into the atmosphere (<https://pubs.acs.org/doi/10.1021/acs.est.1c04277>). It almost seems poetic, in a way, that the sea is spitting our most recalcitrant and toxic industrial chemicals back at us. Even the ocean doesn’t want to deal with PFAS.

For those who haven’t seen the increasing media coverage (including the recent “John Oliver” special at <https://tinyurl.com/2p-988fvj>, or the Hollywood movie “Dark Waters”), PFAS are a class of industrial chemicals that have been used for over 50 years to create products that are nonstick, heat resistant, waterproof and/or chemically stable. We can find PFAS in our nonstick pans, our waterproof jackets, our carpets, our fast food packaging and our cosmetics, to name a few common household sources. PFAS has also been widely used in industrial firefighting foam (known as AFFF, which stands for “aqueous film-forming foam”) at airports, military bases and hydrocarbon storage facilities worldwide.

PFAS are colloquially known as “forever chemicals” for one simple reason: most of them never break down under natural, environmental conditions. Combine this with



A sample of PFAS-based AFFF, which is typically mixed with water at 100x dilution for use on petroleum fires. Raw AFFF contains about 3 percent PFAS by weight, roughly 1 billion times more concentrated than the regulated level of PFAS in drinking water in several states.



Destroying PFAS in Aquagga's hydrothermal system.

Regulation and Litigation

In October, the Biden-Harris Administration and the U.S. Environmental Protection Agency (EPA) simultaneously announced their "PFAS Roadmap," accelerating efforts to address PFAS contamination (<https://tinyurl.com/5n77e2fv>). The roadmap outlines planned actions over the next few years, including the establishment of a federal drinking water standard for PFAS, continued toxicology investigations, establishing disposal and discharge guidance, and more. These actions were expected, but still came as a welcome step forward toward addressing a national problem that has slowly become more prominent in the public domain.

The story of PFAS entering the public discourse primarily begins with environmental attorney Rob Bilott, as told in his memoir "Exposure." In 1998, Bilott began a 20-year legal battle against DuPont, the chemical manufacturer of Teflon and other PFAS-based products, which had intentionally hidden internal documents revealing the acute toxicity of PFAS while simultaneously dumping PFAS-containing sludge into waterways and unlined landfills. The results of Bilott's legal efforts led to one of the largest epidemiological studies in history, conducted by the C8 Science Panel. After years of research, the panel clearly linked perfluorooctanoic acid (PFOA, or C8) exposure to high cholesterol, ulcerative colitis, thyroid disease, testicular cancer, kidney cancer and pregnancy-induced hypertension. The panel's results were released in 2013, and subsequent toxicology studies have confirmed and broadened these findings.

At this point in time, the science is proven: PFAS compounds, especially PFOS (perfluorooctanesulfonic acid or perfluorooctanesulfonate) and PFOA, cause measurable and significant health effects. In spite of the evidence, the EPA has yet to set an enforceable standard for PFAS in drinking water, instead choosing to publish a "health advisory level" of 70 parts per trillion of PFOS and PFOA combined in drinking water. While unenforceable, the health advisory level has served as guidance for states establishing enforceable drinking water standards. Michigan, California, Delaware, New Jersey, New York and Vermont (among a growing list of other states) have adopted enforceable standards for PFAS, requiring utilities to test for, and correct, high levels of PFAS in drinking water. Some municipalities have gone further, banning the incineration or landfilling of PFAS in light of concerns about the resulting secondary contamination from such activities.

The only other mechanism to force action on the PFAS issue, besides regulation, is litigation. In the past decade, settlements from PFAS lawsuits have reached multiple billions of dollars (<https://tinyurl.com/2p8fmfe6>). Many class-action lawsuits have been filed against the producers or users of PFAS-based products, as many municipalities have no other means to raise the funds necessary to install PFAS treatment infrastructure. Many believe we are only seeing the tip of the PFAS litigation iceberg.

our recent understanding that chronic exposure to PFAS even at single-part-per-trillion (ppt) levels (quite literally one drop in a dozen Olympic-size swimming pools) is enough to cause measurable and lasting health effects, such as cancer, liver damage, endocrine disruption, immune system dysfunction and developmental disorders. And PFAS are incredibly mobile through the environment—infesting municipal drinking water supplies while also being redistributed throughout the world. This is why nearly every living organism, including polar bears living in the Arctic, has detectable levels of PFAS in their blood.

Specific to the maritime industry, PFAS-based firefighting foams are used for firefighting activities at fueling stations, U.S. Navy installations and on aircraft carriers. The "forever" nature of these chemicals has led to a legacy of contamination that will need to be cleaned up, to the tune of billions of (mostly) taxpayer dollars. We can't just dump this stuff into the ocean or burn it. Incineration of PFAS is widely suspected of transporting partially destroyed PFAS back into the atmosphere and back into the environment.



PFAS-contaminated wastewater, collected for disposal via Aquagga's system.

Act Now or Pay Later

Even in the absence of federal drinking water regulations, discharge guidance or regulated cleanup levels, groups such as the U.S. Air Force are taking a proactive approach to disposing of legacy AFFF and cleaning up PFAS-impacted sites. Why? Because these groups recognize that PFAS regulations are coming soon: Cleanup will soon be federally mandated, and site cleanup will only become more complicated and more difficult as regulations emerge.

Stakeholders in the maritime sector have an opportunity to take a similarly proactive approach. The Navy, specifically the Naval Facilities Engineering Systems Command (NAVFAC), has begun testing for PFAS at many naval air stations and has begun remedial efforts at some sites, such as cleaning out AFFF residue from fire trucks at Naval Air Station Whidbey Island.

Any facility with a fire suppression system, hydrocarbon storage or an aircraft landing strip likely has PFAS that has been, or is currently, used or stored on site. Many states, including Washington, are currently beginning AFFF collection and disposal programs to reduce the volume of stockpiled AFFF and to identify suitable disposal options. Any fire suppression system used with AFFF will ultimately need to be cleaned of PFAS residue, and identifying systems that need cleaning is a proactive step that should be taken sooner rather than later, to prevent ongoing contamination liability. Additionally, sam-

pling of soil and groundwater on sites with legacy AFFF use will inform site managers of the magnitude of their specific PFAS problem and will help them understand the scope of remedial actions they will need to take in the future.

