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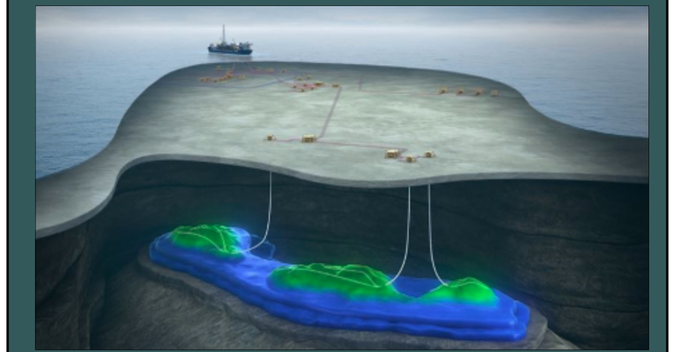
A MENCK hammer being utilised on Vatten fall'sHollandse Kust Zuid I–IV (HKZ) offshore wind farm project in the Netherlands'

AKER BP



Tyrving development

The Tyrving development leverages the planned extended lifetime for the Alvheim field and will increase production while reducing both unit costs and CO_2 emissions per barrel.

The Tyrving development consists of three wells and two new subsea installations (manifolds), tied back to existing infrastructure at East Kameleon and further to the Alvheim FPSO. Recoverable resources in Tyrving are estimated at approximately 25 million barrels of oil equivalent. Tyrving will operate with exceptionally low emissions, estimated at just 0.3 kg ofCO_2 per barrel.

DEEPSEA

Distribution equipment

Deepsea Technologies has recently been awarded the supply of subsea distribution equipment for an independent operator in the Gulf of Mexico.

The company will be supplying subsea distribution equipment including multiple Subsea Umbilical Termination Assemblies, Steel Tube Flying Leads and Hydraulic Distribution Unit.

GREENSEA WHOI

Greensea IQ has announced a strategic partnership with Woods Hole Oceanographic Institution (WHOI) to provide greater diversity of access and accelerate scientific innovation and discovery in the ocean. This operational collaboration with WHOI's Deep Submergence Laboratory (DSL) and the National Deep Submergence Facility (NDSF), hosted at WHOI, combines Greensea IQ's class-leading expertise in navigation, robotics, remote operations, and user interface systems with WHOI's outstanding reputation as a world leader in deep-sea exploration capabilities and expertise in the design and construction of underwater systems for scientific research.

The partnership will create scalable systems to support a wide range of oceanographic research, increasing access to the deep ocean. In addition, technologies and systems developed under this partnership will focus on improving operational efficiency, increasing compatibility with existing systems, and creating and supporting the tele-operation of ROVs.

The primary objective of the partnership between Greensea IQ and NDSF is to create an environment of open collaboration that will facilitate the integration of existing as well as new subsea platforms, that will benefit all of science and discovery in the ocean.

Regina Yopak, Product Manager of Science and Research Technologies at Greensea IQ, presents to WHOI

EXTENSION PROTOTYPE

The development is capable of upgrading VideoRay Defender ROVs

Greensea IQ has announced an extension to its prototype with the Defense Innovation Unit and U.S. Navy following the successful completion to Phase 3 of the Autonomous Expeditionary Maritime Response Vehicle (AEMRV) prototype last Autumn.

The objective of this contract modification is to demonstrate a production-ready edge processing configuration of Explosive Ordnance Disposal (EOD) Workspace, called EOD Edge, deployed in Greensea's IQNS, with the autonomy and Automatic Target Recognition (ATR) components. This contract extension signifies a closer step to providing this enabling technology to U.S. Navy EOD Technicians.

IQNS provides an NVIDIA edge processor, integrated fibre optic gyro, aiding navigation sensors, and Greensea's patented navigation solution for small underwater robots. IQNS is designed as an upgrade solution for systems currently running Greensea's defence software suite and is used throughout Greensea's own robot product line.

Greensea is augmenting IQNS for this programme with advanced autonomy capabilities for acquiring, classifying, and eventually neutralising subsea threats while maintaining a significant standoff for EOD personnel. This new development is capable of upgrading the existing fleet of VideoRay Defender ROVs currently employed by the Navy and other defence forces.

The Phase 4 objective of this contract focuses on further developing EOD Edge to incorporate advanced AI features such as target classification using sonar and "operator assist" autonomy while in an untethered or long-range standoff configuration.

HYDRINS

Exail, manufacturer of advanced inertial navigation systems (INS), has secured a new contract to supply three Hydrins INS to Pliant Offshore, an offshore measurement specialist. These units will be integrated into Pliant Offshore's Installation Measurement System (IMS) to improve the accuracy and efficiency of wind turbine installations.

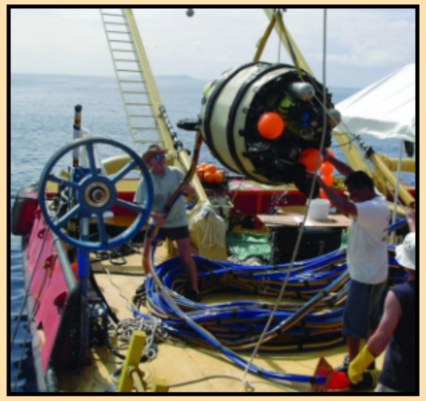
Pliant Offshore's IMS is an innovative technology designed to provide real-time measurements of the inclination and position of structures, such as monopiles, during installation. The system uses 3D point cloud technology combined with laser sensors to measure and virtually reconstruct objects with high accuracy.

The integration of Exail Hydrins INS enhances the system performance by providing precise positioning and motion compensation, even on moving vessels. This enables the IMS to take continuous measurements during the pile-driving process, guaranteeing the correct positioning and stability of wind turbines in challenging offshore conditions.

Installation

Exail Hydrins

SELF SEALING GROUT



Grouting

ASI successfully developed a patented Underwater Self-sealing Grout after research indicated there were no off-the-shelf grouting or mechanical technologies available to seal a leaky joint in a deep ocean outfall.

The patented Underwater Self-sealing can be readily pumped through 305m/1000 ft of a 2 cm/ 0.75in diameter hose without plugging, unlike commercial mixes with chemical additives.

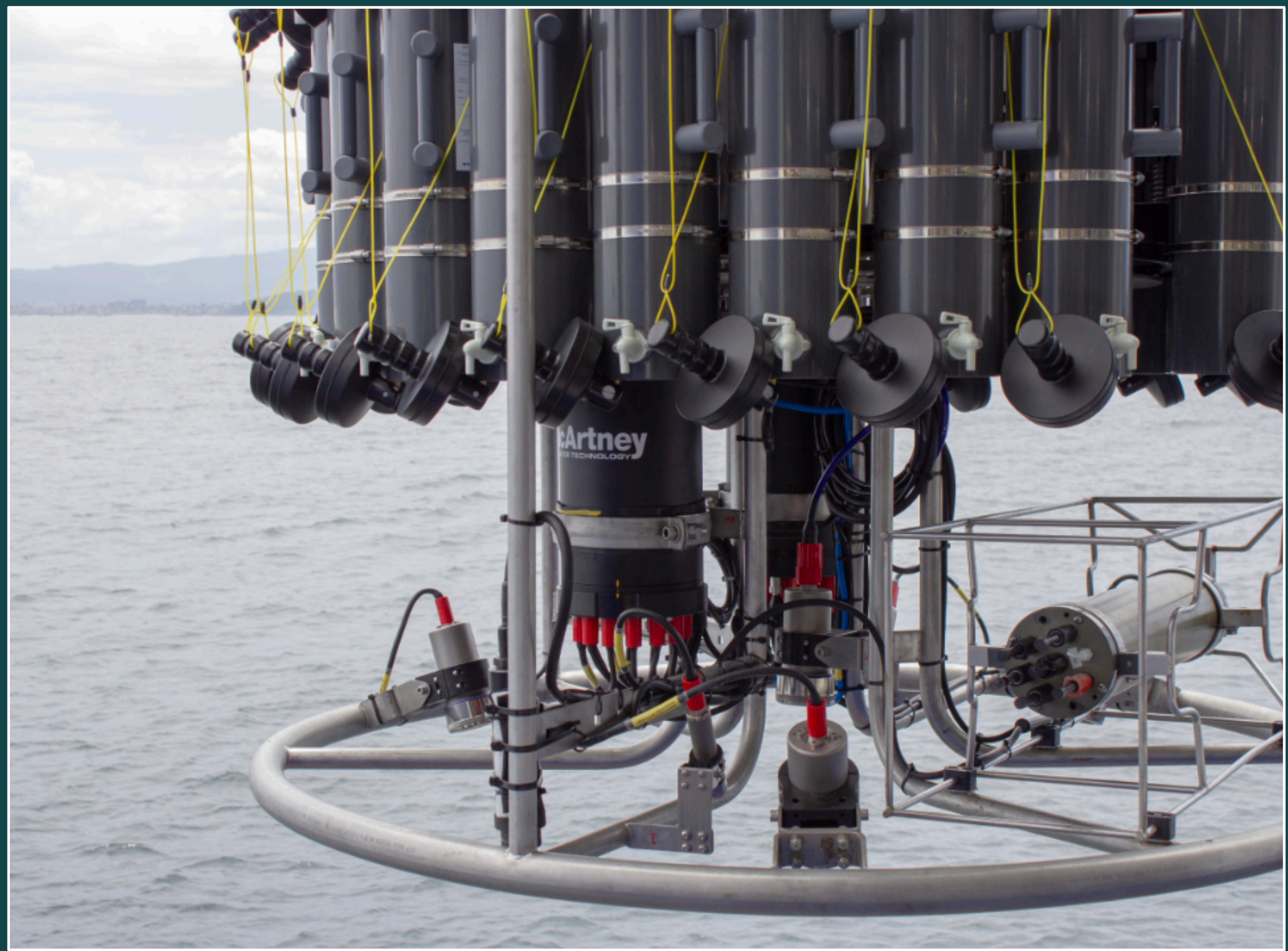
ASI's team developed the patented grout as a solution to seal several leaks of an outfall as part of an annual inspection project in Ponce, Puerto Rico.

The repair required remotely operated vehicle (ROV) deployment for reasons of safety, cost efficiency, water depth and extreme distance from the nearest manhole.

Deep water section of the outfall (115 m/376 ft deep) in the Ponce Deep Ocean Outfall had leaks that were inaccessible from the outside as they were covered in grout mattresses.

NEWS

MACARTNEY / SEA-BIRD SCIENTIFIC



Sea-Bird Scientific vertical profiling CTD system

MacArtney will distribute Sea-Bird Scientific's comprehensive precision instruments, enabling a broader range of solutions to meet customer needs. The partners are extending their collaboration to support ocean science, naval, and marine offshore customers while also broadening the range of ROTV integration options.

Known for their high-end, market-leading accuracy, Sea-Bird Scientific's instruments are engineered to withstand some of the harshest marine environments.

This new distribution agreement encompasses a wide array of equipment, such as a variety of sensors, water samplers, and auxiliary products, all designed to deliver unparalleled precision in measurements.

The contract covers distribution in Norway, Sweden, Finland, and Denmark, with MacArtney serving as an integrator partner for global projects. This partnership enables MacArtney to seamlessly integrate Sea-Bird Scientific products into its systems and offer turnkey solutions worldwide.

MacArtney already has a significant track record in projects integrating Sea-Bird Scientific equipment, including solutions comprising CTD systems for survey and research vessels, real-time oceanographic mooring solutions, purpose-built systems, and more.

MacArtney's workshops also offer essential maintenance support for Sea-Bird Scientific equipment and facilitate assistance in calibration tasks globally, ensuring marine instruments function optimally.

TOW CAM UPGRADE

A newly upgraded tow camera system from SubC Imaging is tailored to meet the evolving needs of seabed transects, visual surveys, and underwater inspections.

With enhanced real-time video capabilities, advanced stills capture, and user-friendly field deployment, this system empowers researchers and inspectors to collect high-quality visual data with unmatched precision and efficiency.

It has a maximum operating depth of 380m, utilizing Kevlar tow cable up to 410m. It features a high-specification Rayfin Coastal camera that streams uninterrupted real-time HD and 4K video with simultaneous 12.3MP digital stills, and topside recording.

