

Islet of the Grindstones



PES brings you Jan De Nul's experience of constructing the Tahkoluoto wind farm. The geographical location, the elements and the difficult terrain all posed different types of challenges. Previous knowledge gained on other ventures, suitable equipment and engineering skills were crucial to the success of this project.

Jack-up vessel Vole au vent installing the offshore wind farm Tahkoluoto



Possible ice and rocky soil: these were the conditions in which Jan De Nul Group installed the very first Finnish Offshore Wind Farm, Tahkoluoto. It is named after the port nearby, meaning 'islet of the grindstones.'

In fact it was hard diabase bedrock below the seabed and a layer of moraine clay and boulders of different sizes on top of it. Being the remains of scraping glaciers in previous glaciation periods, it was a challenging environment in which to construct a wind farm, able to withstand the severe Finnish winters.

None of the classical monopile driving methods, such as the one Jan De Nul Group used to construct the Belgian offshore wind farm Nobelwind, could be used here, in the Gulf of Bothnia, because of the soil conditions. An atypical design and construction of the wind turbine foundations was necessary.

The only option was to place ballasted foundations on a prepared seabed. This was certainly no practice run for Jan De Nul Group. The Group had already designed, constructed and installed sixteen gravity based foundations for Karehamn, the Swedish wind farm. The foundations had specific dimensions ranging from 15 to 25 metres. The heaviest of them had a weight of 1,940 tonnes. The Jan De Nul Group was able to use the know-how gained from this prior experience on this project.

Waiting for summer

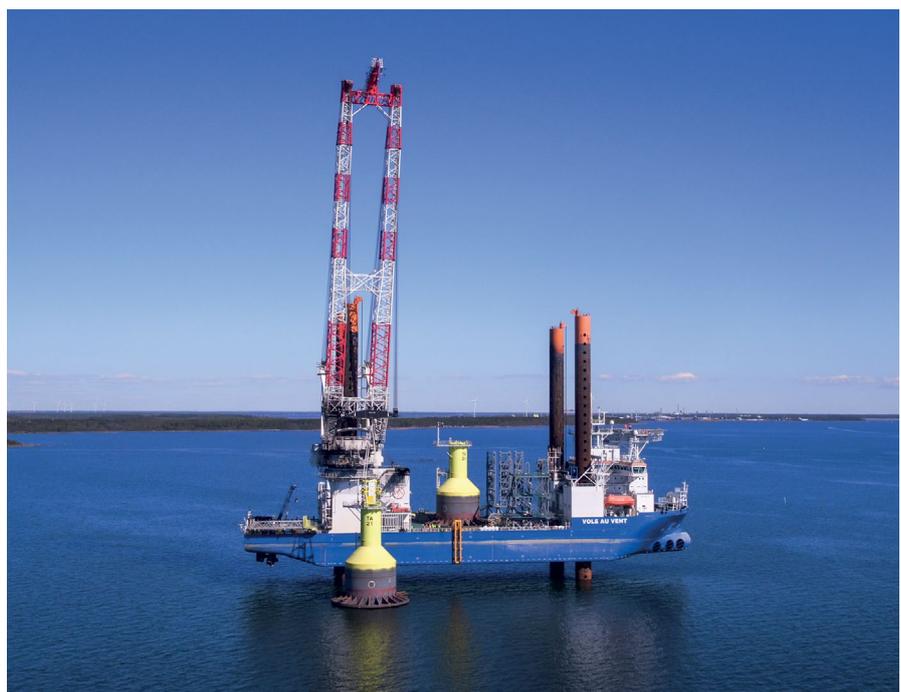
First things first: the seabed needed to be prepared in order to receive the massive gravity based foundations. No offshore, or

sea work, could be carried out during the winter, due to the possible frozen sea. So the total project was split into two summer campaigns: one in 2016 and one in 2017. Of course, engineering and preparations continued in full swing at the project offices in winter time as well.

To perform the preparation work during the summer of 2016, Jan De Nul Group mobilised its large backhoe dredger Mimar Sinan, equipped with a bucket of 20 m³. Ten foundation pits - with an average diameter of 25m - needed to be dredged for the future turbines, as well as the 6km trenches for the 12 km of power cables between the turbines and the land.

