Winds of change

The starting gun has been fired for a new generation of deep-sea windfarms. PE investigates some of the pitfalls facing the brave new world of renewable energy

By Ben Sampson

Going up: The Vestas tower crane can operate longer hours than a regular crane under strong wind conditions and can be mounted three times faster

In 2020 the sun sets behind a swathe of white towers cutting a line through the sea. Each tower is as tall as a skyscraper and is adorned with a trio of rotating blades slicing the high winds into chunks of electricity. Around them at their bases, small boats struggle against the elements, testing, checking and maintaining the site.

The offshore wind industry of the future can finally begin to take shape now that the Crown Estate has announced the winners of its "round three" competition. But for engineers the picture is far from complete.

Round three was the biggest auction of the UK coastal shelf yet, with the development rights for an estimated 30GW of wind-generating capacity sold. The nine sites could produce up to a quarter of the UK's total predicted electricity requirement in 2020 as 18 companies try to develop the biggest windfarms in the world. Successful bidders include established names such as Centrica, Scottish Power and E.On as well as less familiar firms such as Seaenergy Renewables, Mainstream Power and Eneco.

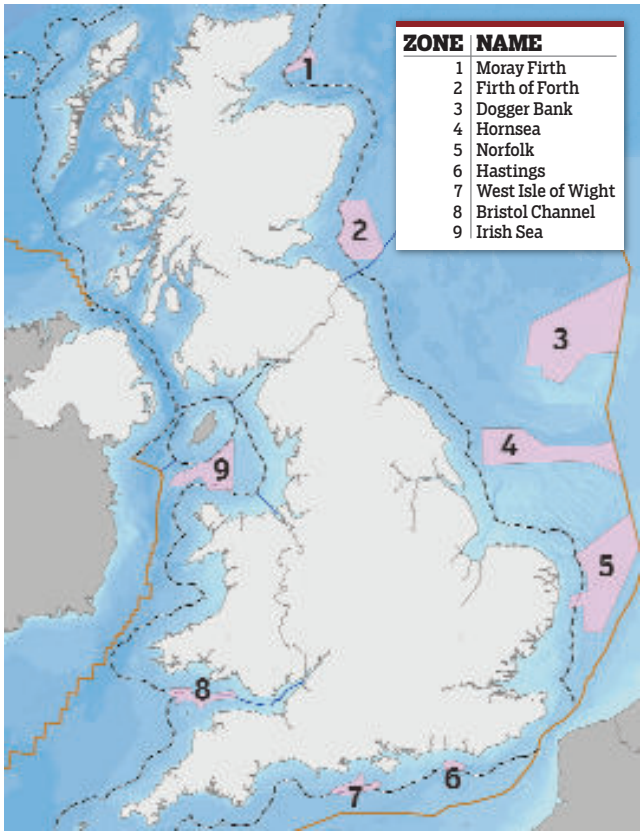
The sites are the furthest out to sea ever planned. Some, such as Dogger Bank in the North Sea, will be more than 100km from the coast. Harnessing the stronger winds is potentially lucrative but comes with a downside: the remote locations and stormier conditions mean a new set of engineering and operational problems.

A major barrier may be reliability – a crucial unknown factor to many engineers.

Along with BP and the Technology Strategy Board, Qinetiq is to develop condition-monitoring systems that will predict when maintenance needs to be carried out on turbines. Mark Roberts, strategic business director for energy and environment for Qinetiq, says: "The drivetrain has been an issue for as long as wind turbines have been around. Gearboxes simply fail quicker than the design says they should. One view is that this is caused by the loads on the turbine being out of the experience of gearbox designers."

Most engineering experience in wind turbine gearboxes comes from the processing and petrochemical industries which use stable plant running at constant speed under constant loads in a controlled way. Turbines erected 100km out to sea are a very different matter. Some rotor blades for larger turbines will be 128m long. Not only do the loads from the wind fluctuate dramatically but loads are different over the length of a blade. That accelerates the degradation of gearbox components and degradation can be compounded by assembly errors during manufacturing.

On land a problem with a gearbox can be fixed relatively easily with a crane. At sea the task becomes more difficult and costs increase. One major expense is the chartering of jack-up vessels for maintenance: there are not enough ships



ZONE	NAME
1	Moray Firth
2	Firth of Forth
3	Dogger Bank
4	Hornsea
5	Norfolk
6	Hastings
7	West Isle of Wight
8	Bristol Channel
9	Irish Sea

Windfarms face a cloudy future

The Crown Estate is the owner of the UK's coastal seabeds and has granted the rights to energy firms to develop the sites on behalf of the government.