Tow camera system

ROPELESS FISHING

Teledyne Benthos has been awarded a $975,000 grant from the National Fish and Wildlife Foundation (NFWF) to advance on-demand, or ropeless, fishing technology. Ropeless fishing provides lobster and crab fisheries a means to recover fishing gear remotely, through subsea acoustic communication, thus reducing, or removing, the need for ropes, lines, and surface buoys.

Teledyne Benthos, EdgeTech and the Sea Mammal Education Learning Technology Society (SMELTS) have been at the forefront of developing and testing ropeless fishing gear since 2018.

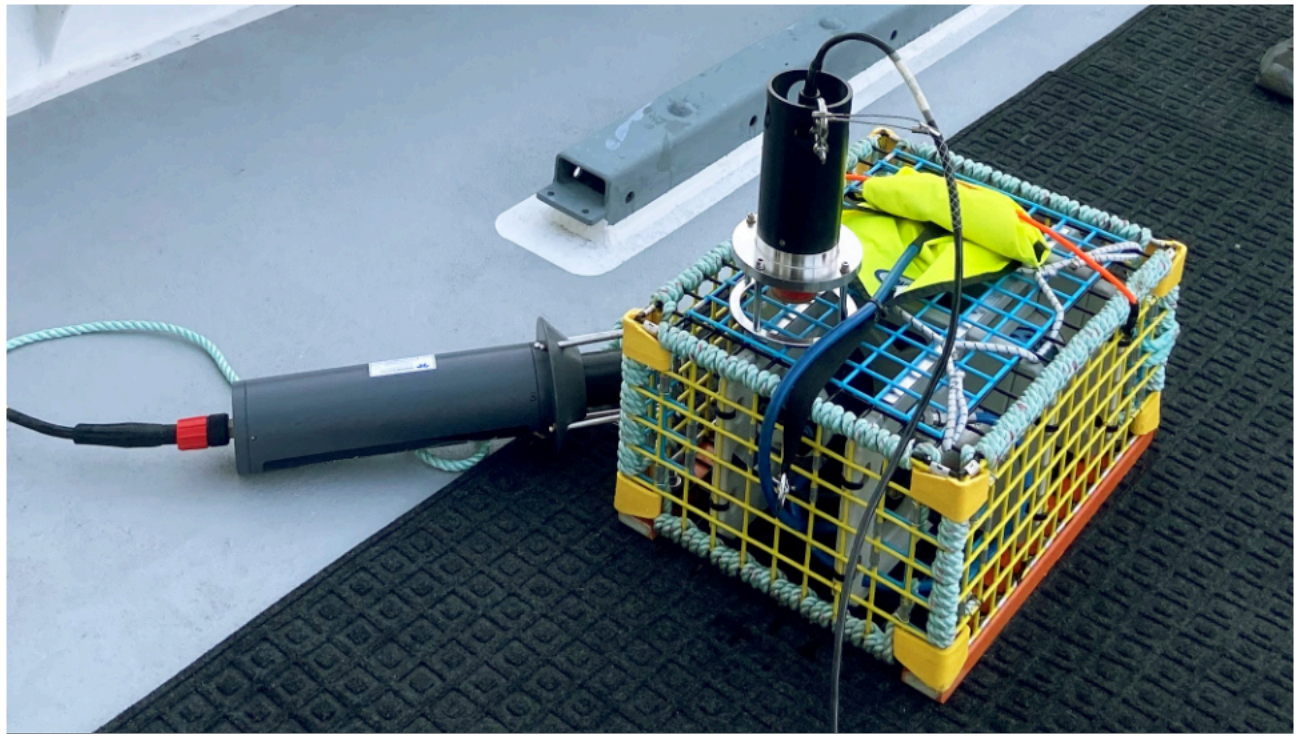
The funded project is focused on modifying commercial equipment to enable these organisations to collaborate on a common user interface and associated acoustic transducer for vessel or portable use. The focus will be the interoperability between transponders and acoustic modems developed by Teledyne Benthos and EdgeTech. Gear marking will also be improved through directional measurements, enabling a common interface with Teledyne Raymarine chart plotters, and enhance usability, making ropeless fishing gear more accessible to end users.

Teledyne Benthos acoustic modems are the backbone of the ropeless fishing system. They facilitate reliable subsea communication that provides the information needed to deploy and retrieve gear without the traditional ropes and lines that can entangle marine mammals.

Developing a universal deck box used with an associated transponder will allow for a robust method for gear marking and retrieval.

The transponders emit acoustic signals that are then detected by the vessel's deck box, enabling precise location marking and ensuring a seamless operation between Teledyne Benthos and other devices.

The integration of a chart plotter provides a user-friendly interface designed to meet practical needs.



Ropeless Fishing

HIGH RES SURVEY

Kraken Robotics recently completed a contract to supply high-resolution seabed mapping sonar service to Precision Hydrographic Services (PHS), a customer supporting the Australian Department of Defence.

The Australian Department of Defence project sought to undertake Hydrographic High Resolution Route Surveys (RS) for a number of Australian ports.

The purpose of these surveys was to enable the collection of Maritime Geospatial Information (MGI) to support maritime domain awareness through the acquisition of high-resolution seabed foundation data and associated oceanographic data.

Under the scope of Kraken's contract, a KATFISH high-speed survey/detection solution was used to acquire high-resolution route surveys of Australian ports.

Under the contract, the survey campaign commenced in January 2024 and was fully complete in May 2024. This contract follows the results of a successful in-country demonstration of KATFISH for the RAN in Q1 of 2023 and the purchase of a KATFISH system by the RAN last year.

Katfish lowered from an A Frame

IRON BULL

SEABED PRE-CUTTING AND CLEARANCE TECHNOLOGY

Seatools has unveiled Iron Bull, its patented seabed pre-cutting and clearance technology. This mitigates risks posed by adverse soil conditions and subsurface obstacles, offering Offshore Wind Farm (OWF) developers and contractors significant reductions in both risks and costs during offshore cable installation operations.

The technology removes all (sub-)surface objects, such as boulders and obsolete cables, that could obstruct cable laying and burial operations.It also loosens the soil through pre-cutting with unique drum cutting technology.

Achieving burial depths directly minimises cable manipulation during installation, reducing the risk of cable damage. Mechanical loads cause about 50% of subsea power cable failures.

Protecting critical infrastructure like submarine cables through effective burial against external threats such as anchors, fishery, and sabotage is vital.

However, cable burial in hard soil conditions like (boulder) clays, rocks, dense sands, and glacial till is a common industry challenge. Difficulties in meeting required burial depths, along with low and unpredictable progress rates, lead to high costs, high risk mark-ups, and construction delays.

By fully clearing and loosening the cable trajectory over a 4m width, productivity, predictability and accuracy in achieving required burial depths for subsequent cable operations are significantly enhanced.

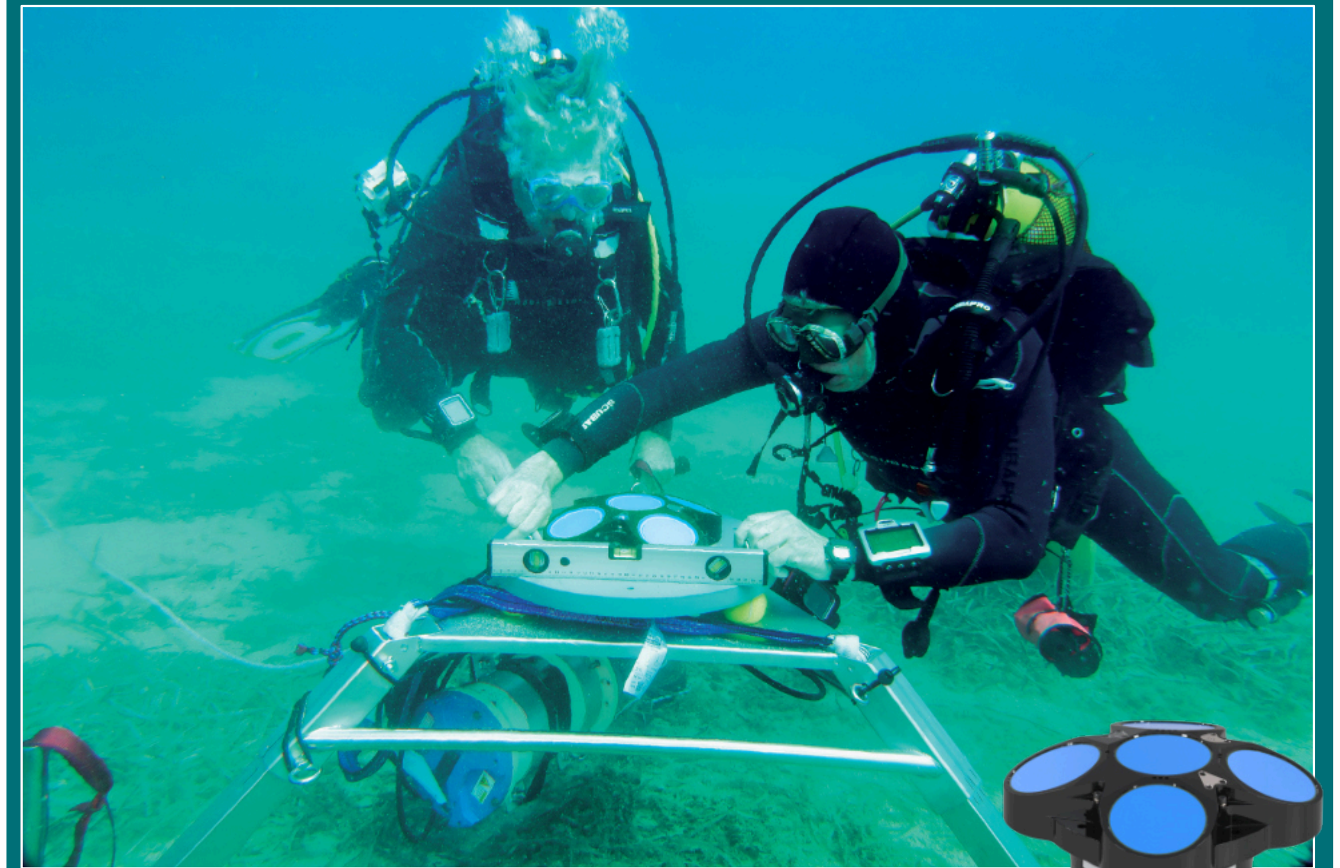
These improvements lead to substantial cost reductions due to shorter cable burial times and higher success rates in meeting required burial depths, reducing the need for extra unplanned protection work like subsea rock installations.

The technology features a 2 MW towed sledge, comparable in size and weight to a typical cable plough, incorporating robust and proven dredging technologies. Jet-assisted rippers at the front remove large obstructions like boulders.

The hydraulically tiltable rippers can exert immense break-out forces on objects stuck in the seabed, eliminating the need for costly vessels with high bollard pull capacities that would otherwise be required by conventional tools relying solely on towing forces to remove obstructions.

Additionally, the tool features twin counter-rotating drum cutters for transforming virtually any type of soil into loose, eventually jet-able material. The drum cutters, equipped with Seatools' proprietary jet assistance technology, prevent clogging even in the stickiest clay materials. Aft rippers remove any remaining small objects.

PROTEUS



Teledyne RD Instruments (RDI) has announced the Workhorse Proteus, the latest and most technologically advanced edition of its industry-standard Workhorse ADCP's.

RDI developed the industry's first commercially available ADCP in 1982.

With the processing horsepower to simultaneously sample at multiple spatial and temporal scales, Proteus can unlock a new understanding of waves, turbulence, and the changing currents below the surface.

Its technical advantages deliver the most data possible with a single instrument. Its features include the Proteus Advanced Doppler Sonar Platform (ADSP) - the most advanced Doppler processing platform; Catalyst Processor for fast processing; new RDI AHRS and dynamic bin mapping; elegant planning software; five beams for direct measurement of ocean's vertical velocity; versatile deployment options; robust, repeatable broadband techniques; and multiple communication options.

Workhorse ADCP

MacArtney Asia has been appointed as the regional reseller for Teledyne RD Instruments' Acoustic Doppler Current Profilers (ADCP) and Doppler Velocity Log (DVL) products. This strategic partnership will enhance the availability and support of Teledyne RDI's advanced ADCP and DVL technology across the region.