Corrective and proactive actions can help inform a strategic action plan to mitigate public exposure to PFAS, and to mitigate environmental site owners' exposure to lawsuits and emerging regulations.

Using Water to Clean Water With a Pressure Cooker on Steroids

So, how do we deal with a toxic environmental contaminant that exists everywhere and lasts forever? The good news is that technologies *do* exist to remove PFAS from contaminated water and contaminated soil. Several options work, including granular activated carbon (GAC), advanced resin-based systems, soil washing and thermal vaporization. Unfortunately, these are all expensive to implement, and they produce a PFAS-contaminated byproduct that must be destroyed.

Currently, there are no options to destroy PFAS safely and effectively on an industrial scale. Our work at Aquagga is focused on changing that. In partnership with the Colorado School of Mines and the University of Washington, and through funding from the National Science Foundation, the U.S. Air Force and the EPA, we are developing containerized PFAS destruction systems

for rapid deployment at AFFF-impacted sites worldwide.

The science itself is quite extraordinary: Under moderately high pressures, high temperatures and at a high pH, water itself can be used to pull apart the PFAS molecule, converting these toxic chemicals into small quantities of salts such as calcium fluoride and sodium fluoride. This hydrothermal process is simple and energy efficient, requiring a small fraction of the energy required to incinerate liquid PFAS wastes, and it has been shown to destroy more than 99.99 percent of PFAS. We essentially use a modified “pressure cooker on steroids” to end the PFAS cycle, enabling safe remediation of contaminated sites and safe disposal of AFFF stockpiles.

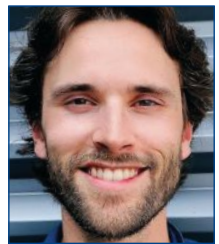
Aquagga’s latest efforts have demonstrated excellent treatment results in feedstocks such as stockpiled AFFF, fire-training pit water, soil wash water, landfill leachate and several other remediation byproducts. Our initial prototype system is scheduled to be field-tested this summer. Full-scale commercial deployments are planned for 2023 as part of broader military base remediation and industrial wastewater treatment efforts. By the end of 2023, we expect to have several systems actively destroying PFAS at military bases and industrial facilities nationwide.

Even as the remediation market is changing to adapt to emerging regulations and an increasingly litigious environment, smart stakeholders are keeping an eye on emerging technologies and are taking proactive steps to

get ahead of their PFAS cleanup needs. Pilot tests of new technologies are a great way to assess the suitability of a treatment approach for addressing the cleanup needs of a site before standards are put in place, so that a full-scale treatment effort can be mobilized when cleanup standards are established. Proactive stakeholders will be able to meet cleanup targets more efficiently, and will end up saving money on drinking water treatment and other stopgap measures that would be needed in the interim.

PFAS chemicals will not go away on their own. These forever chemicals will persist and will eventually need to be cleaned up. Regulations are coming rapidly, as are technologies to assist with this inevitable cleanup effort. The maritime industry would do well to assess their own historic use and storage of PFAS-based firefighting foams and should take a proactive stance on sampling and cleaning up contaminated sites to mitigate legal exposure and to protect public health. **ST**

Dr. Brian Pinkard is the CTO and co-founder of Aquagga, a start-up company working to end PFAS “forever chemical” contamination through the application of hydrothermal processing for safe and effective PFAS destruction. Aquagga’s work is supported by grants from the National Science Foundation, the U.S. Air Force and the EPA.



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AIP for Ammonia-Fueled Ships

The Korean Register (KR) has awarded approval in principal (AIP) to two green ammonia-fueled ships: a 60,000 m³ ammonia carrier (currently the largest ship that can be docked at Korean ports) and a 38,000 m³ ammonia carrier/bunkering ship, developed by Korea Shipbuilding & Offshore Engineering (KSOE), Hyundai Heavy Industries (HHI) and Hyundai Mipo Dockyard (HMD).

The AIP is the first result from the Green Ammonia Marine Transport and Bunkering Consortium, comprised of six organizations: KR, LOTTE Fine Chemical, KSOE, LOTTE Global Logistics, HMM and POSCO.

NAVTOR to Acquire Ingenium

NAVTOR and Ingenium Marine have signed a term sheet under which NAVTOR will acquire Ingenium Marine. The transaction is subject to execution of definitive agreements. Once completed, Ingenium will become a fully integrated NAVTOR company and continue to operate from Mumbai, India. NAVTOR will integrate digital logbooks into its e-navigation and performance product portfolio. The move “propels vessel logbooks into the smart shipping age,” said NAVTOR CEO Tor Svanes.

Damen Acquires Skoonbox to Cut Yard Emissions

Damen Shipyards Group has taken over the Skoonbox from Skoon Energy. The Skoonbox battery container houses 314 lithium batteries, good for 638 kWh of renewable energy. The world's first maritime-certified, multipurpose battery container will be used to deliver renewable power at Damen's yards for applications where diesel generators or ships' engines are primarily used. This 20-ft. container is the first step toward Damen's sustainable battery network for mobile and temporary applications. In time, it can potentially also be deployed for customers worldwide.

Technip FMC Sells Technip Energies Shares

TechnipFMC plc has sold 9 million Technip Energies N.V. shares through private sale transactions at €13.15 per share, yielding total gross proceeds of €118.4 mil-

lion. Upon completion of the sale, representing approximately 5 percent of Technip Energies' issued and outstanding share capital, TechnipFMC retains a direct stake of approximately 7 percent of Technip Energies' share capital.

AI Solution for USC Barnkrug Fleet

Berlin-based Kaiko Systems has entered a partnership with USC Barnkrug. After a successful trial phase, the ship management company decided to roll out Kaiko Systems' solution to its entire fleet.

Kaiko Systems enables shipping companies to collect structured and verified inspection data and process the data into actionable insights using AI. This helps companies avoid incidents, reduce downtime and optimize their maintenance costs.

Sovereign Wealth Funds Shift to ESG Investments

Sovereign wealth funds (SWF) are the latest class of investors increasingly focusing on sustainability-centered products. The involvement comes as investors continue to push asset managers to focus on environmental, social and governance (ESG) products.

