

# North Hoyle Wind Farm



The North Hoyle Windfarm is the first completed large scale UK offshore windfarm, comprising 30 x 2 MW wind turbines. The windfarm is located 8-11 km off the coast of Rhyl in North Wales in an area with very high tidal variations.

**LICEngineering** undertook design of the 30 monopile foundations and associated structures such as tower flange connection, grouted transitionpiece, boatlanding, J-tubes and access platform.

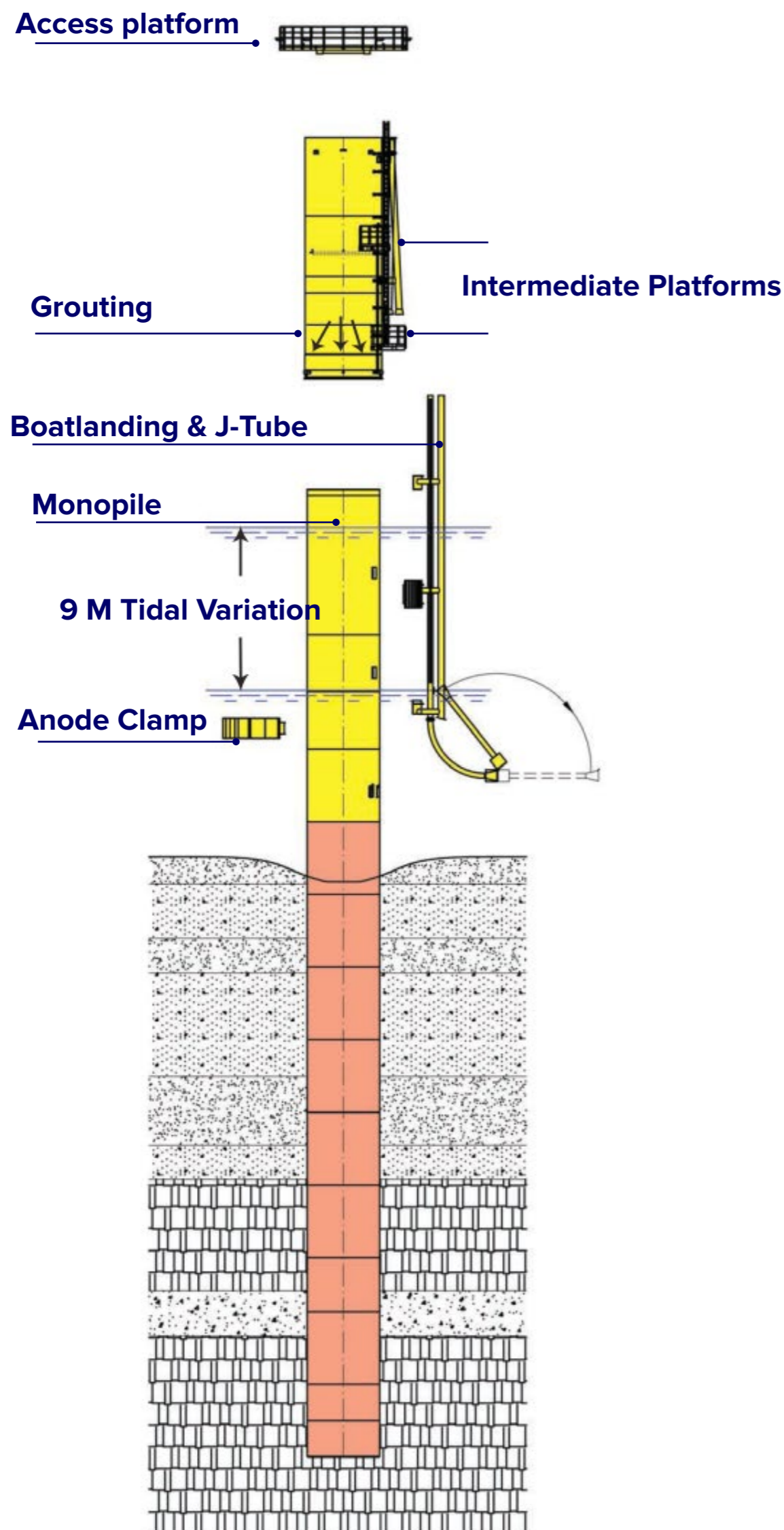
The foundations were installed in 2003.