CONVEX SEASCAPE SURVEY

CMS GEOSCIENCE RECENTLY PARTNERED WITH THE BLUE MARINE FOUND ATION, THE UNIVERSITY OF EXETER AND JERSEY MARINE RESOURCES ON A PROJECT TO QUANTIFY BLUE CARBON

The Convex Seascape Survey initiative is a pioneering collaboration to quantify and understand blue carbon stored in the coastal ocean floor, and the effects of marine life upon it. The project will deliver new, reliable open-source data which will educate, inspire and enable informed decisions on ocean use, to harness the power of the sea in the fight against climate change.

The role of CMS's specialised geotechnical team was to collect 55 vibrocores and 8 multicores across various locations in the waters around Jersey. The company collected undisturbed samples of sediment and supernatant water using a multi corer at 8 locations on the south and east of the island. One core from each location was transferred back to shore where the research team could perform eDNA testing.

Dr Richard Tennant established a field molecular laboratory that allowed the team to both extrude and subsample the cores, as well as purify and sequence the DNA in Jersey. This data was then taken back to Exeter to investigate which flora and fauna are contributing to carbon stocks and determine how they have formed over the past two centuries.

As the survey team were able to conduct on-site analysis, the data they generated can be validated once the other cores have been received in Exeter, to better understand the impacts of storage and/or transportation.

The project also looked at how protection from trawling and dredging activities might affect the capacity of the seabed to accumulate and store organic carbon.

Researchers had a particular interest in how this protection affects the biodiversity of seabed habitats, as it is likely that the animals that live around jersey may play an important role in the flux of carbon through these environments.

The CMS team collected cores both inside and outside of the Jersey Marine Protected Area where mobile fishing gear is prohibited. This will allow academics to compare the differences in seabed organic carbon content and biodiversity according to different levels of seabed disturbance. The samples they cored will be analysed alongside short sediment cores of 30-60cm that they survey team gathered by hand using SCUBA.

Researcher, Dr Ben Harris, utilised a range of techniques to measure differences in biodiversity. Baited Remote Underwater Video Systems (BRUVS) were deployed to collect information on the abundance and body size of different fish and highly mobile invertebrate species such as crabs or lobsters.

ROV and photo-quadrants were used to quantify the density and species diversity of less mobile animals living on-top of the seabed, these include sponges, ascidians and hydrozoans. The third approach was collecting sediment grabs for counting the biodiversity of animals, like worms and bivalves, living within the sediment itself.

CMS GeoScience worked with Anna Smith and the Convex team to design this survey. Jersey is a challenging place to operate, having the third-largest tidal range in the world with a range of >10m and 5-6 knots. Looking at sediment types as well as potential obstructions and limitations, CMS advised on sample locations to ensure that the needs of the project were met.

With more interest in the top layers of sediment, it was decided that the HPC corer would be deployed in 3m mode, with a smaller corer aiming to help mitigate some of the tidal restrictions. After consultation, the project scope was defined as 55 vibrocores, predominantly around the south and east of the island.

Hayley Santer, the Senior Surveyor on the project, spoke about the level of preparation needed:
'To maintain efficiency, and with several tidal locations spread in various bays around Jersey, it was crucial that we worked to minimise time spent waiting on

the tide when trying to access more shallow locations.

In addition to significant tidal ranges and rocky coastline, many of the reefs were poorly charted. With the team finding that there were large discrepancies in the data, it was important for us to take the additional time to capitalise on rising tides as well as note and mark a safe route into shoal areas, paying particular attention to locations that, while technically deep enough, were enclosed behind prominent, sometimes awash, rock.

Using these proven routes, and ensuring we received regularly updated tidal information, enabled real-time assessment of the observed depths both on approach and when were deployed at each location. This also allowed us to establish what depths we could expect on completion of the sampling. We were often operating within busy shipping routes, and St Helier VTW and the Jersey Coastguard were instrumental in reminding other vessels of the requirements of space and safe passing. To add to the intricacies of this project, our team were working over a number of weekends which meant that the increase in recreational club activities added to the difficulties of working in an area where marine traffic was already saturated.

Our choice of a smaller, more compact vessel enabled us to work alongside these clubs and societies and we were able to complete the campaign safely with minimal disruption to us and the public'.

The geology around Jersey also presented a specific challenge to the team, with rocky outcrops being exposed

by the high tidal range. Extensive planning using tidal and weather forecasts, as well as water depths, enabled the team to maximise working windows.

Owing to the unique tidal movements around the island, Rory Bardner, CMS Marine Geologist, found it interesting to discover such variation in the geology sampled throughout the campaign:
'Cores recovered deposits ranging from silty sands to coarse gravels, often in proximity, and igneous bedrock was samples in many cases. Using the multi corer to recover undisturbed samples of the shallow seabed gave a real insight into the sediments, marine life and seagrass below us.

Due to the testing required, the cores had to remain at a constant temperature of between 4-5 degrees, which was made more difficult as many of the locations were >4-hour steam away from harbour. A solution was found which allowed for onboard chilling facilities, as well as a space to safely operate the vibrocoring system, the multi corer and other equipment.

Mechanical Design Engineer, Jack Foll, reported on the difficulty in operating the geotechnical systems and the performance of the team overall:
'There was a great deal of preparation in anticipation for this campaign as we knew we would be working within a demanding environment. The waters in which the team were deployed experiences a tidal height of up to 12m, and this meant that our HPC corer had to operate in 3m to compensate for the strength of the tide. As well as this, we experienced unseasonably inclement weather throughout our time on the island which meant the team had to work within tight windows of opportunity, adding even more to the complexity of the project.

INSTALLATION

Svanen upgrade

When the Van Oord-owned vessel Svanen received a major upgrade, a key element was the fitting of a bigger A-Frame. This would enable it to install larger, next generation monopile foundations for offshore wind turbines at sea.Weighing 960 tonnes, measuring 26 meters in width and 30 meters in height, the new A-Frame would increase the total height of the Svanen to 125 meters.

With few cranes in the world capable of the lift at the 65-meter height to clear the vessel's deck, the PTC ring crane was perfect for the job – it allowed the frame to be prefabricated and lifted as a complete unit.

Mammoet was approached to support with two elements of the project. The first was the transportation and lifting of the three key components that made up the A-Frame.

These were fabricated by Holland Shipyards at two separate warehouses near Rotterdam, before being shipped by inland vessels to Mammoet's quayside headquarters in Schiedam.

Once in Schiedam, the A-Frame was offloaded onto Mammoet Self-Propelled Modular Transporters (SPMTs) and moved to a laydown area.

The second stage was the main PTC hoist. This saw the assembled A-Frame driven 66 meters using 64 axle lines of SPMT trailer and parked on a temporary support, ready for the PTC to perform the hoist.

The configuration of the PTC ring crane to perform the lift was 107 meters of main boom, 67 meters of luffing jib, and more than 4,000 tonnes of counterweight.

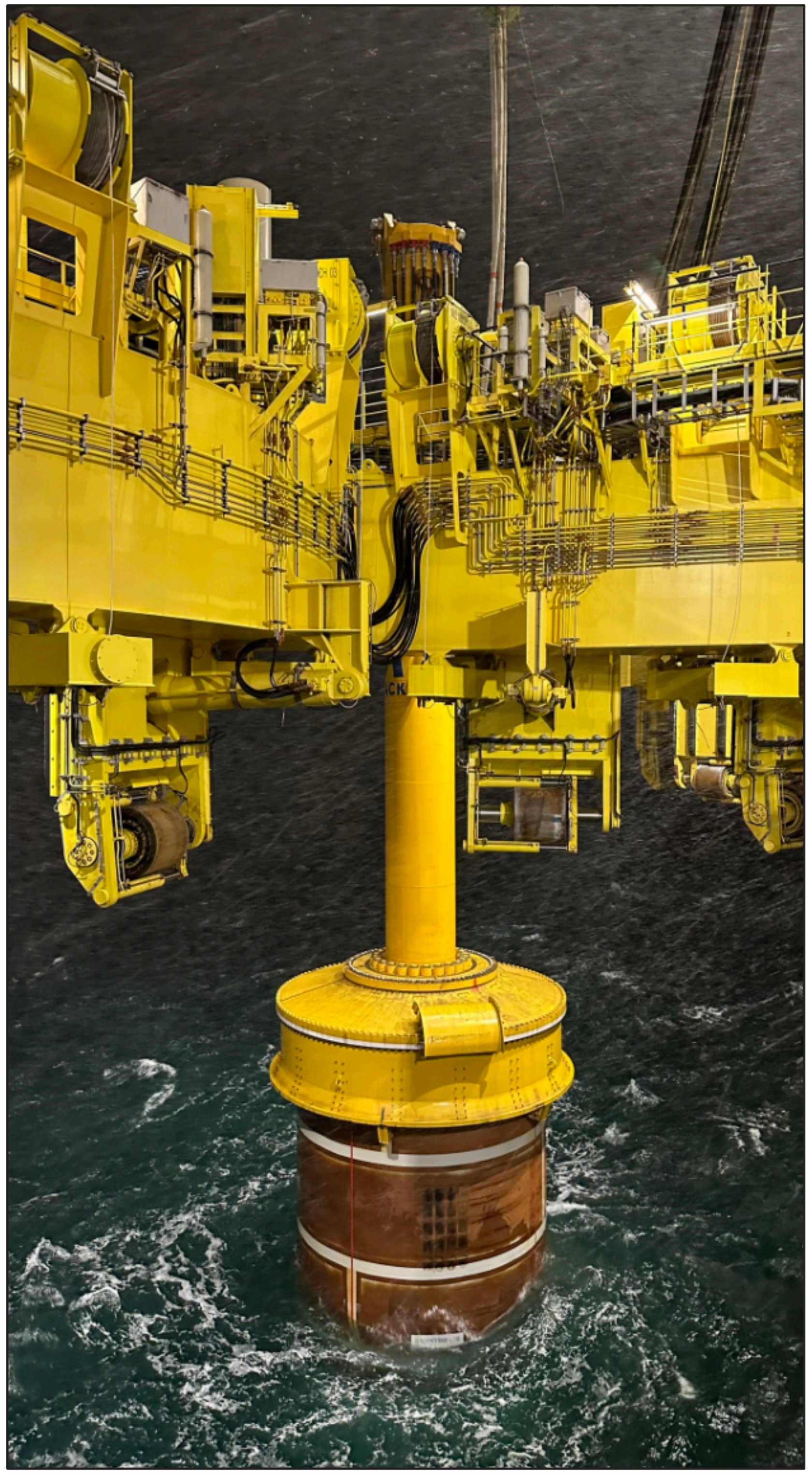
NOISE REDUCTION

MENCK HAS BEEN BUSY DEVELOPING PILEDRIVING TECHNOLOGY TO MEET THE CHALLENGES OF THE NEXT GENERATION OF OFFSHORE WIND FARMS

MENCK, a brand in Acteon's Marine Foundations business line, actively innovates pile-driving technology to meet the demands of the next generation of offshore wind turbines. They aim to scale up services and equipment for larger projects in ways that are more sustainable, quieter, and economical. This approach aligns with the growing global focus on renewable energy and the need to minimise environmental impacts.

MENCK focuses significantly on reducing the acoustic impact of piling on marine ecosystems, addressing a key environmental challenge for offshore installations. They widely use standard practices like bubble curtains and hydro sound resonance dampers to mitigate extraneous noise. MENCK takes these solutions further by developing its own proprietary noise reduction technologies.

Offshore pile driving equipment



"Offshore wind is the future, and minimising environmental disruption is central to that vision," says Fabian Hippe, Sales Director, Acteon Marine Foundations. "MENCK's development of the MENCK Noise Reduction Unit (MNRU) represents a breakthrough, effectively lowering underwater noise without sacrificing the force needed to drive larger monopiles.

Conventional impact pile driving systems rely on the hammer's ram repeatedly striking the anvil to drive the pile into the ground.