According to data acquired by Finbold, SWF investments in the ESG space globally surged 215.27 percent between 2020 and 2021, from \$7.2 billion to \$22.7 billion. Over the same period, the number of deals increased from 19 to 37.

In 2019, the investment stood at \$5.2 billion, while in 2018, the figure was \$6 billion, a slight drop from 2017's value of \$6.6 billion. Over the last six years, 2016 recorded the least investment at \$3.7 billion.

In 2021, SWFs' involvement in the oil and gas space dropped 46.92 percent to \$6.9 billion from 2020's figure of \$13 billion. Last year also recorded the lowest deals in oil and gas at eight.

Sonardyne Hybrid Positioning Chosen for Vessels

Sonardyne's acoustic and inertial position reference systems have been chosen to underpin the critical station-keeping activities of multiple deepwater vessels operating in the energy and ocean research sectors.

Through a combination of upgrades to existing installations and the purchase of new systems, four deepwater drillships, a marine construction vessel and a floating



production system working in North and South America will be using Sonardyne's 6G (sixth-generation) Marksman DP-INS technology. In addition, an ultradeepwater scientific drilling vessel has now also upgraded its Marksman DP-INS system to the latest (sixth-generation) equipment configuration.

'Innovating Maritime' Project in UK

Regional cluster organization Mersey Maritime is launching a new service to its northwest maritime ecosystem, which will help organizations maximize and capitalize on innovation funding opportunities within the U.K.'s maritime sector, worth almost £50 billion. In alignment with national and international targets, including the Maritime 2050 strategy, Mersey Maritime is set to fully fund a pilot project called "Innovating Maritime," led by Dr. Matt Fulton from the University of Liverpool.

Following the COP26 global climate summit, the U.K. is setting ambitious targets to decarbonize its maritime economy, but many smaller firms are confused about how to make the most out of these opportunities. Mersey Maritime's Innovating Maritime project will help by pointing toward sources of funding and providing expert support and end-users, helping drive innovation.

Bollinger Delivers Another FRC to USCG

Bollinger Shipyards LLC has delivered the USCGC *Clarence Sutphin* to the U.S. Coast Guard (USCG) in Key West, Florida. This is the 170th vessel Bollinger has delivered to the USCG over a 35-year period and the 47th fast response cutter (FRC) delivered under the current program. The USCGC *Clarence Sutphin* is the final of six FRCs to be home-ported in Manama, Bahrain.

Patent for Woolpert LiDAR System

Woolpert has been granted a patent by the U.S. Patent and Trademark Office for its "Airborne Topo-Bathy LiDAR System and Methods Thereof." A LiDAR sensor system was developed by a multidisciplinary research and development team incorporating these technologies that enable the collection of high-resolution topographic and bathymetric data at a higher altitude, resulting in a broader swath than previously developed LiDAR systems. The patent applies to the technologies that enable the LiDAR system's optical design, hybrid detector approaches and field-of-view management.

Addition to KVH Watch Program

Navis Engineering, a maritime dynamic positioning (DP) control system manufacturer, has joined the KVH Watch Solution Partner program and will offer KVH Watch Cloud Connect services to deliver a remote monitoring solution for its DP and joystick maneuvering control systems. Navis's primary markets are the oil and gas and renewables industries.

CCUS in US Gulf of Mexico Policy Paper

The National Ocean Industries Association (NOIA) has released the policy paper "Carbon Capture, Use, & Storage: An Economic, Employment, & Climate Opportu-

nity for the U.S. Offshore Region." Along with key policy recommendations, the document details the vast advantages that the deployment of carbon capture, use, and storage (CCUS) in the U.S. Gulf of Mexico can provide as the U.S. works to meet ambitious emissions reduction targets to address climate change.

Eco Wave Power Ceremony at Nasdaq

Eco Wave Power Global AB, specializing in the production of clean electricity from ocean waves, has held its official bell ringing ceremony on the Nasdaq Stock Market to celebrate becoming a public company on the Nasdaq U.S. Eco Wave Power began its trading on the Nasdaq in July 2021, under the symbol "WAVE."

Geodata Science Skills Project

Fugro has joined the University of Houston (UH) and its four partnering universities, UH-Downtown, UH-Victoria, UH-Clear Lake and Sam Houston State University, on a project to advance geodata science skills in the energy sector. The project, Data Science for the Energy Transition, is being funded by a three-year grant from the National Science Foundation (NSF) and will offer undergraduate and master's students specialized training in statistical and machine learning techniques for subsurface geodata. Fugro's role as an industry partner on the project is to provide UH with real-world geodata and guidance for hands-on training opportunities. **ST**

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Sonardyne's Fusion 2 Supports Construction in Australia

Combined long baseline (LBL) acoustic positioning and inertial navigation system (INS) software from Sonardyne has helped to support the latest phase of an offshore project in northwest Australia. The project is the first full use of Sonardyne's Fusion 2 software and associated 6+ hardware in the country.

Geodata insights firm UTEC, the lead brand for Acteon's geoservices segment, used Fusion 2 software and 6+ hardware in support of full and sparse LBL operations to position and install a new subsea well gathering system being tied back to an existing facility.

DelTek Helps Deliver Deepwater Well in GOM

Well construction expert Deltek Global has supported PETRONAS Mexico in the successful deliv-

ery of a deepwater exploration well (BC-1) off the coast of Tampico in over 5,000 ft. of water.

This project marks the first Gulf of Mexico (GOM) deployment of DeltaTek's cementing technology, SeaCure, and the world's first deepwater application of QuikCure, DeltaTek's rapid cement hydration technology.

SeaCure, DeltaTek's flagship technology, provides stabbed-in inner-string cementing for subsea wells. QuikCure is a patented process that utilizes SeaCure as a conduit for circulating heated fluids inside the casing after the cement job, which increases the environmental setting temperature and helps to rapidly build compressive strength in the cement.

ICR Aids Cruden Bay Terminal Regeneration

ICR Integrity, a provider of in-

tegrated maintenance, repair and production solutions for the offshore oil and gas, power, defense, nuclear, utilities and renewables industries, has completed a crucial scope of work for Doosan Babcock on the Forties Pipeline System (FPS) shutdown project at the Cruden Bay Booster Station in northeast Scotland. By utilizing ICR's multi-skilled team, headcount was reduced by six providing time and cost savings for the project.