## Project Details

The windfarm is operated by National Wind Power Offshore. Vestas-Celtic was the main partner in the supply and construction contract and Seacore installed the 30 monopile foundations, using an 8 legged jack-up drill rig. The turbines and towers were supplied by Vestas. LICEngineering A/S carried out the detailed design for the foundations and provided engineering support throughout the project. Smulders B.V. supplied the main steel and provided the fabrication layout for some of the steel details.

## Design Analysis

The design analyses were carried out to determine the required wall thickness and penetration depth for the monopile. Dynamic analyses were carried out including the vibrational behaviour of the pile and tower subjected to combined wave and wind loads. The pile was designed to resist ultimate storm loads and fatigue loads in the operational lifetime. The integrated boatlanding and J-tube arrangement was analysed for extreme waves on the location.



## Installation Aspects

The handling of the very heavy and large pile onshore at the yard and quayside was a difficult task. The weight of the foundations was up to 270 tonnes. The piles were offloaded directly to sea and floated to the site towed by tugboats. The installation was then carried out from a large 8-legged jack-up rig. This saved large costs. The bulkhead arrangement included an upending tool. After upending, the monopiles were installed using a combined drive and drill technique. Each pile was initially driven through the upper sand and clay layers using a large hydraulic offshore hammer. A slightly undersized hole was then drilled into the underlying bedrock formations and the pile finally driven into this hole to the required penetration. After pile installation the transition piece was landed and grouted in place. The access platform was then installed and bolted in place. The lower part of the access arrangement including a hinged lower J-tubes section was then installed on the doubler plate hangers and locked to these with bolt arrangements. The hinged J-tube extensions were then rotated into position. After cable pull-in, scour protection was installed.

## Foundation Layout

The main components of the foundation consist of a monopile with an outer diameter of 4 m and a grouted transition piece landed over the monopile top section after pile installation. The monopile is mainly a bare pile only fitted with a number of doubler plates. This allows for driving of the pile. The doubler plates are used for hang-off of the J-tube and boatlanding arrangement after completion of the grouted connection. It is welded on flange for connection to the turbine tower. There is an internal platform in the upper part of the transition section.