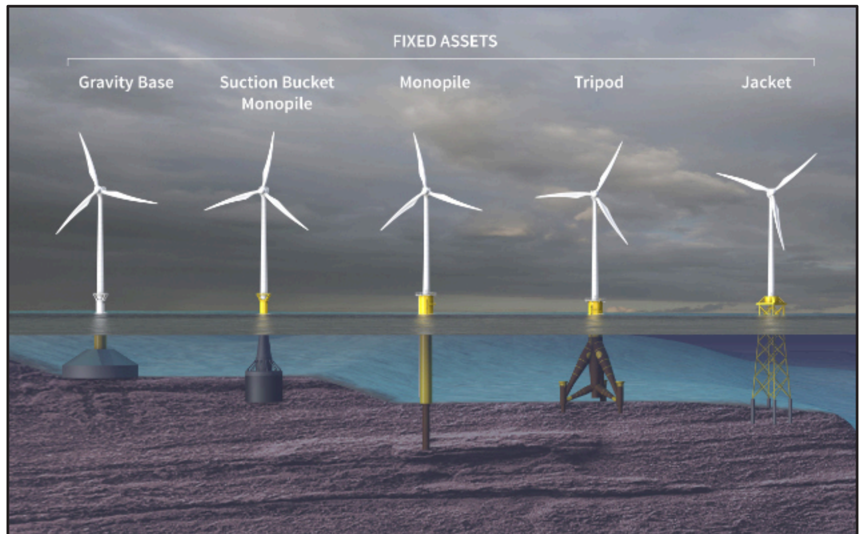
When the hammer strikes the pile, it causes the pile to flex outward. This flexing creates rapid vibrations that generate acoustic energy.

These vibrations result in intense sound waves that spread outward through the water column. The primary concern is the lateral flexing of the pile, which produces the underwater noise, rather than the direct strike of the hammer itself."

The MNRU features an assembly stack of six 1.5 Te steel blocks positioned between the anvil and the ram. This design ensures the ram strikes the first steel block instead of directly impacting the anvil. Each block becomes part of the energy transfer from the ram to the pile, progressively transferring the energy until it reaches the anvil and then the pile. This method produces a similar magnitude of downward force, with the force transfer over time significantly reducing noise during the driving process.

"Imagine dragging your hand through water," said Hippe. "Doing this quickly creates resistance, while doing it slowly requires far less force. Similarly, in relation to the above process, changing the speed at which the pile flexes reduces the pressure. This approach creates a more environmentally friendly pile driving process."

"Each steel block acts like a spring, loading and then releasing energy onto the next block. Instead of the ram falling directly onto the anvil, which corresponds with a sharp release of energy, these blocks flatten the time curve in milliseconds. This makes it more of a push than a sharp knock, without adversely impacting energy transfer."

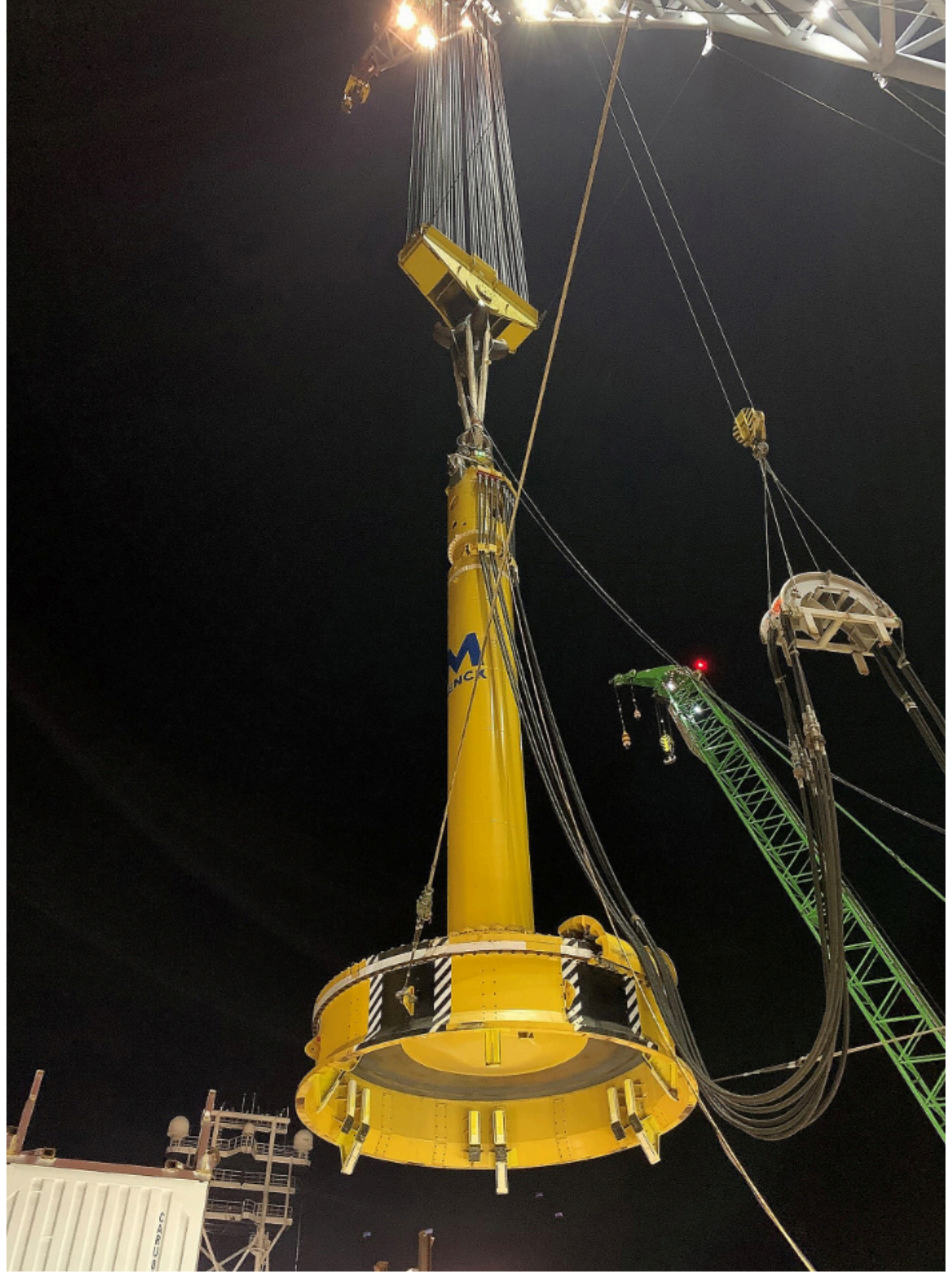


Fixed substructures

A CHANGING MARKET

The renewable market has transformed over the past decade. The first type of monopiles were installed using impact hammers ranging from 500 kJ to 800 kJ. Soon after, MENCK introduced the 1900 kJ hammer, MHU 1900S, becoming the first dedicated offshore wind hammer. In 2015, MENCK launched the largest offshore renewables impact pile driving hammer, the MHU 3500S, which was surpassed by the MHU 4400S in 2021.

The growth of installation technology testifies to the broader technological changes in the market. Wind turbine generations have grown in size and weight.



A MENCK hammer being utilised on Vatten fall's Hollandse Kust Zuid I–IV (HKZ) offshore wind farm project in the Netherlands'

While they deliver more electricity, they require longer turbine blades, resulting in larger windmill diameters. Consequently, turbines need to be located at higher elevations to allow the blades to sweep around. This change necessitates larger monopiles with greater diameters, requiring significantly more powerful hammers to drive the next generation of monopiles.

MENCK has introduced its latest innovation in September this year at the recent WindEnergy Hamburg conference – the MHU 6000W Wind Hammer. This state-of-the-art system, designed to meet the growing demands of the offshore renewable sector, opens new possibilities for offshore wind projects by handling larger and heavier piles in increasingly challenging environments. The Wind Hammer is engineered to drive larger and longer piles in tougher environments, enabling the deployment of a future generation of monopiles even in deeper waters. Delivering from 200 kJ to 6,250 kJ of energy, the Wind Hammer drives monopiles with top diameters up to 9 m and beyond. It provides unmatched power, control, and efficiency, setting a new benchmark in performance for offshore installations.

SMARTER, NOT HARDER

Due to the challenges posed by modern piling techniques, MENCK enhances the hammer's intelligence using digital technology. By incorporating additional sensors, they gain significantly deeper insights into the piling process and progress.

Instrumental operations yield additional benefits. Just as driving a penetrometer into the seabed provides valuable data, hammering a pile into the seabed and measuring resistance also generates useful information. This data enhances the model and potentially aids in installing nearby piles.

Hippe explains, "We are currently conducting a demonstration to analyse resistance data, showing the piling process in real-time. This approach aims to identify formation horizons at the site that may present higher or lower risks for pile run events.

This information database may be useful when designing our next generation of hammers and can aid in real-time risk assessment for any hazardous events during installation."

"While the primary goal is always to install the pile in the safest and most efficient manner, it is important to revisit how this can be achieved economically from both environmental and commercial perspectives.

A dashboard that provides situational awareness enables users to make smarter decisions. Crucially, it allows them to leverage past experiences to predict beneficial or harmful outcomes before they become critical."

"MENCK maintains a database of approximately 40 million hammer blows, making it likely that similar conditions have been encountered for any pile at any location. This data can be utilised to develop algorithms that enhance safety and success in the most economical way possible."

PILE RUN

As monopile diameters increase, challenges and risks arise, including pile run.

Before installing piles in a given area, extensive surveys using geophysical and geotechnical site investigations determine if and how the soil can support the structure's weight. One standard test involves cone penetrometers. These instrumented cones push into the soil, and sensors measure parameters such as resistance and cohesiveness to understand the seabed's structural geology.

Despite extensive testing, anomalies may occur where the pile, driven into the seabed, starts to descend uncontrollably under its own gravity, effectively freefalling. This abrupt absence of sufficient ground resistance is dangerous and can cause the lifting line to rupture. In extreme cases, it can lead to the complete loss of the hammer and damage to additional installation resources and the vessel.

"Established geotechnical frameworks were based on analytics developed for smaller diameter piles; now a monopile may not behave like these smaller companions," said Hippe. "Because the resistance distribution changes, we may need to revisit all our design assumptions. This is not necessarily a challenge in areas like the North Sea, where the terrain is well understood and extensive data is available from historic installations, but many regions of the world have no structures and are completely new territory."

Additionally, site investigation techniques effectively detect geo-hazards such as underground streams, weak spots, or thin crusts, and the presence of harder layers. These harder layers may cause a phenomenon called 'punch through,' where piles hammered through thick rock suddenly enter an underlying layer of poorly resistant soils.

The seabed in some areas, particularly on the northeast coast of the United States or Australia, can contain formations rich in glauconite or carbonate, respectively. The presence of either of these formation types present a challenge due to their unusual behaviour under cyclic loading.

"Glauconite increases its strength under dynamic load, so during pile driving, a pile may reach refusal, but a couple of days later, the contractor can return and successfully continue driving," explained Hippe. "Importantly, once the pile passes through the glauconite-rich layers, the passage may become more easily drivable, and that sudden lack of resistance introduces the risk of pile runs. However, assuming that pile run is only linked to the presence of glauconite would not sufficiently represent the challenge."

VIBRO PILING

Piling is a common offshore construction technique based on embedding vertical columns, typically steel, into the soil with the intention of creating a deep foundation, strong enough to secure large accompanying structures in place

These piles are traditionally driven into the ground by impact piling. When the ramweight of a pile hammer falls onto the top of the pile, kinetic energy transfer generates a shock force, driving the pile into the ground.

This shock, however, is accompanied by loud impulsive sounds that propagates freely into the marine environment.

This noise pollution is seen as deleterious to the heath of marine fauna. It affects marine mammals' ability to communicate acoustically and may lead to a reduction in population growth rates. It can disrupt hunting and feeding, leading to a reduction in fitness or a reduction in growth. In response to regulatory authorities, companies are constantly developing for ways of minimising the amount of noise produced.

One avenue for noise mitigation is to minimise any sudden high energy release. Research for a practical solution resulted in the vibratory hammers or vibro drivers. These are attached to the top of the pile, delivering vibrations which are subsequently transferred into the surrounding soil.

The vibrations generate localised pore pressures changes which reduce the friction between the pile and the soil, particularly along the length of the pile shaft. This is especially true in compact -loose silty sandy soils.