The three-week shutdown, intended to ensure reliability to 2040, supported the removal and reinstallation of the main valves and piping from the sealine receiver from the Forties field through to the new, above-ground piping system and pig launcher at the land line during the planned FPS outage scope.

Petrobras Relies on TechnipFMC Flexible Pipe

TechnipFMC has been awarded three frame agreements by Petrobras



The poster for the 2022 CHC (Canadian Hydrographic Conference) features a yellow background with a green silhouette of the Ottawa skyline, including the Peace Tower. A large blue wave graphic is on the right. The text includes the conference name in English and French, the location (Gatineau/Ottawa), dates (June 6-9, 2022), and the theme 'Hydrography 2022: A World Transformed'. The CHC2022.ORG website is at the top right, and the CHC logo is at the bottom right.

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that reaffirm the company's leadership position in Brazil's flexible pipe market. Altogether, the frame agreements form a large contract for TechnipFMC.

The contracts were awarded as part of Petrobras's drive to increase oil recovery in its brownfield developments, mainly in post-salt fields offshore Brazil. The frame agreements cover the manufacture of more than 500 km of flexible pipe over the next four years, as well as services. This brings the company's total contracted volumes in the current year with Petrobras to around 600 km.

JF Subtech Completes First Project After Rebrand

James Fisher Subtech (JF Subtech) has successfully completed a challenging subsea inspection, repair and maintenance project for Ithaca Energy on its floating production facility, the FPF-1, 280 km east-southeast of Aberdeen. JF Subtech achieved incident-free operations with a 99 percent equipment operational uptime rate.

This is a milestone for JF Subtech as the first project completed following a rebrand in March 2021, when the group consolidated its core competencies to provide expertise for offshore extremes.

Utilizing a mix of air diving and ROV techniques, JF Subtech undertook the installation and removal of cofferdams to facilitate internal valve maintenance, carried out rectification on riser guides and completed essential inspection work on over 160 areas of the FPF-1 hulls and substructure.

Despite having to contend with short workable weather windows, the team on board the *Olympic Challenger*, a DP2 construction vessel equipped with a JF Subtech air dive spread and Cougar light work-class ROV system, was able to execute 80 air dives and 126 hr. of ROV operations.

TDI-Brooks Survey for BOE

TDI-Brooks has completed a geotechnical site investigation for Beacon Exploration & Production LLC (BOE) in the deepwater Gulf

of Mexico. The project consisted of "heavy" geotechnical coring/cone penetration testing (CPT) with TDI-Brooks' RV Gyre.

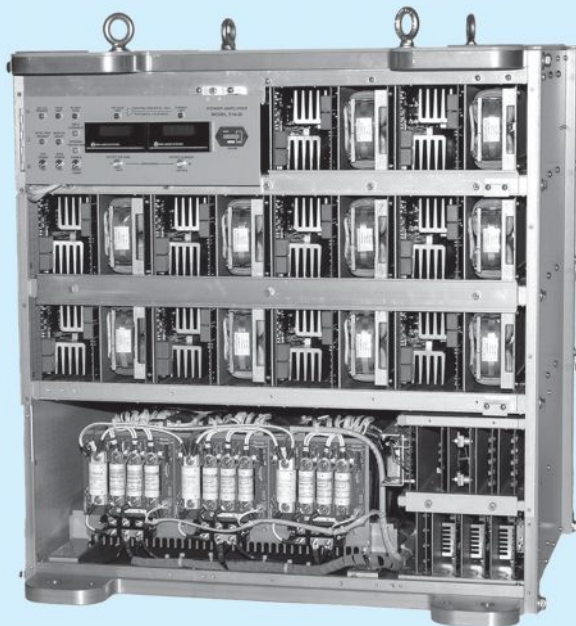
The project included the acquisition of 20-m Jumbo Piston coring, 40-m CPT-Stinger samples and 40-m Shelby-tube Stinger samples. Other piston, box core and gravity CPT (gCPT) samples were acquired, associated with oil and gas export pipelines.

Deepwater AI AUV

A consortium led by the German Research Center for Artificial Intelligence, as part of the Mare-IT project, has developed a two-armed, 6,000-m-depth-rated AUV for complex inspection and maintenance tasks for subsea offshore installations. Its IT infrastructure enables intuitive control and monitoring and effective information flow with the plant operator. **ST**

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Environmental Planner



A dynamic timeline provides a real-time look ahead at the environmental rules and restrictions in force during a voyage. Navigational and environmental planning can be done in a simple, integrated workflow. The timeline displays a comprehensive list of environmental events that can safely and legally take place aboard a vessel during a rolling 12-hr. window, based on the ship's departure time, its current position and speed. OneOcean Group.

GPS, Data Combo

GPS trackers collect precise, real-time data on the positioning of each vessel, which are processed and analyzed by the Marinsights platform to provide meaningful insights that can improve safety, optimize operations and reduce fuel consumption. Opsealog and IDEN-TEC SOLUTIONS AG.

Offshore Compass

The 5-in. Globemaster Binnacle-Mounted Compass provides an exact course heading no matter the speed and becomes crucial in the event of a power failure. It is available in three dial styles: 5° or 2° marks, or 2° marks with points. Designed for use in any lighting condition and engineered for extreme offshore conditions, it is ideal for sailboats, yachts, sportfishers or workboats. Ritchie Navigation.

Corrosion Protection

Lubricant additive M-535 is compatible with ashless oil systems. This is valuable for gearboxes, turbines and other lubrication systems at

risk for corrosion from trapped water or moisture condensation. It has been formulated for use in turbines, as well as many general lubrication systems where ashless chemistry is not mandatory. Cortec Corp.

Electronic Logbook

DNV has approved NAPA Logbook's MARPOL electronic record keeping following the implementation of MARPOL Annex I, II, V, VI and the NOx Technical Code. This will support the shipping industry's transition from traditional hard-copy record books to electronic record books. NAPA.

