XXL Monopiles & Vibro-Hammers for Cheaper Offshore Wind

Leaving no stone unturned, the offshore wind industry continues to innovate and look for new and more cost-effective ways to develop renewable energy. Driven by the need to design systems that can be installed quickly and cheaply at extreme ocean depths, engineers are working on several approaches to provide the industry with more options for achieving the offshore wind expansion the world wants to see. Two of the most interesting recent developments in the design of offshore foundations are the use of extra-extra-large monopile foundations that can reach exceptional depths, along with new pile driving technology using vibrations for installing monopiles in every-deeper waters.

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Baltic 2: XXL Monopile Foundations & Unique Installation Methods

Certainly monopiles are already highly popular in the offshore wind industry, with this technology making up 66% of the offshore turbine foundation market.[i] Yet even this highly prevalent technology is in the midst of adapting to changing times as cost cutting within the industry continues and offshore farms are installed in deeper and deeper waters. To date, many old monopile designs cannot function in deep waters. In order to thrive, many monopile designers are looking to new variations on their technologies to maintain a competitive advantage in the industry.

Enter the XXL monopile – the extra long designs that can reach seabeds when water depths are 30+ metres. Not only will XL monopiles make it possible for this type of foundation to maintain a foothold in ever-deeper waters, it may also provide lower cost solutions for extreme offshore installations.

Touted as the world's largest offshore monopiles ever to be installed, the giant foundations being put into place at German EnBW's offshore wind farm, Baltic 2, will support 80 Siemens 3.6 MW wind turbines, and will rely on the installation of 39

monopiles and 41 jacket foundations. As a joint venture between Ballast Nedam, GeoSea N.V., as well as the EPCI (Engineering, Procurement, Construction and Installation) contractor Hochtief Solutions AG, the project will offer turnkey solutions for the Baltic 2 project's foundation work. [ii] Located 32 km north of Ruegen Island in the western Baltic Sea, the finished wind farm will have a capacity of 288 MW. The offshore wind farm is estimated to produce 1.2 billion kWh of energy annually, which is enough to power 340,000 homes and cut 900,000 tons of carbon dioxide emissions in the process.[iii]

Each of the 39 monopiles for this project will weigh 930-tons and measure 73.50 metres in length and 6.50 metres in diameter at the bottom, making them truly the world's first XXL monopile, at 15% larger than any other monopiles including those installed at the Walney 2 Offshore Wind Farm. In fact, compared to the first monopiles first installed by Ballast Nedam in 1994 which weighted only 71 tons, and those installed by Egmond aan Zee in 2006 that weighed 230 tons, to say the size of these foundations is somewhat larger would be an understatement.[iv] [v]

Getting these massive foundations to the offshore site will be a challenge – a process which will rely on the feeder concept whereby foundation components are brought to the HLV Svanen at the installation site. Using a floating method over the 62 nautical mile distance, the monopiles will travel from the EEW fabrication yard in Rostock to the Baltic 2 site, after which they will be upended and driven into the seabed to the required depth. The installation will be completed by Svanen, the Ballast Nedam's heavy lift vessel – a vessel that has already completed the installation of 400 offshore wind turbine foundations.[vi]

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Of course, the farm will also contain 41 jacket foundations which have been designed by Hochtief in-house. Using a 3-leg design, the team optimized the structure to prevent corrosion, protect joint connections, and improve the safety of equipment and plant. These foundations will be constructed using 80,000 tons of raw steel. When it comes to installation, these jacket foundations will be put into place using specialized jack-up platforms and crane ships. [vii]

Given the huge scale on which these

foundations are being built, they are projected to be some of the most cost effective designs in offshore wind for applications with harsh conditions and severe water depths. By optimizing the logistics using the feeder method and using a highly cost-efficient installation method, the installation consortium believes they will achieve lower costs overall. [viii] The XXL nature of these incredibly huge foundations makes them ideal for larger turbines as well, thereby further increasing their cost effectiveness over the life of the offshore farm. [ix]

Riffgat: Vibro-Hammers and Monopile Driving

Another innovation in the offshore wind foundation sector is that of the vibro hammer for installation of monopiles. Though vibro-driving has been used extensively for the installation of foundation piles in civil engineering structures for decades, this is just now gaining attention in the offshore wind industry, in part because of its lower cost. What's more, compared to hammer driving, vibro-piling has been shown to emit far less noise during pile installation.

In tests done in full scale at Anholt Offshore Wind Farm in 2012, it was found that for a total of 111 monopile foundations installed via vibro-driving, the vibro-piling was more cost effective than predicted. Additionally underwater noise measurements were shown to be below 160 dB re. 1 µPa Sound Exposure Level (SEL) at a distance of 750 m for piles of approximately 5 m in diameter. Though certain soil conditions can cause a vibro-driver to act more like a hammer (thereby diminishing any noise improvements), overall this technology appears to be far less disruptive for natural environments. The tests also looked at costs, discovering that to provide the greatest budget benefits, the vibrator and pile must be lifted simultaneously (which is a function only a few installation vessels can currently provide). Nevertheless, the cost saving potential is great if experts can continue to refine it and retrofit vessels to expand their fleets for this specialized installation technique.[x]

Perhaps one of the developments best known for use of this technology is Riffgat Wind Farm in the German North Sea. The monopiles for this project were installed by a cooperative between CAPE Holland and Seaway Heavy Lifting. For this application, four APE 600 vibratory hammers were operated in tandem but independently to form an APE Super Quad Kong. This four-hammer system was pressed into service to install the 30 heaviest piles.[xi]

Reports suggest that these piles were the heaviest every driven using a vibratory hammer, and yet the installation was considered environmentally friendly because of how quiet it was. The APE 600 vibratory hammers apparently are able to drive

piles into the seabed quickly and quietly, which is useful for keeping installation costs down and remaining within regulatory restrictions for environmental disturbance.

Lending credence to the growing popularity of this technology, Seaway Heavy Lifting recently purchased CAPE Holland Vibratory Hammers for their two offshore wind projects: Helwin 1 and BorWin 2. The Tandem Super Kong will be put to use installing 16 piles.[xii]

Further Refinements of Offshore Foundations on the Horizon

As offshore wind farm managers continue to squeeze every dollar out of the development process, innovations such as vibro-driving and XXL monopiles will continue to be released. As always, by consulting with experts that already use offshore technologies for other purposes (such as those in oil and gas), the offshore industry will continue to mature and refine its processes to achieve greater financial gains and environmental sustainability.

Maryruth Belsey Priebe

Maryruth can't help but seek out the keys to environmental sustainability - it's the fire that gets her leaping out of bed every day. With green writing interests that range from sustainable business practices to net-zero building designs, environmental health to cleantech, and green lifestyle choices to social entrepreneurism, Maryruth has been exploring and writing about earth-matters and ethics for over a decade. You can learn more about Maryruth's work on JadeCreative.com.

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