Eliminating soil resistance acting on the pile allows the vibrating tube to penetrate into the soil and sink under its own weight.

VIBROHAMMER
One such service is offered by Dutch company CAPE Holland. Their advanced vibrohammer consists of three basic components.

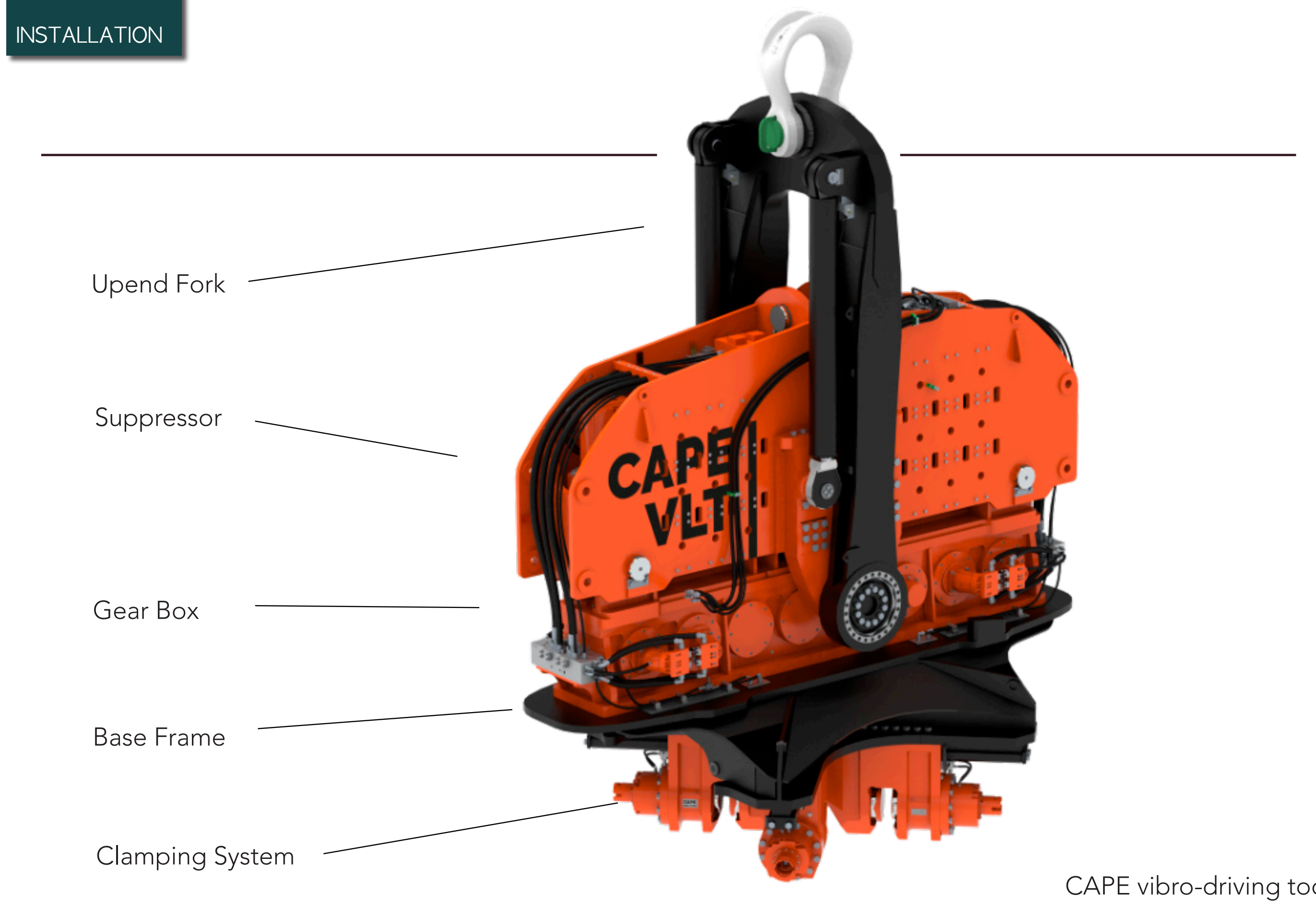
The vibration is actually generated by the main gearbox with its eccentric gears. The body also has a suppressor which contains dampers to minimise the vibrations from the gearbox going into the crane. The third main component is the clamping system that securely fixes the vibro tool to the pile.

CAPE Holland has also developed a number of components that turn the basic vibro hammer into a pile lifting tool (The CAPE VLT) - a device very useful for the installation process.

An upend fork can be used to rotate the tool in order to pick up a stored pile and upend it to a vertical position. This can be used. in reverse for decommissioning

In addition, the company has

Piling from the HMC vessel Sleipnir



CAPE vibro-driving tool

developed a patented lock system within the suppressor housing. This locks the suppressor to the gearbox during lifting (bypassing the dampers), making the tool certifiable as an Offshore Lifting Appliance in its own right (under the Lloyd's Register Code for Lifting Appliances in a Marine Environment (CLAME).

Yet another feature is the CAPE Inclino System which accurately monitors the inclination of the tool and pile during driving. Elsewhere, the CAPE Monitoring System monitors all parameters of the CAPE VLT during operation like the pressures, flows and accelerations.

Because the vertical vibrations temporarily reduce the oil resistance, the pile structure experiences significantly less deformation and this leads to much lower noise generation compared to impact driving.

Importantly, sound levels remain well below the limits set by the Bundesamt für Seeschifffahrt und Hydrographie (BSH) in Germany for impact driving, even without additional noise mitigation measures such as bubble curtains. During a monopile installation project in the German North Sea, measurements indicated that the noise levels were only marginally higher than the ambient background noise when no construction was taking place. This background noise primarily stemmed from shipping and other maritime activities.

In another project in the Dutch North Sea, conducted with a Heavy Lift Vessel, vibro-driving noise was barely detectable due to the continuous noise generated by Dynamic Positioning (DP) thrusters and a nearby Crew Transfer Vessel.

These vessel emissions provide a constant noise source similar in nature to the vibrations from the

CAPE vibro-piling

vibro driver. Analysis of the sound frequency spectrum showed that vibro driving noise was lower than background noise at most frequencies, only exceeding it slightly between 40 and 800 Hz.

Although data on vibro driving noise is currently limited due to insufficient field feedback, ongoing research and joint industry projects are working to improve predictive models for vibro noise.

AIRBORNE
Not only does the vibro hammer resuce subsea noise, but dramatically reduces airborne noise. In many cases, the only noticeable sound during vibro driving comes from the power units operating the CAPE VLT system.

In offshore wind installation projects near shorelines, vibro driving has been preferred due to its lower noise levels. Some projects have imposed restrictions on impact driving at night to comply with airborne noise limits, but vibro driving was permitted, allowing 24-hour operations without interruption.

REDUCING PILE RUN

The term "pile run" or "drop fall" refers to the sudden and uncontrolled free fall of piles during impact pile driving. This is a significant concern within the geotechnical and offshore construction communities.

It occurs when the bearing capacity of the soil is insufficient to resist the combined downward forces of the pile's self-weight, the hammer, and the inertia generated by the hammer's impact.

Once a pile begins to move downward under these forces, gravity accelerates the motion, intensifying the load. This continued motion persists until the pile's toe reaches a depth where the soil's bearing capacity is sufficient to counteract the applied forces, halting the movement.

Pile runs are caused by a number of factors. A common cause is the transitioning from a stiff into a softer soil layer but not picked up by geotechnical surveys or from an incomplete understanding of the soil stratigraphy.

As monopiles have increased in size, the required bearing capacity to prevent uncontrolled penetration has similarly escalated. Under identical soil conditions, larger monopiles exhibit significantly greater self-weight penetration compared to smaller piles. The increased inertia from larger, heavier piles also makes it more difficult to arrest their motion once they begin to penetrate the soil.

As a result, soft soil layers that previously offered adequate support for smaller piles may now fail to prevent pile runs in modern XXL monopiles.

In many regions, subsurface stratigraphy consists of alternating layers with differing bearing capacities. A common scenario involves a layer of dense sand overlaying softer clay.

CAPE vibro-driving tool

While this is not a universal soil profile, it can pose specific challenges during pile driving, particularly when transitioning between layers with contrasting stiffness.

The industry has developed a number of mechanisms to control pile run.

Once such is the CAPE's VLT hydraulic clamping system designed to securely fix the pile during the entire driving process, reducing the likelihood of pile runs or sudden pile drops but remains stable during installation, even in low-bearing capacity soils.

The system only releases the pile once it has reached its intended or stable depth, ensuring safe pile driving without the risk of overturning.

This means that it maintains precise control during transitions through soft layers, avoiding sudden movements and ensuring accurate pile placement.

SUBSEA POWER

Andy Martin, Chief Commercial Officer, Verlume and Ian Crossland, Commercial Director, Mocean Energy

Last June marked the end of a successful 13-month deployment in the UK North Sea, of Verlume's Halo underwater battery storage system. The Halo was connected to the Blue X wave energy converter (WEC) built by Edinburgh company Mocean Energy.

This low carbon and communications project provides fully autonomous offshore power generation from renewable energy, delivering a cost-effective and flexible alternative to power and communications from shore for operating subsea equipment.

In this deployment, the combined wave and battery energy storage system was used to power Transmark Subsea's ARV-I AUV dock-mounted onto the Halo basket, as well as Baker Hughes' Subsea Electronics Module (SEM).

The project was managed by the Net Zero Technology Centre (NZTC) and further supported by industry players Serica Energy, Harbour Energy, TotalEnergies, PTTEP and Shell MRE (Marine Renewable Energy).

The testing took a three-phase approach

Phase 1 began in 2020 in the form of a detailed front-end-engineering-design study

Phase 2 consisted of system communications bench testing, assembly of the subsea systems,

Subsea battery energy storage system and wave energy converter ahead of at-sea trials

and onshore commissioning of both the wave energy device and energy storage system.

Phase 3, the final phase, included integrated system deployment at a site 5 km off the East coast of Orkney in the UK North Sea in February 2023, combining the wave energy converter and seabed energy storage system for local, reliable subsea power and communications delivery.

PHASE 3

The main objectives of the Phase 3 testing programme were to show how renewable energy generation technologies can be made reliable and consistent using intelligent energy management and subsea energy storage. When combined, it can provide reliable low carbon power and communications to subsea equipment.
With an extended deployment over 13 months, the WEC, subsea battery system, AUV dock and SEM successfully withstood the elements from being deployed in February during harsh winter months following a two-month delay due to waiting for operational weather windows, to withstanding Storm Babet.

During this time, the WEC demonstrated its survivability by still being able to produce power despite unprecedented weather conditions with wave heights as high as 7.2m.

During the deployment, the AUV docking station was continuously monitored to ensure reliable operation. System uptime was coordinated with Verlume to manage the power budget, prioritising power to the SEM.

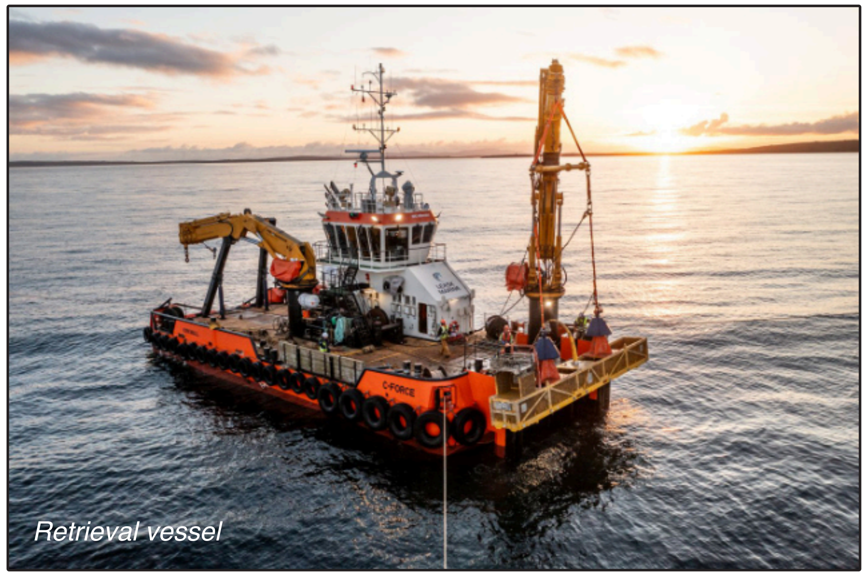
The docking station operated without faults throughout the deployment. Successful autonomous navigation to the dock and transition from acoustic positioning to docking using machine vision cameras and object detection and localisation ArUco markers were demonstrated during testing.