Hydrographic Software



NaviSuite Kuda Core supports hydrographic surveys with a single USV or small survey vessel using multibeam echosounder (including backscatter), LiDAR and/or camera. It is simple to configure and run, and affordable for entry-level survey professionals. Advanced features include autonomous operations. EIVA a/s.

GFCI Receptacle

In a damp and corrosion-prone on-board environment, electrical devices can short circuit to ground, creating a potentially fatal shock hazard. Installing a 15-A, 125-V AC GFCI receptacle is a simple way to help keep people safe. It is offered in standard, weather-resistant and extra-heavy-duty models in a wide range of colors. Hubbell Marine Electrical Products.

Sustainability Assessment

A new online self-assessment tool enables the tracking of individual progress against environmental

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Oyster Aquaculture Could Improve Potomac River Estuary

Oyster aquaculture in the Potomac River estuary could result in significant improvements in water quality, according to a new NOAA and U.S. Geological Survey study published in *Aquatic Geochemistry*. 40 of the oysters currently planted in the Potomac River estuary were removed if 40 percent of its riverbed were used for oyster cultivation, according to the latest study. [3-2 SeaTech.com](#)

Navy's Laser Weapon Ready For Summer Deployment

Navy engineers are making final adjustments to a laser weapon prototype that will be the first of its kind to deploy aboard a ship into the sea. The prototype, an improved version of the laser weapon system, will be installed on the USS Zumwalt (DDG 1000) in the Persian Gulf. Navy leaders have made direct-energy weapons a top priority to counter what they call asymmetric threats, including unmanned and light aircraft and small attack boats that could be used to deny U.S. forces access to certain areas. [3-2 SeaTech.com](#)

Ferry Sinks Off Coast of South Korea

With 462 passengers aboard, a ferry sailing from Incheon, South Korea, to the island of Jeju sank on the southern tip of South Korea Wednesday, reported Associated Press. Most of the more than 400 people on the ship were high school students headed for a school trip to the island. In the rescue effort, more than 60 vessels and at least 18 aircraft swept in to pull passengers from the water to safety. [3-2 SeaTech.com](#)

Pay Increase for Sailors Soon to Come

Sailors working in the coming weeks, reported the Virginia Pilot. On May 1, sailors serving on board ships will receive a pay raise. The increase in pay comes as an effort by the Navy to incentivize thousands of sailors seeking jobs. The bonus is a part of pay pay, a work to those who work in jobs involving long deployments. Currently, this stipend is between \$30 and \$700 dollars. [3-2 SeaTech.com](#)

US Senate Reviews DOE Budget Request

For fiscal year 2015, the Department of Energy requested \$27.3 billion. The U.S. Senate Appropriations Committee, Subcommittee on Energy and Water Development, held a hearing last week to review the funding request and discuss fiscal priorities. According to Lamar Alexander (R-Tenn.), research should be a focus of spending. [3-2 SeaTech.com](#)

US Technology Helps in Search for Flight 370

More than a month after Malaysia Airlines Flight 370 went missing, crews are hard at work trying to discover what happened to the Boeing 777. Acoustic signals emitted from the plane's black box, which houses records from the flight, provide a lead to the location of the plane, and eight countries are participating in the effort to scan the waters off the coast of Southeast Australia. Civilian Navy is helping in the search. [3-2 SeaTech.com](#)

2014 Sea Technology Buyers Guide Now Available

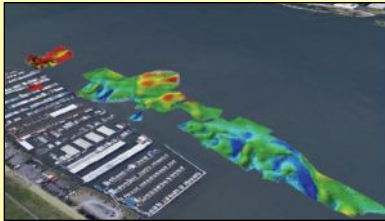
Published annually by Compass Publications, the 2014 edition of the *Sea Technology Buyers Guide* is now available. The *Buyers Guide* features a market analysis and seven sub-directories, including industrial forms, services, federal government organizations, educational institutions, oceanographic research vessels and geospatial survey vessels.

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sustainability expectations in the Recommended Code of Practice launched last year. The tool, which has been developed for IMCA members' internal use, presents their self-assessment score and a comparison with other users' outcomes. International Marine Contractors Association.

Sonar Software Updates



SonarWiz V7.09.00 enhances localization features and visualization of side scan sonar data sets with gap filler data. Depth below seafloor has been added to the SBP contact properties, and support is now available for Kongsberg Navlab bin files. Chesapeake Technology Inc.

Turbocharger Analytics

Turbo Insights is a new data analysis feature based on operational data received from the vessel, at no additional cost or need for additional hardware on board. Now as a standard feature on all two-stroke engine A100-L and A200-L turbochargers, this capability provides simple visual indicators of turbochargers' performance levels, both for individual vessels and entire fleets. ABB Ltd.

Radiometric Infrared Camera

The Boson camera module is now available in five additional configurations. The new models offer an 8°, 18°, 32°, 50° or 95° horizontal field of view at 640 x 512 resolution. They support industrial, commercial and defense integrators requiring high thermal image resolution within a small, lightweight, low-power package. Teledyne FLIR LLC.

Carbon Accounting Reporting

An expanded toolset for monitoring, measuring and benchmarking shipping-related GHG emissions

will help accelerate the reduction of Scope 3 emissions across maritime supply chains. Carbon outputs and key emissions hotspots can be identified and used to establish attainable paths to emissions reduction. Users also benefit from vessel, cargo and route type filters; supplier comparisons; and vessel performance metrics to make informed sustainability decisions and set intelligent ESG strategies. RightShip.

Sonar Combo

Building on the success of the popular 6205 and 6205s systems, the 6205s2 has been redesigned into a more compact and lighter package that comes with additional features, including options for an integrated INS, higher-resolution frequency pair of 850/1,600 kHz, and gap-fill side scan output. 6205s2 produces real-time, high-resolution, 3D maps of the seafloor and provides integrated swath bathymetry and a dual-frequency side scan sonar system. EdgeTech.

Environmental Compliance

AER Monitoring & Analysis, CII Monitoring & Analysis, and MRV & DCS Compliance Documentation and Reporting are new tools to help shipowners to keep pace with evolving maritime environmental regulations. The tools allow owners to monitor and analyze their fleets' greenhouse gas emissions (GHG) against industry metrics and facilitate the reporting of GHG emissions. METIS Cyberspace Technology SA.