## Geotechnical Conditions

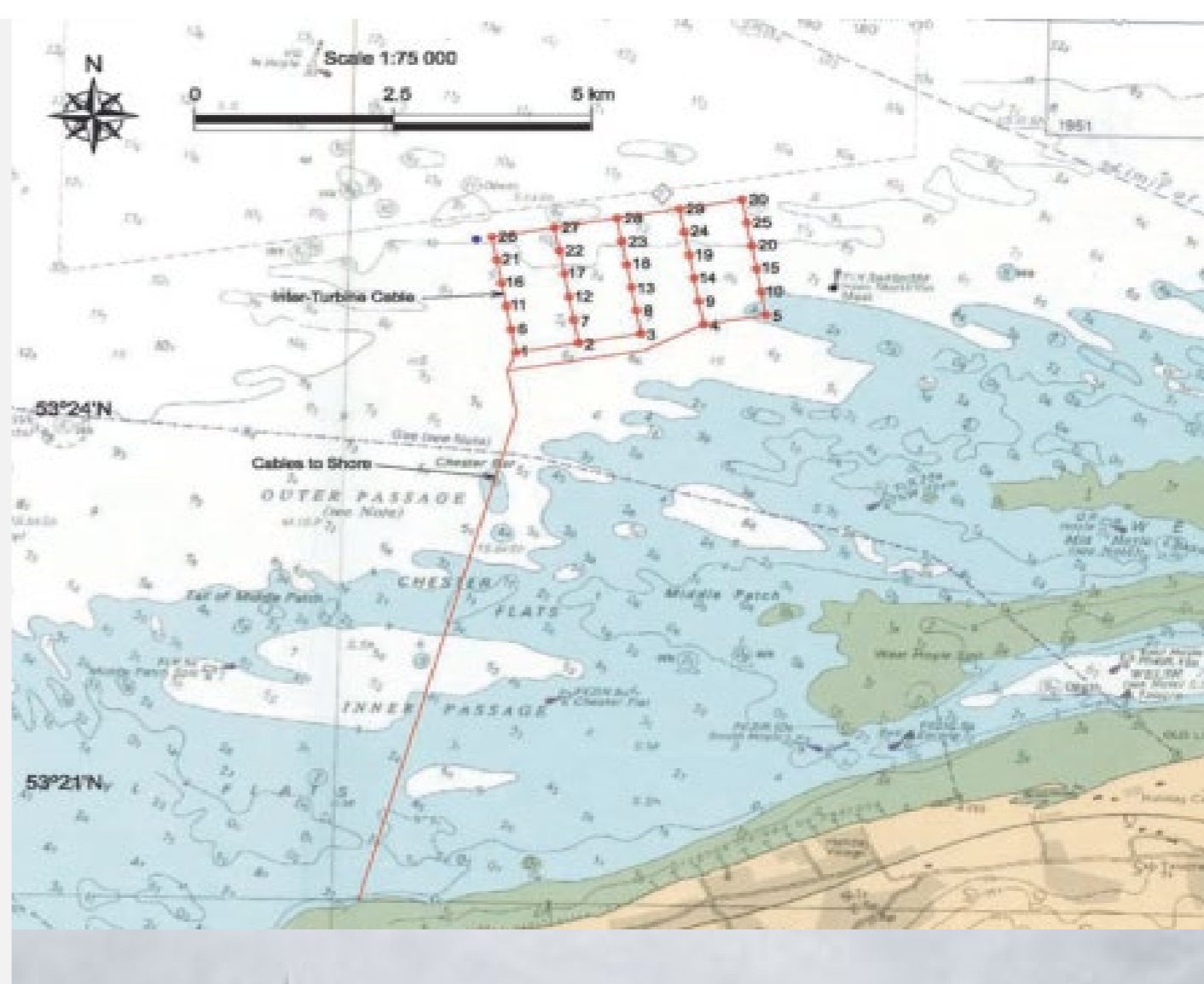
The geotechnical conditions on the location show high local variations. A number of geotechnical boreholes were drilled prior to foundation installation. The upper seabed layers comprise variations of sand and clay layers. Layers of mudstone or sandstone are present below these top layers.

## Hydrographics

The windfarm is placed approximately 8 km from the shoreline. The seabed is relatively level at the location but subjected to very high tidal variations. The mean water depth is around 12 m but ranging up to 21 m at high tide.