The backhoe dredger, with a capacity to dredge up to 20 meters deep, was perfect for creating the foundation pits in the water depths of between 10 and 18 meters. One pit was located directly in the bedrock and required blasting before dredging. The blasted fragmented material was sustainably reused, as preliminary erosion protection, at another turbine location. The dredged material was loaded into the Tiger, a 3,700m³ self-propelled split hopper barge, and transported and dropped at dedicated dumping locations.

Once the foundation pits were dredged, the seabed preparation into these pits could start. So-called 'mass replacement' layers were installed into the pits. A total of 20,000 tonnes of rock - delivered and procured from a local quarry - was loaded into Tiger's hopper and fixed excavators were installed on board. Good teamwork between crew and staff and the precise positioning system



Jack-up vessel Vole au vent installing the steel gravity based foundations for the Tahkoluoto wind farm



Installation of the wind turbines by jack-up vessel Vole au vent of Jan De Nul Group



Loading the turbines on board the jack-up vessel Vole au vent of Jan De Nul Group for Tahkoluoto wind farm installation



Jack-up vessel Vole au vent installing the steel gravity based foundations for the Tahkoluoto wind farm

of the vessel, to fill the pits up to the required level and volumes, was indispensable.

The compaction of the layers was done by freefalling a compaction weight from a cable crane, following an allotted pattern. The multipurpose barge DN126 was especially equipped with the Liebherr LH895 crane and compaction weight. The same barge was also used to install the fine, and final, fine graded gravel layer into the pits.

The Jan De Nul Group was able to answer the quite demanding tolerances, on the

flatness and angles of these gravel beds, by using a fully automated underwater levelling tool. Precise levelling is key in ensuring a regular weight distribution of the Gravity Based Foundations, as well as a perfectly horizontal tower flange.

First Finnish guest

In the Summer of 2017, the jack-up vessel Vole au vent, having just finished the installation of the Belgian offshore wind farm Nobelwind, was mobilised to the Technip facilities in Mäntyluoto Port, to pick up the steel gravity based foundations. This was the first time a four-legged-jack-up vessel was used in Finland.

It is one of the largest of its kind in the world and was built specifically to install offshore wind parks. The huge 3,400 m² deck space was fitted to transport two foundations at a time.

Each of the ten foundations was fitted with a funnel system and fall pipe inside to ballast them immediately after installation to handle waves and wind. The ballast material could easily be guided through the different internal floors inside the foundation due to the funnel system.

Precise planning and operational procedures for the allocation of the vessels and barges were crucial. The weather forecast was continuously assessed and consequences on the foundation installation and ballasting continuously adapted.

The ten Siemens-Gamesa 4MW-wind turbines, each with a tower height of 76 meters, blades of 63 meters long, and a rotor diameter of 130 meters, were

manufactured in Denmark and transported to Mäntyluoto port.

Each tower was built in three sections. The assembly of these sections was done on board of the jack-up vessel Vole au vent. Purpose made sea fastenings to fit all of the wind turbine components and lifting tools were designed and constructed to be able to withstand the forces of the wind and of the movement of the vessel during sailing.

As the wind farm was only a couple of kilometres offshore from Mäntyluoto, the loading time, installation time and sea fastening costs for the client were optimised by loading and installing only two wind turbine generators per vessel trip.

Pompeï, the subsea rock installation vessel, was in charge of protecting the foundations and the power cables from the erosion patterns around the foundations: first a rock filter layer, and secondly a layer of armour rock was put in. In total 160,000 tonnes of rock was used on this project. Early July 2017 Jan De Nul Group installed the very last armour stones, well ahead of time.

The owner of the Tahkoluoto wind farm, Suomen Hyötytuuli Oy, together with shareholders of the major energy companies in this city, already operated four onshore wind farms in Finland, with a total capacity of 107 MW. Their brand new and very first Finnish offshore wind farm will be fully operational in October 2017 with a 42 MW capacity. The Tahkoluoto wind farm will produce enough electricity to power up 30,000 homes per year.

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