GNSS Reference Antenna

VeraChoke provides multipath suppression and repeatability of phase center variation (PCV) and group delay variation (GDV). It has a very tight PCV and strong multipath mitigation, and it performs across the full GNSS spectrum. The PCV and phase center offsets (PCOs) are repeatable from unit to unit, making the antenna ideal for network RTK applications. Tallysman Wireless Inc. **ST**

EPA's Coral Research

Coral reefs cover less than 1 percent of the Earth's surface but house 25 percent of the world's biodiversity. Coral reefs worldwide are under threat from natural and human-made stressors, including dredging, climate change and plastic pollution. At the U.S. Environmental Protection Agency's (EPA) Coral Research Facility, an indoor wet lab in Gulf Breeze, Florida, scientists are studying how stressors such as sedimentation, ocean acidification and microplastics affect corals' health.

The facility is EPA's only coral laboratory and is one of only a few research facilities in the U.S. that operates with recirculating systems. This unique setup uses natural seawater from the Gulf of Mexico and allows scientists to maintain and grow corals in culture systems for use in research at any point during the corals' development.

Using recirculating systems, researchers can precisely control many environmental factors, including temperature, salinity, light and other variations in water quality, allowing them to isolate the specific stressors they are studying in order to target areas for better management practices.

Recently, EPA scientists studied how microplastics impact two different species of coral and found that long-term exposure to microplastics impaired the corals' growth. Specialized lab equipment at the facility allows researchers to estimate corals' 3D surface areas using 2D photogrammetry. Unlike other measurement methods that can destroy coral samples, photogrammetry is nondestructive and allows researchers to measure the growth rate of corals without harming them throughout experiments.

The exact mechanisms causing adverse effects remain unknown. One theory is that ingested microplastics could block the corals' digestive tracts, which would either leave them feeling satiated, like they have a full stomach, or prevent digestion of their natural diet.

Additional research has shown that microplastics adhering to coral tissue could also impact coral, either by preventing them from capturing prey or causing them to lose precious energy removing microplastics from their surface.

Although scientists now know that microplastics can impact coral, the next steps will be to determine if other stressors, such as increased temperature, combined with microplastics have cumulative impacts on coral.

While EPA's Coral Research Facility has focused primarily on Atlantic corals, scientists are exploring options to study Pacific corals in the future.

NSF Grant for Automated Hull Inspections

With increasing water temperatures from climate change, the extent of biofouling on hulls can increase. As modern ships need to maintain their speeds to reach destinations on tight schedules, hull fouling leads to increased fuel consumption and, thereby, higher greenhouse gas emissions. Hull fouling can also include ma-

rine invasive species that hurt coastal ecosystems near ports and cause negative economic impact in sensitive regions.

Berkeley Marine Robotics Inc. (BMR) has been awarded an innovation research grant (SBIR) by the U.S. National Science Foundation (NSF) to conduct R&D and field demonstration of an autonomous underwater swarm robotic system that can perform rapid automated inspections under ships to assess hull biofouling and detect invasive species.

BMR is working on an innovative system of autonomous swarm control and underwater wireless communication to enable fast, low-cost, automated inspections of all ships coming into a port. The unmanned system will measure and track hull-fouling levels to optimize cleaning schedules and increase coating performance. Simultaneously, the system scan can flag invasive species to ports and thereby reduce costly delays in manual spot checks. BMR's objective is to enable shipping operators to reduce their fuel costs and help them comply with the International Maritime Organization's (IMO) stipulated goal for carbon emission reduction.

\$12.6 Million for US Marine Highways

The U.S. Department of Transportation's (DOT) Maritime Administration (MARAD) has awarded \$12.6 million in grants to nine marine highway projects under the America's Marine Highway Program (AMHP). AMHP grant funding will also expand existing waterborne freight services in Delaware, Hawaii, Indiana, Kentucky, Louisiana, North Carolina, New York, New Jersey, Tennessee, Texas and Virginia. AMHP will promote novel and more efficient transportation options and enhanced surface transportation system performance, with the assistance of public and private stakeholders.

This is in addition to the funding approved under the Bipartisan Infrastructure Law (formerly known as the Infrastructure Investment and Jobs Act)—\$25 million to support marine highway projects and to increase the use of U.S. waterways. The funding in this law for the Port Infrastructure Development Program (PIDP) is roughly equivalent to previous investments in total port infrastructure from all DOT-administered grant programs since the start of federal investments in ports.

Preliminary Results from 2021 Hurricane Data

Five Saildrones collected data during the 2021 hurricane season, and NOAA has announced preliminary results from this ground-breaking mission. During Hurricane Sam, scientists were watching the real-time data from SD 1045 and noticed something surprising: The ocean wasn't cooling. "I thought there was something wrong with one of the sensors, but that wasn't the case," said Greg Foltz, a physical oceanographer at NOAA's Atlantic Oceanographic and Meteorological Laboratory. "There actually was no cooling. There was a lot of freshwater in that area, which added stability to the ocean and may have minimized the vertical mixing by the strong winds. The bottom line is that when salinity is lower in the ocean, rapid intensification is more likely." **ST**

Submarine Built in India

INS *Vela*, the fourth P75 *Kalvari*-class submarine, has been commissioned in India's Navy. The vessel was built by Indian shipyard Mazagon Dock Shipbuilders Ltd. (MDL), based on the Naval Group Scorpene design.

The commissioning highlights the success of India's indigenous submarine construction program and demonstrates the successful technology transfer from Naval Group during the construction and trials of the first three boats.

DDG-121 Delivery for US Navy

Huntington Ingalls Industries' (HII) Ingalls Shipbuilding division has delivered the *Arleigh Burke*-class guided missile destroyer *Frank E. Petersen Jr.* (DDG-121) to the U.S. Navy. It is the 33rd destroyer Ingalls has built for the Navy, with four more currently under construction.

DDG-121 is named for Frank E. Petersen Jr., who was the U.S. Marine Corps' first African-American aviator and general officer. After entering the Naval Aviation Cadet Program in 1950, Petersen went on to fly more than 350 combat missions during the Korean and Vietnam wars.