Over the course of the RSP project, fifty autonomous docking and undocking operations were successfully completed.

The RSP system set out with the aim of keeping a subsea SEM powered continuously while meeting the API 17F acceptance criteria of 1 in 1000 for packet loss. Packet loss performance for the SEM showed several months in excess of the API 17F acceptance criteria with an average packet loss performance of 1 in 723.

With weather and operating conditions generally favourable, it is speculated that increased cruise ship activity around the Orkney Islands in the summer months could have led to network congestion affecting performance during these months.

It is recommended that the selection of wireless communication technology for any



Retrieval vessel

client application is closely analysed to ensure that it meets the required level of performance.

Over the three phases, the RSP project has successfully demonstrated that a WEC can be paired with a subsea battery system to reliably power and operate subsea equipment, offering a cost-effective alternative to umbilical cables, which are carbon intensive with long lead times to procure and install.

RETRIEVAL OPERATIONS

Lessons have been learnt in terms of identifying opportunities to improve wireless communications, umbilical robustness and power storage and distribution efficiency – all of which can be delivered on future commercial deployments to demonstrate further how the industry can benefit from using low-carbon, standalone renewable energy, and communication ecosystems for existing and new developments such as: CCS (Carbon Capture and Storage), reservoir and asset monitoring systems, providing an alternative to traditional umbilical solutions (e.g. long tie-back replacements) and subsea autonomous underwater vehicle residency.

MOCEAN AND SUBCTECH

Mocean Energy and SubCtech are to explore how wave and solar generation can be coupled with batteries to deliver continuous low carbon power and communications to a range of subsea technologies.

The two companies have signed a Memorandum of Understanding (MoU) pledging to pool their expertise and to seek potential collaborative projects which will bring together their respective technologies and know-how, and deliver standalone, customisable low carbon subsea solutions for a range of customers globally. The MoU also commits the firms to share system engineering and analysis and to offer engineering support where appropriate.

SubCtech has a long track record in manufacturing a range of subsea equipment, including batteries and monitoring equipment, with uses as diverse as greenhouse gas monitoring and micro-plastic sampling.

FLOATING WIND

AN OVERVIEW OF CURRENT TECHNOLOGY

In recent years, fixed seabed-founded offshore turbines have become established as a valuable renewable energy resource.

Globally, the installed turbine base for captured offshore wind stands at 75 GW. By far, the majority of this is in China with Europe responsible for around 34GW.

Of all European offshore wind capture, 80% is enabled using monopiles (with the remainder coming from turbines mounted on jackets, gravity bases etc).

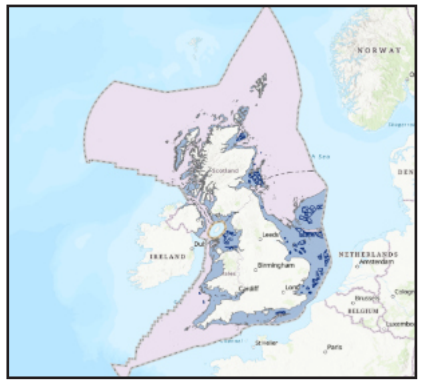
Monopiles are essentially, long cylindrical tubes that are installed by being hammered into the ground. The turbine is then mounted on this stable structure. These monopiles are fairly basic and relatively cheap tubular structures but only really suitable for 40m. Jackets can be used to extend the limits to 60m

Many companies are looking to harness the stronger winds further offshore using larger turbines, but these are beyond the economical limits of fixed-bottom foundations.as optimal locations are often in deep water.

Part of this report was written with reference to a webinar given to the SUT by Matthew Barnott, Engineer at Flotation Energy.

TYPES OF FOUNDATION

	Foundations
Monopiles	80%
Jacket	10%
Gravity Base	6%
Floating	0.4%



Map of UK EEZ limit showing depth less than 60m ◻ and greater than 60m ◻
Source: Flotation Energy

They require a different technology- Floating systems.

ADVANTAGES
Floating systems have a number of inherent advantages over fixed technology.

● Floating systems allow wind turbines to be placed in an optimum position for maximum energy capture. Further offshore, there is less interaction with the landmass and the result is a much smoother, less disturbed flow of air, which can lead to higher capacity factor.

(*The capacity is a term describing the proportion of energy the wind turbine can actually produce compared to the amount of energy it is theoretically possible to produce. Typically, fixed technology can harvest 30 - 40% of their potential but when placed further out into a better wind resource, this factor can increase upwards towards nearer 50% – 60%.*)

● Being much further away from land also reduces visibility from the coastline. This addresses concerns from some coastal communities.

● Offshore wind developers are conscious of ensuring that marine ecosystems and seabed habitats are disturbed to the bare minimum. Because floating offshore turbines are anchored to the seabed, the minimal piling of the mooring lines causes less vibration disturbance than those fixed directly to the sea floor.

● Installation of floating structures is more efficient because there is less requirement for large heavy lift vessels. They also do not require the same scale of seabed preparation and foundation work that fixed-bottom turbines demand.

● While at the end of the structural life, decommissioning is much easier as there is less infrastructure deeply embedded in the seabed. As more data is gathered subject to an end-of-life integrity assessment, it could be possible to relocate the turbine to another location. This is easier for floating systems.(This was done for the initial 2MW turbine that was installed at Kincardine. It was taken from one windfarm and placed at another site

● Floating platforms can be designed in a modular fashion, allowing for scalability. There is also greater potential for much higher local content as it is advantageous that the assembly of substructures and the turbines ideally are as close to the site as possible.

● Floating technology is well understood by decades of development by the oil and gas industry, however, serial production of these systems represents a challenge. At present, floating systems are relatively expensive because they are deployed on a small scale, but this could change as designs mature and become standardised.

COST

"Accessing deep waters has advantages, but this comes at a cost" said Matthew Barnott, Engineer at Flotation Energy. "A 2020 study suggested that the current economic cross-over between fixed and floating wind is around 90m, so that deploying either technology in these depths would cost about the same.

"It is important to highlight, however, that only 44 units have ever been installed globally, highlighting how new this technology is and the amount of learning still to do"

The relative cost difference is due to a number of factors. Floating systems are relatively more complex, requiring buoyancy chambers, a ballasting system, trusses etc. It also incorporates a large amount of steel, maybe 3000t for a semi submersible supporting a 15MW turbine.

When financing projects, the risk is largely unknown and, therefore, it costs more to borrow money.

"These projects need to be approached carefully," said Barnott. "At the start of any large projects, there will be a steep learning curve so companies need to reduce this by starting off small with demonstration projects. The results allows a learning curve without a high risk exposure. This also allows the company to slowly build a supply chain file attracting investment.

When the project finally expands, it can fully take advantage of these efficiencies with larger economies of scale. With the same people working on the projects, continually learning and as technology matures, costs will decrease.

TYPES OF FLOATING SUBSTRUCTURE

1 SPAR

SPARs are inherently stable and a relatively mature offshore technology. Examples include Hywind Tampen and Hywind Scotland

Hywind Tampen
Image: Aker Solutions

Of these spars, one is fabricated from steel and the other ,predominantly concrete.

Spars are very slender but needs a very great draught (Typically around 90m to stabilise a 6 MW turbine). All this makes manufacturing and transport & installation in particular very challenging. Deep draft structures require a deep water harbour to integrate the turbine.

While this is available in locations such as Norwegian fjords, it is not a feature of UK construction yards.

2 SEMISUBMERSIBLES

Semisubmersibles are relatively light and port-friendly and it is possible to adjust the design parameters to reduce the draft. They are, however, fairly complex and mass-production can be potentially challenging.

The semi-sub gains its stability from its outer dimensions activating the water plane area to compensate the overturning moment caused by the turbine thrust'.

To support a 6–10 MW turbine a semi-sub requires large outer dimension. This heavily decreases the number of possible manufacturing sites.

3 BARGES

Shallow draft Barges or a tested technology. These do, however, tend to be fairly large and as such the large water plane area is impacted by the waves and may lead to instability.

PIVOTBUOY PROJECT

The X1 Wind-led X30 1:3 scale prototype started April 2019 and was concluded last year as the world's first fully functional TLP floating wind platform to export power and Spain's first floating wind prototype to export electricity via a subsea cable.

The X30 floater was installed at PLOCAN, Canary Islands, with a Vestas V29 turbine adapted to downwind, under the scope of the PivotBuoy Project.

The Project demonstrated the PivotBuoy innovative mooring system configuration that combines the advantages of a SPM (single point mooring) with a small TLP (Tension-Leg Platform) mooring system, allowing the platform to reach deeper waters and minimizing the footprint and impact on the seabed.

Additional features of the platform include the light-weight and stable floater, which can be easily wet towed by local vessels thus simplifying and accelerating the installation process.

The X30 platform was towed to Arinaga Port for its full decommissioning, removing the key elements for further analysis. and offering some parts to the Instituto Técnológico de Canarias (ITC) for educational purposes at its facilities in Pozo Izquierdo.

SBM/TECHNIP

SBM Offshore and Technip Energies recently announced the formal implementation of Ekwil, a 50/50 Floating Offshore Wind (FOW) joint-venture.

Ekwil says it is a pure player delivery partner offering a diversified range of 'series production' Floating Offshore Wind solutions to meet the growing and demanding needs of energy customers around the world.

4 TLP

German wind structure design house GICON says that TLPs have significant advantages. They exhibit minimal dynamic response in restricted modes such as heave, roll and pitch.

The stability is ensured by taut mooring lines, causing the platform to behave similarly to a rigid structure in terms of motion amplitudes and resonance frequencies. The minimal pitching response is particularly advantageous for power production as it has a positive impact on the aerodynamic performance of wind turbines.

By tensioning the moorings, the entire structure becomes firmly braced, which resists even the strongest weather conditions with minimum accelerations and deflections.

Since Cigon proposed its first TLP design in 2009 , the design has undergone numerous evolutionary changes. The original design was based on a latticed structure. While this enjoyed several structural benefits, it was considered complicated and expensive to manufacture.

In 2015, the design incorporated a new gravity foundation that could be lowered to the seabed, greatly enabling one-step installation.

Since then, the company has looked at other technical innovations and computer simulations backed up by wave and wind tank tests to help to accelerate the progress It has also investigated numerous manufacturing strategies to help reduce costs.

GICON TLP

Shipyard and dry-dock rent can be minimised by prefabricating the components and transporting them to a harbour close to the commissioning site.

Most offshore structures are built using welded steel elements. This makes operations expensive and very time consuming. A single steel floating substructure for a 6 MW turbine takes at least four months. Taking into account man hours, rent for the dock and raw materials, the cost for the floating substructure comes in at € 2500-3000 per metric ton.

GICON is looking at prestressed ultra-high performance concrete (UHPC). This has a very high density and therefore high bearing capacities and means the units can be built more efficiently, leading to lighter designs.

SUBSTRUCTURE

When selecting a suitable substructure for a given project, there are a number of factors that should be taken into account, such as site conditions, water depth and especially the metocean regime.

"The turbines are not allowed to tilt or move around too much and there's also a question of where on sub structure to place the turbine," said Barnott. "In many designs, the tower is often positioned in a corner, but we have found that as turbines get bigger and heavier, placing it at the centre of the substructure makes it easier to level and add components.

"The types of construction material is also a important consideration. Steel is often considered the material of choice by shipyards. It is a lot denser than concrete but it requires a smaller mass to provide the same kind of mechanical properties. In this way, steel structures are lighter than concrete.

