Newport East (Nash) Wind Turbine

energy saving and efficient wind turbine powers innovation at a South Wales WwTW

by Andrew Bowen, Paul Thacker & Stewart Bell

Welsh Water is committed to reducing its carbon footprint and protecting the environment from the effects of climate change and is pursuing measures to generate more of its own power from renewable sources. Welsh Water recently signed a five-year contract with Dong Energy to supply green energy to power its sites, as well as introducing ways to reduce the energy use from the National Grid from its operations. To help achieve this outcome, Welsh Water sought planning permission to erect a single 2.5MW wind turbine at the Nash WwTW sited at West Nash Road, south east of the city of Newport. The turbine will generate 6GWh annually, or around 6% of Welsh Water's current renewable electricity generation, delivering significant savings through reduced power costs and via Renewable Obligation Certificates (ROCs) income. The scheme forms part of Welsh Water's strategy to reduce the overall carbon footprint and produce electricity to power its own assets, in the interests of self-sufficiency and environmental sustainability.

Off loading the 47.8m turbine blade at the dock side
Courtesy of Welsh Water

Installation of the first shaft section
Courtesy of Welsh Water

Final shaft section being lifted into position
Courtesy of Welsh Water

The first blade being lifted into position
Courtesy of Welsh Water

The project

The project started in April 2016 and was delivered by principal contractor Skanska. The projects had two key targets:

- To erect and operate the turbine against an incredibly tight programme and ensure the turbine was commissioned prior to the 31 March 2017.
- To build on the environmental and construction practises already demonstrated in the project at Swansea Bay Wind Turbine.

At Nash WwTW, the turbine was designed to generate around 6GWh per annum. When flow rates into the WwTW are low It was anticipated that 37% of the power generated would be exported to the grid and assist Welsh Water achieve its 50% carbon reduction through renewables.

Carbon footprint

A carbon footprint study was undertaken on the project, which involved discussions with the lead design team ARUP to produce a turbine base which would be low in carbon.

The structural designs for the turbine base had to meet industry practice design criteria, which proved challenging with the ground conditions present. Lewis Civil Engineering and piling contractor Skanska Cementation requested concrete mixes (C45/55 and C32/40) which included recycled content of at least 70% GGBS.

Ground conditions

The complex ground conditions and engineering solutions required considerable attention in the planning stages. The initial design was for a monopile foundation, which was 11.2m in diameter and 30m deep (2,955m^3).

This required a caisson shaft design, involving precast units and a concrete pour of over 2955.61m³, in addition to the concrete required for the plug and precast units. This was challenged by the construction team and an alternative design was proposed by Malachy Walsh & Partners (MWP). This met the needs of the programme and required just 760m³ of concrete.

Llanwern steel works required 400,000 tonnes of soil for a landfill restoration project. Skanska engaged with the steel works to see if the soil from the site would be suitable; it was and over 8,736 tonnes was taken there, creating significant cost savings. This approach was part of a wider strategy to try to make the scheme as environmentally sustainable as possible.

Environmental sustainability

Lewis Civil Engineering procured low carbon concrete mixes, recycled aggregate and used Tensar Geogrid. Using Tensar Geogrid reduced the amount of excavation and infilling of materials required for the final design of the pile mat and crane pad by 50%. This lesson was learned from the earlier turbine project at Swansea. The project also identified opportunities to ensure materials used for the temporary works (a piling platform and a crane pad) could be reused as part of the permanent design after installation.

The team identified a further opportunity to add biodiversity value to the WwTW, through the sowing of a wildflower meadow. The diversity of species in the grassland around the site of the turbine was enhanced to create a wildflower grassland and foraging habitat. The wildflower mix is specifically designed to provide maximum food resource for pollinators and other insects. This measure supports the Welsh Government's Action Plan for Pollinators in Wales (2013) to halt and reverse native pollinator decline in Wales.

The scheme is currently seeking Skanska's Deep Green accreditation, similar to the previous turbine installed at Swansea that achieved the following targets:

- Net zero primary energy.
- Zero hazardous materials.
- Zero waste to landfill.