Kongsberg Sonars for Norway, German Navies

Active sonar suite and bottom navigation technology from Kongsberg Maritime has been selected for installation on Type 212CD-class submarines for both the Norwegian and German navies.

The KONGSBERG technology package comprises SA9510S MKII mine avoidance and navigation sonars (MANS) and a bottom navigation system (BNS) containing EM2040 MIL multibeam echosounders and an EA640 echosounder suite. These sensors provide input to Kongsberg Thyssen Atlas JV's (kta naval systems) ORCCA navigation system to enable safe, indigenous, submerged operation of the submarines. ORCCA, a combat system for non-nuclear submarines, enables operators to conduct an integrated data analysis from a wide range of systems on board via one multifunctional console for rapid, well-informed decision making.

DriX USV for Polish Navy

The Hydrographic Office of Poland's Navy has purchased an iXblue DriX USV through the company's local partner, THESTA. The 8-m DriX is equipped with advanced sensors (radar, LiDAR, cameras, etc.) and artificial intelligence to analyze its environment, avoid obstacles and conduct missions autonomously. With its launch and recovery system, DriX can deploy from a vessel or sail from a harbor to autonomously map large areas of the ocean.

Mine-Hunting Sonar Agreement

MIND Technology Inc. has entered into a cooperative research and development agreement (CRADA) with the U.S. Navy's Naval Surface Warfare Center, Panama City Division (NSWC PCD). The CRADA, titled "Advanced



Mine Finding," will allow scientists and engineers from MIND and the U.S. Navy to collaborate on optimizing the next generation of mine-hunting sonar systems to ensure that they fit the needs of the warfighter.

Spare RIX Liquefier Modules for US Ships

RIX Industries has received a contract award by the U.S. Defense Logistics Agency for spare RIX liquefier modules for the Navy's existing shipboard-qualified liquid oxygen (LOX) production systems, also from RIX. These LOX units, currently deployed on board USS *Gerald R. Ford* (CVN-78) and USS *John F. Kennedy* (CVN-79), and planned for future USS *Gerald Ford*-class aircraft carriers USS *Enterprise* (CVN-80) and USS *Doris Miller* (CVN-81), leverage thermoacoustic Stirling pulse tube liquefier module technology to produce liquid oxygen for aviation personnel and shipboard medical use.

ARMADA to Develop UUV Payload Delivery

ARMADA Marine Robotics has won an SBIR Phase I contract with the U.S. Navy to develop an external payload delivery system for cylindrical UUVs. The project extends previous work by Woods Hole Oceanographic Institution (WHOI), which will collaborate with ARMADA on the project. The feasibility study will validate hydrodynamic stability and drag via simulation and in-water tests of different-size UUVs with various sizes and numbers of payloads.

ARMADA is a spinout from WHOI to commercialize a novel form of propulsion for underwater vehicles that was developed at WHOI. **ST**

contracts

The World Association for Waterborne Transport Infrastructure, London, U.K., has signed a memorandum of understanding to enhance the impact of both organizations in waterborne transport infrastructure and to cooperate, communicate and collaborate in the ship-shore interface. Oil Companies International Marine Forum.

NOVACAVI, Milan, Italy, will design and manufacture a special electric data cable for the new DB 24000 EOL data acquisition buoy. This specially engineered armored cable presents a copper four-conductor configuration and a double armor made of high tensile 316 stainless steel, preformed and prestressed wires. Mobilis.

TechnipFMC, Newcastle, U.K., has been awarded an integrated engineering, procurement, construction and installation contract that covers a high-pressure, high-temperature subsea production system and associated equipment for a brown-field tieback in the Åsgard field in the Norwegian Continental Shelf. Equinor.

EDS HV Group, Haslingden, U.K., part of James Fisher Renewables (JF Renewables), has won a multi-million-pound contract to provide the high-voltage safety management commissioning phase at the Baltic Eagle offshore wind farm off the coast of the German region of Pomerania. Iberdrola.

Fugro, Nootdorp, Netherlands, will undertake cable route surveys for the North Sea Energy Island project. The Energy Island will serve as an offshore power plant distributing up to 10 GW of offshore wind to Denmark and neighboring markets. Energinet.

Marcura's, Dubai, United Arab Emirates, PortLog platform will manage port time for an entire fleet of modern handysize and supramax dry bulk ships. Pacific Basin.

SEA-KIT International, Essex, U.K., will supply a SEA-KIT XL-class USV for future North Sea operations. The 18-m USV, the first of its kind, will be built at SEA-KIT's expanding production facility on the Essex coast. Fugro.

Strategic Marine (S) Pte Ltd., Singapore, has secured a contract to build and deliver a 40-m fast crew boat for a new client in Malaysia. Blue Petra Sdn Bhd.

Wärtsilä, Helsinki, Finland, has received its first order for newbuild methanol-fueled engines. A new offshore wind installation vessel will be powered by five Wärtsilä 32 engines capable of operating with methanol. Van Oord.

Kongsberg Maritime, Kongsberg, Norway, will deliver 20 US205FP and US255FP thruster units for installation on new azimuth stern drive tugboats. Sanmar Shipyards.

Damen, Gorinchem, Netherlands, is expanding its ballast water treatment system (BWTS) portfolio with oneTANK, a small BWTS that uses chemical injection methods to clean ships' ballast water. ERMA FIRST. **ST**

meetings

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

APRIL

April 4-7—Nor-Shipping, Oslo, Norway. +47 932 56387, sn@nor-shipping.com or www.nor-shipping.com.

April 5-7—Floating Energy Systems Asia, Virtual. offshorevents@endeavorb2b.com or www.floatingennergysystemsconference.com.

April 12-14—MCEDD Deepwater Development, London, U.K. 713-520-4470, Sara.Wilkins@GulfEnergyInfo.com or https://mcedd.com.

April 12-14—Tech Surge: Florida Estuary and Coastal Monitoring - Looking Ahead to 2030, Fort Pierce, Florida. www.mtsociety.org/fl-techsurge.

April 20-22—NOIA Annual Meeting, Washington, D.C. apar@noia.org or www.noia.org/noia-2022-annual-meeting.

April 25-28—AUVSI XPONENTIAL, Orlando, Florida. www.xponential.org/xponential2022.