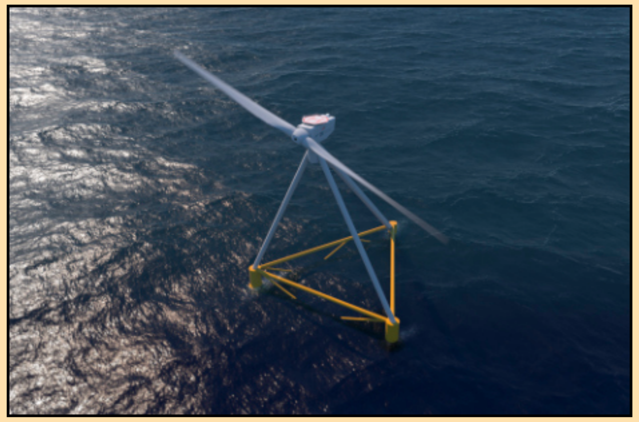
"Concrete substructures can be anywhere up to 15000t to support a 15 megawatt turbine, whereas, only 2500-5000t would be required for the same purpose. Ideally, we want to be able to manufacture components such as buoyancy chambers, trusses and the block components individually and then ship these to a nearby site for assembly.

"Welded connections can exhibit great strength, but research is showing that bolted connections are not only very strong, but can also accelerate the assembly time.

"Another focus is the delivery timeline. The turbine is the longest lead item and typically takes around about three weeks for each turbine to be integrated. In order to build structres at scale, we need to reduce this to nearer seven days.

"In order to achieve these times, we need to design the substructure around the port and not the port around the substructure. We can't be spending millions every time as the substructure of the turbine gets bigger. We need to be trying to design these things around what we've already got to bridge the gap between where we are now and where we need to be.

NEXFFLOAT



The NextFloat Project was launched in November 2022 by a consortium of thirteen partners with Technip Energies as the Project coordinator.

NextFloat's objective is to demonstrate at a full-scale the innovative floating platform design, while advancing in parallel on the industrialisation and scaling-up of the integrated solution up to 20MW+ scale, in preparation for commercial floating wind farms under development in Europe and other continents.

The 6MW pre-commercial prototype, called "X90", will demonstrate a cost-effective integrated system composed of a structurally efficient and lightweight floating platform.

MOORING

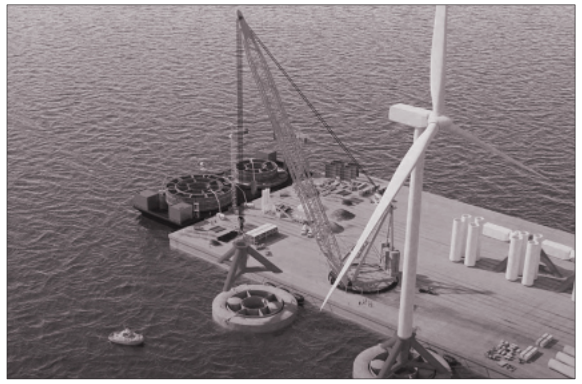
The types of mooring are often dictated by the design of the substructure. The most simple is the catenary mooring system - often used by barges and semi submersibles. This is. effectively a heavy length of chain that hangs down to the sea bed. As the structure moves off station, it lifts the chain upwards. Once the environmental force dissipates, the . weight of this chain pulls it back to its original location. These are typically only. , suitable for shallower sites. Lengths of heavy chain can be expensive, and there are a limited number of vessels that can install these.

It is also necessary to decide how many mooring lines will be required. It might be possible to reduce

WHEEL

Earlier this year, the WHEEL Consortium composed of 2-BENERGY, BOSKALIS, ROVER MARITIME, REPNAVAL, BRIDON-BEKAERT, VICINAY, PLOCAN, FIHAC, CEMEX, EnBW and ESTEYCO as the Coordinator and Technologist, gathered in Santander to witness first-hand the ambitious tank testing campaign of the WHEEL technology carried out in the facilities of FIHAC.

Further tests will be carried out soon -now in collaboration with the UPM (Polytechnic University of Madrid)- in order to also assess the external abrasion resistance of the suspension tendons around the connecting elements.
The next step is the construction of the WHEEL prototype in Q4 2025. It has been funded by the European Commission through the Horizon Europe programme.



The Wheel Image: Esteyco

HEXAFLOAT

Saipem has developed three novel designs for the offshore wind market. It has developed three novel designs for the offshore wind market.

It's STAR 1 one ithas developed three novel designs for the offshore wind market. It's star one it's a star shaped for column semisubmersible that can be fabricated from steel concrete or a hybrid. It uses a passive ballast system.

TheX:Base is a three column semisubmersible designed for 15 MW turbines

The Hexafloat is a novel pendulum structure featuring low steel mass for deep water sites. It is scalable to carry winter buying up to 15 MW.

Hexafloat

CULZEAN

France's TotalEnergies plans to launch a floating offshore wind pilot project to supply renewable energy to the Culzean offshore platform in the UK North Sea.

The 3 MW floating wind turbine will be located two kilometres west of the Culzean platform, 220km off the eastern coast of Scotland.

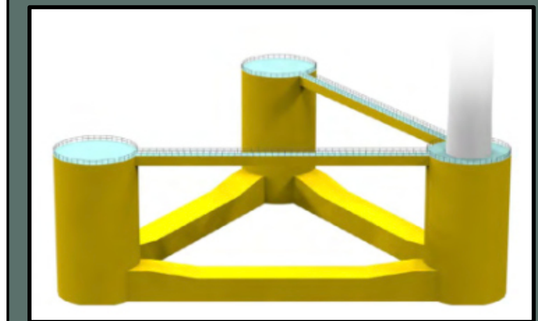
The wind turbine is planned to be installed on a modular, light semi-submersible floater hull designed by Ocergy, allowing for fast assembly and optimised costs, said TotalEnergies.

Expected to be fully operational by the end of next year, the turbine will supply around 20 per cent of Culzean's power requirement, thereby reducing its greenhouse gas (GHG) emissions, according to the company.

the chain size with the use of more lines but this means the total amount of chain is greater and it takes more hours installing it.

An alternative is a taut line, which is lightweight and has a smaller sea bed footprint. They may be challenging to install and subject to high loading. A combination of these is embodied in semi taut moorings. The footprint is small but the lines are lighter and better suited for deep water applications. It is, however, less field proven.

INO15



Technip Energy T.EN has developed the INO15 a cost-competitive 15 MW floater, standardised and easily scalable for mass production.

The INO15 is built on the IN012 concept (12MW), initially developed by subsidiary Inocean in 2021. The concept received Basic Design Approval from DNV and Approval in Principle from BV. The INO concept represents a three-column semi-submersible foundation designed to withstand diverse environmental conditions worldwide. This foundation embodies efficiency and resilience with its DNA rooted in lean design principles.

As part of the INO15 by T.EN programme, TEn leveraged in-house simulation tools to thoroughly analyse the dynamics between the floating platform and its integrated turbine. This comprehensive evaluation ensures optimal performance and seamless operation.

In the transition, weight was reduced by round 10% by mitigates risks and ensures fast implementation, engineered by T.EN teams as an assembly strategically eliminating diagonal bracings enabling businesses to embrace the ongoing
of several simple blocks, all sharing identical and an upper beam.

STANDARD FLOATING FOUNDATION

Image: BW Ideol / V. Joncheray

BW Ideol is one of the more established floating offshore wind developers. The company, however, recently announced that it was adopting a new market approach combining standardisation and mass production.

The universal floating foundation is based on BW Ideol's patented technology, the Damping Pool, characterised by a ring-shaped floating foundation which provides the stable base for the turbine. This can be optimised for all metocean conditions and compatible with all 15 MW+ wind turbines currently available.

"Our standard floating foundation design can be deployed in various site locations" said CEO, Paul de la Guérivière. "Previously, the normal practice in the floating wind industry is to re-engineer the floating foundation for each project. Because we have a standardised system, however, we can postpone the actual selection of the wind turbine size because our floating foundation will be the same.

"As such, it can be easily scalable to the next 20 MW+ wind turbines when available. This standard product, pre-certified in advance, unlocks mass-production by allowing multiple projects to be supplied from the same manufacturing line.

"This design retains the competitive advantages of the Damping Pool, particularly its compactness, with dimensions limited to 54m, and its shallow draft, below 12m in operation.

BW-Ideol's first use of the system was in 2018 on its Floatgen product, France's first offshore wind turbine at the SEM-REV test Site at Croisic where it was anchored in 33 m of water.Floatgen has already surpassed the 30 GWh electricity threshold, averaging 92.18%. In December 2023 it set a monthly production record of 922.026 MWh and a 61.96% capacity factor.

"Initially designed for a 5-year lifespan, the demonstrator observed results and the current condition of the floater and turbine allow for an additional 5-year extension without major maintenance. This extension will enable us to continue research and development projects.

We are testing new components on it, and we are so accumulating expertise . Over the time we have been able to. identify potential issues and components, and examine different behaviours and fatigue issues.

Floatgen with its 2 MW turbine was quickly followed by the Hibiki which was installed at the Kitakyushu Site in Water depths of 55m where it supported a 3Mw turbine.

The company is currently working on the precommercial development of the EOLMED PROJECT which will see three 10 MW (total of 30MW) Installed in Occitanie (France) by end of -2025 The turbines will be installed in 55m of water.

NEZZY²

TWIN TURBINE OF A 15-MEGAWATT FULL-SCALE MODEL OFF THE COAST OF CHINA

EnBW is a major player in the offshore wind industry. This summer, it installed 64 foundations in the North Sea on He Dreiht, Germany's larger wind farm. The company has been particularly active in floating wind.

Its 2020 Nezzy² the double-rotor floating platform research project has become the OceanX structure that was fabricated at 1:1 scale in China by the company MingYang.

Earlier this year, MingYang successfully transported the turbine to its final location, 700km (much less, approx. 50nm) away off the southeast coast of China. It has been installed at the existing Qingzhou IV Offshore Wind Farm. The platform boasts a total capacity of 16.6 MW (2 x 8.3 MW),

NEZZY2 The Nezzy² design consists of two wind turbines supported by a partially submerged floating foundation. North German engineering company Aerodyn engineering tested the original 1:10-scale predecessor model based on a single turbine, in the sea off Japan in 2018. The 1:36 scale twin rotor successor was tested in an artificial wave channel in Cork, Ireland in 2017.

The two rotors double the output per floating foundation. Due to the two adjacent rotors, the point of attack for the wind is far lower than with a single large rotor. This gives the model greater stability in the water.

A keynote of the design is that a

Nezzy², Hymendorf

platform operates downwind, with the wind impacting against the back of the nacelle rather than the side facing the hub. This allows the entire structure to rotate around its anchoring point, enabling it to passively align with the wind direction, like a vane.

The next stage was an 18m tall 1:10-scale prototype which was installed in a flooded gravel pit near Bremerhaven. There, the lack of waves and currents meant that wind tracking could be studied in isolation.

The water was about ten metres deep, which is equivalent to 100 metres water depth at full scale.

The next stage looked at its response to at wind and wave conditions. It was installed in the Baltic Sea, 650 metres off Vierow port in Greifswald Bay.

The18 metre tall model was tested in two different rotor configurations featuring two and three rotor blades respectively.

The body was composed of precast prestressed concrete elements, flooded so that only the three floats and the central tower protrude from the water.

The floating foundation self-aligns with the wind direction and is moored by six chains to anchors on the seabed. Two towers rising in V-formation from the centre of the foundation support the two wind turbines. Guy ropes link the towers together and to the foundation. –

With 180 sensors, it was tested how Nezzy² behaves when exposed to different wind directions and speeds, wave heights and directions. Nezzy² even withstood a storm tide.

Scaled up to the later true size of Nezzy², the wave and wind conditions were equivalent to a category four to five hurricane with waves reaching heights of up to 30m. Even under these extreme weather conditions, Nezzy² remained stable in the water.

The data produced went into the design of the 1:1 scale model used in China.

CENTEC TLP

A novel TLP has been designed by the Centre for Marine Technology and Ocean Engineering (CENTEC) of the University of Lisbon.

It is a self-stable platform carrying a 10Mw three-bladed turbine designed by DTU (Technical University of Denmark). The rotor diameter is 178.3m and the 673998kg Nacelle sits on top of a 628 422kg tower.

It has a total height (from keel to nacelle top) of 149.0 [m] and the Overall length beam is 49.0m. The Pontoon sides are 4.0m and the lower column is height is 7.5high by 10.5m in length.