Auctions of sites became larger as the development areas move further from the coast. It is unlikely that work on round three sites will begin before 2016.

Offshore wind remains a central aspect of the government's policy of achieving 2020's carbon emissions reduction targets. Around 32GW of capacity needs to be built in the next decade, a twentyfold increase over today. According to the government the sector will be worth £75 billion and employ 70,000 people by 2020.

The Royal Academy of Engineering and the Institution of Mechanical Engineers say that 32GW is not achievable by 2020 and warn that a lack of manufacturing capacity and skills, poor economic conditions and engineering challenges will delay projects considerably. Some critics say reliability and intermittency problems will make offshore windfarms an expensive mistake.

There are also doubts over the amount of economic benefit wind energy will provide for UK manufacturing. Although turbines will have to be installed in the UK, the two major turbine manufacturers supplying to UK farms so far, Siemens and Vestas, both manufacture outside Britain. Last year Vestas closed its only UK manufacturing site, on the Isle of Wight, blaming lack of demand.

Fields of promise: The nine deep offshore sites (left); the Horns Rev 2 accommodation platform is lowered into place (right)

available because of their constant use by the oil and gas sector.

"There is no question there will be problems," Roberts says. "The question is how big the problems will be. The economics are already on a knife edge because of the high capital cost of windfarms. Ultimately, nobody knows because our experience of maintenance on offshore windfarms is very limited. Condition-monitoring will be a critical technology in solving that."

Designers are developing improved gearboxes and research is being undertaken into alternatives and hybrid designs. Siemens, among others, is looking into direct drive turbines. Nevertheless, Roberts believes accurate condition-monitoring systems will be crucial to making round three windfarms viable. "Their job will be to detect and characterise faults as accurately as possible, as early as possible, so an operator can run a turbine, maybe for months, until the appropriate replacement hardware can be sourced without it reaching critical failure.

"To achieve that we need a better understanding of what effect different loads have and the information we can get from different vibration signatures."

Benj Sykes, senior technology acceleration manager for the Carbon Trust, says safety and cost need to be addressed. "Round three is a critical part of the low carbon puzzle. But doing it safely is not a trivial challenge," he says. "Already some firms are experiencing the challenges of transporting engineers for two and half hours on a boat and then transferring them safely to work on a turbine."

The Carbon Trust says it is necessary to develop cheaper and more efficient ways to access turbines in high winds. It's not always going to be practical to winch someone to the top of a 100m-high turbine. Systems such as Vestas' tower crane, the only crane that can operate on tapered towers and that is flexible enough to lift all types of main components, and gangways between maintenance vessels and turbines are being developed.

Another way of reducing servicing costs includes building platforms, or "motherships", to provide staff accommodation. Some windfarms outside UK waters have gone down this route. Horns Rev 2 is a 209MW capacity windfarm built by Dong Energy 15km off the western coast of Denmark. Dong has built an accommodation platform for 24 workers next to the site's electricity substation. Each of the 91 turbines is linked to the platform and the shore so monitoring and maintenance can be conducted.

Sykes says: "It's likely offshore communities will develop around some of the sites and it will be interesting to see if there will be collaboration between different zones and firms like there is in the oil and gas sector. There will be people moving every day around windfarms. There is a lot more risk in terms of logistics than in the oil and gas industry."

A typical oil rig will house a few dozen workers. According to Sykes, a round three windfarm will consist of hundreds of turbines, each of which will need to be serviced at least once a year during a window of roughly 250 days. Engineers and workers will therefore be frequently moving on and off the platform, sometimes in rough conditions. "It will be on a much bigger scale than the oil and gas sector," he says.

Captain Peter Hodgetts is chief executive of Brighton-based offshore engineering firm the SeaRoc Group, which expects to be involved in development of several round three sites. A member of the British Wind Energy Association's health and safety committee, he agrees that demand for servicing will be high but does not believe that will make operations more risky. "We move thousands of people offshore using helicopters in the oil and gas sector," he says. "The other big difference is that windfarms will not handle hydrocarbons. It's not impossible for an explosion to occur but there can't be a Piper Alpha-type disaster with renewables."

He believes that lessons learned in oil and gas, such as improving self-sufficiency by having medics based offshore, can be transferred to the renewables sector. "We are an industry in its infancy but we are inheriting a huge learning curve from the oil and gas offshore industry," he says.

"The Crown Estate is keen to set the best safety standards. It's all very doable – there are no showstoppers." ?