April 26-28—International Offshore Wind Partnering Forum, Atlantic City, New Jersey. https://www.offshorewindus.org/2022ipf.

MAY

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

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

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

JUNE

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

June 1-3—MegaRust, San Diego, California. 703-836-6727, asnehq@navalengineers.org or www.navalengineers.org/Symposia/MR2022.

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

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

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

June 21-23—Interspill, Amsterdam, Netherlands. +0333 444

1890, info@interspill.org or www.interspill.org.

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

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

JULY

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

SEPTEMBER

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

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

OCTOBER

October 9-12—Maritime Cyprus, Limassol, Cyprus. <https://maritimecyprus.dms.gov.cy>.

October 16-19—AAPA Annual Convention & Expo, Orlando, Florida. <https://my.aapa-ports.org/AC2022/Home/AC2022/Home.aspx>.

October 18-20—International Ocean Conference on Ocean Energy and Ocean Energy Europe, Donostia/San Sebastián, Spain. <https://icoeoe2022.donostia.org>.

October 18-21—EURONAVAL, Paris-Le Bourget, France. euronaval.fr.

2023 MARCH

March 26-28—Canadian Underwater Conference & Exhibition (CUCE), Halifax, Canada. www.cuce.ca.

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

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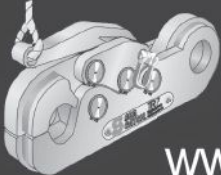
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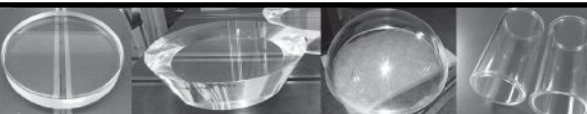
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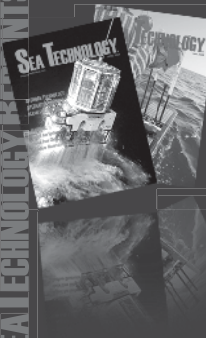
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The Blue Economy Diversifies in the Age of Wind—Bente Pretlove

Bente Pretlove is the program director for Ocean Space in DNV Group Research and Development. In this role, she manages DNV's research efforts related to the sustainable development of ocean-based industries. She is the co-chair for blue growth in the EU technology platform "Waterborne" and is a member of the international Advisory Board for the UN Decade of Ocean Science for Sustainable Development.



The blue economy is entering a period of sectoral and geographic diversification. Currently, the regions that benefit most from the ocean in economic terms are those with access to oil and gas fields off their coastlines. But as the world decarbonizes and the need for renewable energy grows, countries unable to be part of the age of fossil fuel can be part of the age of wind.

DNV's "Ocean's Future to 2050" predicts that the exponential growth of offshore wind power will be the main driver of a nine-fold increase in demand for ocean space by mid-century. Offshore wind will require ocean space equivalent to the land-mass of Italy by 2050. The growth will be pronounced in regions with long coastlines that presently have low penetration of offshore wind.

The rise of wind will be pivotal to the transformation of the blue economy. Currently, 80 percent of capital expenditure (capex) in the blue economy is invested in the offshore oil and gas sector, but by 2050 that number will drop to 25 percent. By then, offshore wind will receive the largest investments, accounting for half of all capex. The decreasing prominence of oil and gas will be largely responsible for capex inflows into the blue economy being less in 2050 than today, while operating expenditure will increase below GDP growth. Capex in the blue economy will decline

from \$517 billion in 2018 to \$461 billion in 2050. The cumulative capex in the period will be close to \$20 trillion.

Offshore wind production will grow strongly from the 2030s, supported by it powering rising hydrogen production. By 2050, offshore wind will provide about as much energy as offshore oil, but 31 percent less than offshore gas. Offshore wind will supply 13 percent of electricity by then, indicating 14 percent average annual growth between 2019 and 2050. Installed capacity of fixed offshore wind (1,800 GW) will be slightly higher than that of gas-fired power generation in mid-century, producing 25 percent more electricity in comparison.

Demand for ocean space will grow 50-fold in the Indian subcontinent and 30-fold in North America. The blue economy will be more focused on Asia, with Greater China to account for more than a quarter of capex by 2050 as it builds its offshore wind capacity and marine aquaculture. Greater China will experience steady growth from the current level of 10 percent of global capex to 26 percent in 2050, and will take a dominant position in the blue economy. Europe will maintain a strong position, growing from 11 to 14 percent. Yearly capex will decline in the Middle East and North Africa, in line with reduced fossil fuel demand.

Aquaculture production will more than double by mid-century, approaching the level of wild catch. But seafood (inland and marine) will account for only 9 percent of global protein demand in 2050. Total annual wildcatch is forecast to be 95 million metric tonnes by mid-century. This is above the sustainable yield limit and stresses the need for optimal fisheries management as highlighted by the UN Sustainable Development Goal 14 target to "effectively regulate harvesting and end overfishing, IUU

and destructive fishing practices." The forecasted trajectory shows that global efforts are falling short of meeting this goal.

In 2050, 368,000 km² of ocean surface will be occupied by infrastructure for energy and food production, compared to about 40,000 km² in 2018. This represents a tremendous challenge for marine spatial planning. The great majority of the forecasted area occupied will be required for offshore wind production; marine aquaculture will represent a much smaller footprint.

Shipping plays a major role in the blue economy as the mode of transport for 80 percent of global trade. Special vessels support all ocean-based activities, and ports connect seaborne trade with land-based logistics. There will be a shift in the types of cargo and vessels between 2018 and 2050. The total trade volume and the merchant fleet will see a smaller growth compared to historical trends.

After years of faster-than-GDP growth, seaborne trade will only grow 35 percent to 2050, while global GDP almost doubles. Bulk will remain the largest segment in the merchant fleet, despite reduced demand for coal transportation. Tankers will be overtaken by container vessels as the second largest segment, even if demand for gas tankers remains robust.

While serving a growing and more prosperous global population, future trade will also be impacted by the move toward more circular economies, reflecting a more climate-conscious and sustainability-focused society. The energy transition's ongoing decline in coal and oil consumption, and a much later reduction in natural gas use, will significantly impact future fleets. The resulting changes in seaborne trade will also affect infrastructure, such as shipyards and ports.

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