The central column stands 10m above the waterline

During transport, the CENTEC-TLP is designed to float on its pontoons. The waterplane area stays constant as the structure heaves.It has a large moment of inertia to increase the metacentric radius , providinginherent stability. The prismatic lower and upper columns have rounded corners

When free-floating, it allows the platform to be towed irrespective of depth limits. The body needs to keep wave excitation ranges to below 5sec. A 3m significant wave height is an upper limit where towing operations can be safely undertaken.

The model has undergone considerable testing in various locations and in the wave tank at 1.60 scale is both regular and irregular waves approaching from the front and various diagonals.

DEMOSATH

Based in Leioa on the bay of Biscay, Spain, Saitec is the floating offshore wind company behind SATH technology.

For may years, it has been developing prototypes and testing progressively models reaching full-scale demonstration with the DemoSATH which was assembled in the port of Bilbao in northern Spain. Last September, the platform, with its 2MW turbine, was towed to the test site 2 miles offshore in a water depth of 85m. Hybrid mooring lines, composed of chains and fibre, anchored to the seabed hold the unit in position.

Saitec is also working closely on Geroa, a precommercial project planned for 2027. This will be followed by a second project in the Mediterranean Sea that is called Medfloat.

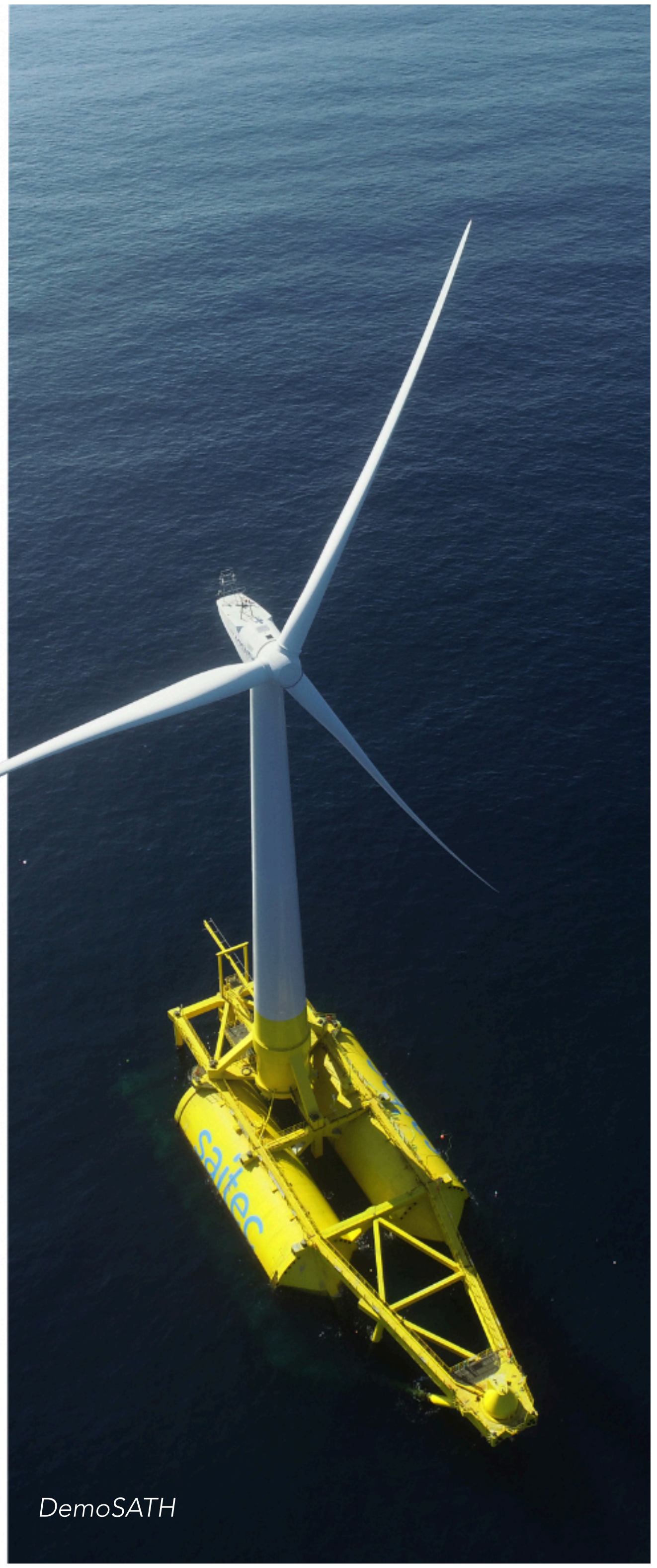
The basic concept is a floating body consisting of twin horizontal cylindrical hulls with conical ends, mounted on a heave plate. Above this is the frame structure that holds the transition piece on which the turbine sits. This frame structure extends to a single point morning of the type commonly used in FPSOs for the oil and gas industry.

This allows the platform to weathervane around the mooring, always assuring it is facing the wind. The mooring reduces environmental factors on the lines. The key feature of the design is that it is fabricated from reinforced concrete which provides an extended operational lifetime, reduced manufacturing and maintenance cost, has low emissions compared to steel, and often can be carried out provincially , maximising local content.

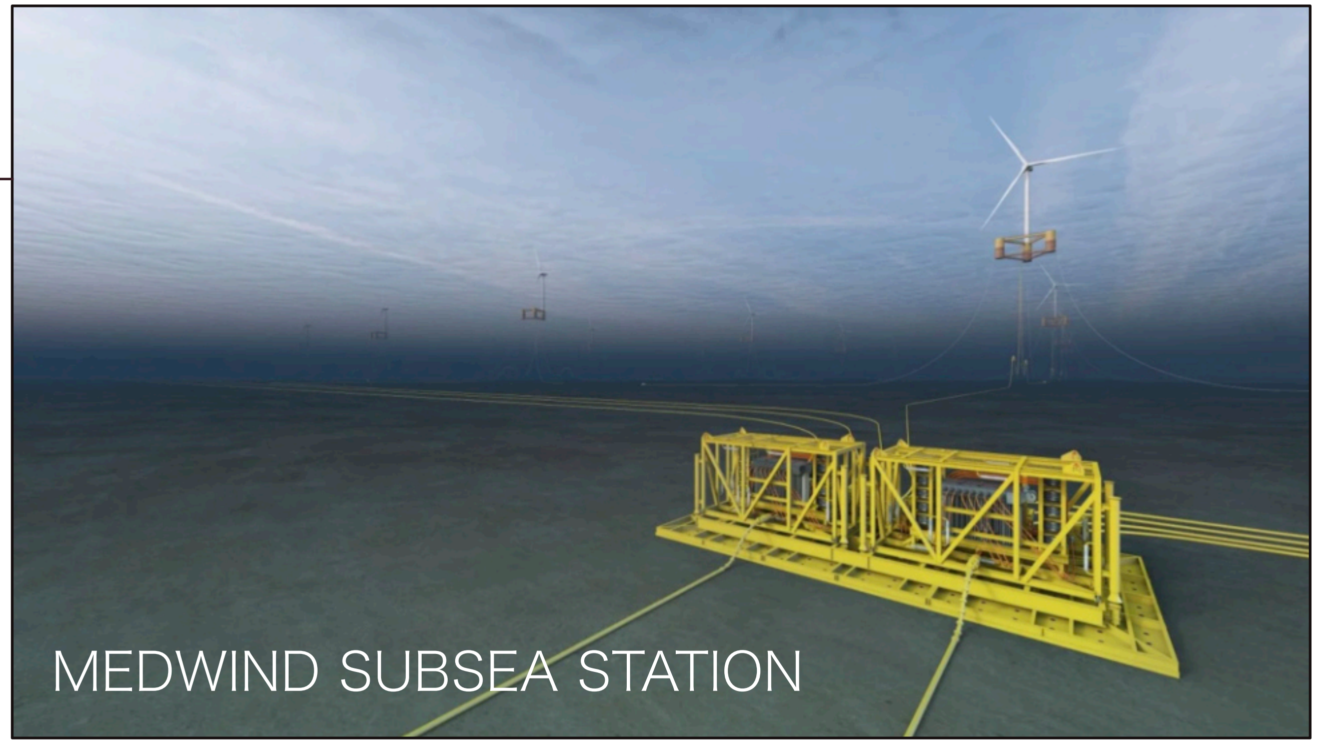
“We have designed the systems for very harsh conditions,” said Melisa Aparicio, Marketing and Communications at Saitec,” and have rigorously tested the structure at the Ifremer test tanks as well as those of the IHC in Santander and LIR in Cork, Ireland.

The design has demonstrated to be suitable for all the different locations where floating offshore wind is being planned. That includes extensive areas in both southern and northern Europe, west coast US and a great portion of the APAC region, among others.

“We are also planning to develop a construction hub to enable serial production of SATH floaters. Work is on going on in the region of Langosteira in Galicia.”



DemoSATH



MEDWIND SUBSEA STATION

Renexia has signed a front-end engineering and design contract (FEED) with Aker Solutions to design the underwater substations for Med Wind. Aker Solutions will work in close cooperation with its subsea power alliance partner ABB ABB.

The agreement involves the design of eight modules, two for each section of the Med Wind park, to be laid on the seabed of the Strait of Sicily, at a depth of between 520 and 660 metres, into which the cables of the plant's floating turbines will be conveyed.

The energy produced by will then arrive on land at the Partanna and Partinico power stations, via a system of submarine and land-based cable ducts.

The start of the design phase was made possible by the results of oceanographic campaigns on the seabed where Med Wind will be built. The collected samples and analyses, along with studies of sea currents, helped identify the most suitable areas for the entire plant. These surveys also confirmed that the project meets all sustainability criteria and aligns well with the marine environment. Moreover, no sites of historical or archaeological significance were found anywhere near the area where the turbines will be moored.

Med Wind will be developed in several stages and, once fully operational, will be able to produce about 9 TWh per year of clean energy, equal to the energy needs of 3.4 million households and equivalent to 3% of the national energy demand, an important step for the energy transition path undertaken by Italy.

K-FLOATER

Last year, SK ecoplant and POSCO carried out model tests on their K-floater design. This secured basic design certification from DNV

The K-floating body is a 10 MW semi-submersible floating model which is capable of withstanding a typhoon of about 40 metres per second that occurs once every 50 years. It is understood to maintaining structural and functional stability even in extreme sea environments such as currents of 2m/s and 10m-high waves.

CONCRETE

Concrete floaters will play a key role in the future of offshore wind, and for good reason. So says Javier Berenguer, CEO of Madrid-based shore engineering company Beridi Maritime which specialises in the offshore wind sector.

Concrete has a number of inherent advantages.

"Concrete systems are built to endure," he said. "With minimal maintenance, these platforms help keep long-term costs in check. Moreover, concrete platform's robust nature means are less prone to fatigue, which translates to fewer maintenance."

LOCAL ECONOMICS

Concrete's primary ingredients are locally abundant, meaning that every project has the potential to significantly boost the local economy.

ECO-FRIENDLY PRODUCTION

It is worth noting that concrete production generates fewer greenhouse gases than steel. This could make a big difference in reducing overall project costs, especially with the notable efforts of concrete producers to create more efficient and less polluting mixtures.

SIMPLIFIED LOGISTICS & ASSEMBLY

Many concrete platform designs, especially Triwind, is their compatibility with slipforming construction. This allows for the entire manufacturing and assembly process to take place

Concrete floater

on-site, eliminating the need for transporting massive components, which in turn slashes logistical costs and complexity.

LOWER AND PREDICTABLE UPFRONT COSTS

Compared to steel, concrete platforms generally come with a lower price tag and more stable pricing, allowing for more financial flexibility right from the start.

ACCESSIBLE EXPERTISE

With more specialists available in concrete construction, you're not just reducing costs; you're also opening the door to a broader range of expert services, ensuring your project is in the best hands.

SCALABILITY

As offshore wind turbines grow in size and capacity, concrete platforms are up to the challenge. They can easily scale to support larger turbines.

SECOND LIFE

What happens when a platform's job as a floater is done? Thanks to their similarities with port caissons, these structures can be repurposed for coastal defence or port expansion, extending their usefulness and value far beyond their initial purpose.