## Access and J-Tube Arrangement

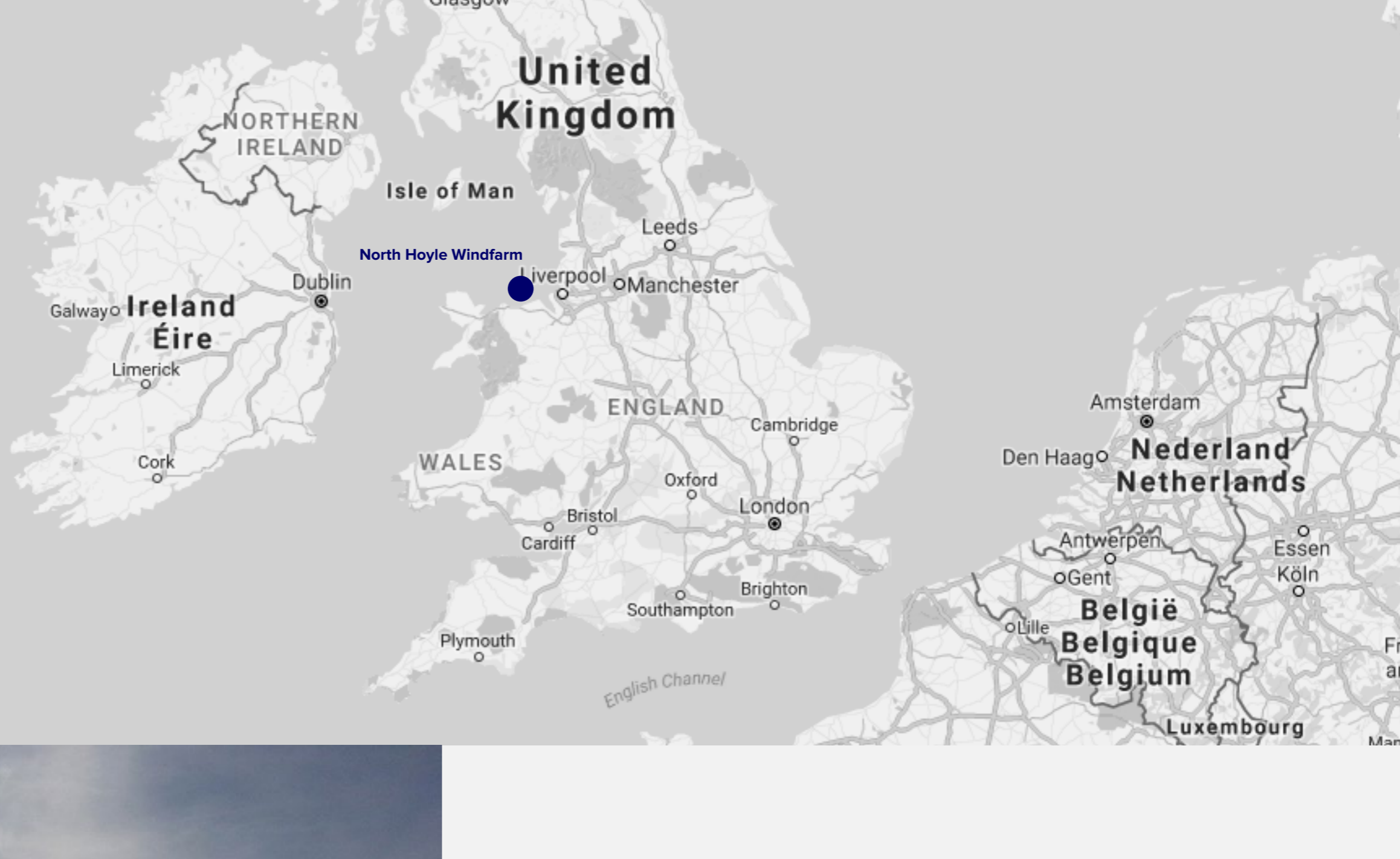
Due to the very high tidal variations the access arrangement was made in two main sections. The upper part of the access arrangement and the access platform is welded and bolted to the transition piece. The lower part of the access arrangement comprising boatlanding with fenders is a separate item which is locked to the doubler plates by a hanger and bolt arrangement. The J-tubes are part of the fender arrangements on the boatlanding and includes a hinged straight J-tube extension section to allow for lowering of the J-tube and protection of the cables all the way to the horizontal exit on the seabed well away from the pile.



## North Hoyle Wind Farm Project Facts:

Type of Structure	Wind turbines, 2 MW, Vestas type, V80
Location	Irish Sea, Liverpool Bay
Maximum Water Depth	21 m <sup>1</sup>
Pile Diameter At Seabed	4.0 m
Installed	2003
Installation Method	Driving through upper sediment layers followed by drilling and driving through rock layer
Number of Foundations	30 (Under installation. At present all foundations installed with 10 of the turbines fully installed)
Maximum Pile Penetration Below Seabed	33 m
Connection Tower/Pile	Flange connection on grouted transition piece.
Special Feature	Grouted transition piece between pile and tower above sea water level
Scour Protection	Stones placed on stony sea bottom protecting power cables.
LIC Engineering Tasks	Concept development, Tender design, detailed design, Specifications, Installation design, Engineering follow-up, Special supervision.

<sup>1</sup> Water depth at highest tide. The tidal variations in the area are up to 10 m.



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