Floating new ideas

The project brought about considerable logistical challenges, with the movement of the turbine itself being the principle one. The turbine had to be delivered down the River Usk on a barge, before being transported the short distance to the South Wales site. The use of the river as a transport link saved considerably on disruption to the local traffic, had the extra-long 50m blades been transported by road on a lorry.

Site access

Components such as the 10-tonne rotor blades would have required escort riders and even road closures to access the site by road through the village. The alternative route was created especially for the project, to deliver the 127m-tall wind turbine on site to Nash WwTW.

The project team implemented a suitable construction and reinstatement plan and carried out all the work associated with the delivery, transportation and erection of the turbine. The access road that was built to the turbine location went through Liberty Steel and SIMEC Power Station and needed to be removed following installation.

The access route required considerable upgrading and modifying to accommodate the 50m long transporter wagons. The road construction had to navigate across two drainage channels (known locally as Reens), both of which were heavily protected environmentally. These factors collectively made the installation a complicated prospect at several points in the project.

Newport East (Nash) Wind Turbine Project – Key Participants	
Principal contractor	Skanska UK
CAT III check - wind turbine foundation	Raymond Brown
Wind turbine foundation design	Malachy Walsh & Partners
Access road and electrical design	ARUP
Design checks on piling platform	Skanska Technical Services
Civils	Lewis Civil Engineering Ltd
Electrical installation	SSE Enterprise Contracting
N100/2500 turbine	Nordex
SCADA kiosk & platform	Bridges Electrical
Piling	Skanska Cementation
HV Switchgear	Hawker Siddeley Switchgear

The transport barge moored up at Uskmouth Power Station
Courtesy of Welsh Water

The completed 127m tall wind turbine in Nash WwTW
Courtesy of Welsh Water

The road forward

Within the works, the design team also considered the existing assets to be 'at risk', so the project team overcame this by installing almost 1000m^2 of protective concrete road surface. The complicated engineering works resulted in the subcontractors working day and night to prepare the site for piling works initially.

Following the completion of the piling work, the site was then prepared for the formed reinforced concrete (FRC) work at the wind turbine base, which consisted of around 400m^3 of concrete. With the FRC completed, Lewis then installed over 14000 tonnes of recycled aggregate to form a 1200m access road.

The site team working on the concrete road deployed over 300 sheets of A393 mesh and almost 300m^3 of RC 40/50 concrete placed to protect the existing assets. One challenge was the speed the work needed to be carried out, to maintain continued access to the site. A bespoke rapid-setting concrete was used, which was designed by Lewis and its concrete supplier Cementation under the P450 description. This allowed curing to take place within 24 hours, and tankers could drive safely on it within a day of it being laid.

Lewis's worked on the project for 30 weeks, with the sub-contract valued at £1.27m+ as part of the overall budget.

Delivering the turbine

As the site was fully prepared for the arrival of the turbine structure, an unforeseen circumstance hastened a potential delay. At the docks where the turbine was being stored, the crane broke down during the loading of the barge with the crane components. This resulted in the vessel missing the tide for the delivery slot.

When the components arrived, the heaviest component had to be loaded on the port side of the ship. But when the vessel arrived at the jetty near Uskmouth Power Station, the starboard side of the barge was closest to the quay. This resulted in most of the cargo being unloaded, then a patient wait for high tide, so that the ship could be repositioned to gain access to the remaining components.

Despite these delays, the turbine was erected, powered up and commissioned almost a week before schedule.

Conclusion

Work was completed on the turbine in June 2017. The Nordex N100/2500 turbine will provide over half of the annual energy needed to operate the Nash works.

The construction of the wind turbine at Nash has engendered many benefits:

- It cements Welsh Water's aspiration for more energy to power its assets from renewable sources.
- The construction processes were aligned to minimise its impact on the environment.
- Brings biodiversity benefits not just to the local site, but across the wider region. It will mean that the National Grid will not have to build more assets (power stations and electricity sub stations etc) that will encroach on greenfield sites and impact the biodiversity present in those areas, because of future energy demand by Welsh Water.

The wind turbine has been performing well, with high availability maximising output from the turbine.

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A Liebherr LTM 1500-8.1 laid down due to high winds - Courtesy of Welsh Water

Overview of the project and delivery of the final turbine shaft section Courtesy of Welsh Water