nwip

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Solutions for Business
Funded by government

Moving Forward: The Northern Way

one NORTH EAST
Yorkshire Forward
Northwest Regional Development Agency

The Northern Wind Innovation Programme

Funding and support for the offshore wind industry in the North of England

nwip

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Moving Forward: The Northern Way

one NORTH EAST
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Northwest Regional Development Agency

Foreword by Hugh Morgan Williams, The Northern Way

The UK's energy supply is undergoing significant change. Over the next decade a third of UK electricity generation capacity will be decommissioned. With indigenous North Sea oil and gas resources depleting, we are becoming more reliant on imports. All this is happening at a time when we need to create low carbon energy systems that satisfy the UK's commitment to reduce carbon emissions and meet our future energy needs.

A huge challenge, but also a major opportunity for the North. The North of England has the potential to become the low carbon powerhouse for the UK. No other region can offer the same strengths in advanced technology, with natural resources, ports and a tradition of manufacturing and engineering.

The Northern Wind Innovation Programme is an excellent example of what's possible. We were delighted to support this unique collaboration across the North. This investment will ensure we capitalise on our strengths and ensure that Northern businesses are in a position to win a share of the market in the search for clean reliable electricity. It will help to resolve the complex technological and manufacturing challenges we face in developing a world-class new industry, and forge the alliances that we will need to succeed.

We shouldn't blunt the healthy impact of competition - between companies, or between different places. But we also know that the scale of the opportunity is so vast that solutions will only arise from partnerships, between businesses, with universities, and between the public and private sector. Working together, we will have the opportunity to create nothing less than a new industrial revolution for the North.

Hugh Morgan Williams
Chair
The Northern Way

Moving Forward:
The Northern Way

The Northern Wind Innovation Programme (NWIP)

The offshore wind market is set to be one of the biggest growth sectors in the UK. It is estimated that if just 20GW of offshore wind capacity is developed by 2020, £60 billion of private investment can be secured along with the creation of up to 45,000 UK jobs*. The nwip project aims to bring the majority of this investment to the North of England.

NWIP is a two year project funded through The Northern Way to help businesses access this growing market. It aims to:

- Help businesses to access opportunities in the offshore wind sector through the provision of a £3 million research fund;
- Support businesses to develop new products and processes;
- Increase knowledge transfer between academia and industry;
- Enable businesses with current capabilities or potential in the offshore wind sector to access market information and realise these opportunities;
- Enhance the reputation of the North as an international centre for wind technology.

The programme will be delivered by Narec and Envirolink Northwest who both have significant experience of working with businesses in this sector.

About the Funders

The Northern Way is a unique initiative, bringing together the cities and regions of the North of England to work together to improve the sustainable economic development of the North towards the level of more prosperous regions. Formed as a partnership between the three northern Regional Development Agencies (Yorkshire Forward, Northwest Regional Development Agency and One Northeast), we also work with local authorities, universities, the private sector and other partners to secure a strong coalition in support of this goal. The Northern Way has prioritised offshore wind as one of four investment areas to support innovation across the North.

Our Lead Partners

CMT · DAVID BROWN Engineered around you · RICARDO

Romax TECHNOLOGY · SIEMENS · TWI Technology Engineering · Xanthus Energy

** Figures referenced from RenewableUK publication "What does the Round 3 announcement mean?" Briefing note on offshore wind energy, http://www.bwea.com/pdf/Round3Briefing.pdf*

www.thenorthernway.co.uk

About the Delivery Partners

Narec, providers of R&D, consultancy, test and demonstration facilities for the renewable and electrical power sectors, is a national centre dedicated to accelerating the deployment and grid integration of renewable energy and low carbon technologies, utilising wind, wave, tidal, solar PV and thermal power. Narec is creating a world-leading technology advancement hub for the offshore renewables industry in North East England, and works with global turbine, blade, electrical infrastructure manufacturers, project and device developers on their large turbine, blade and associated equipment development programmes.

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Envirolink Northwest is a not-for-profit organisation,which supports the development and growth of the energy and environmental technologies and services (ETS) sector in England's Northwest. Funded by the Northwest Regional Development Agency (NWDA), the European Regional Development Fund, and the region's local authorities, Envirolink Northwest works to stimulate the market for ETS products and services and helps companies to commercialise and promote themselves in the market.

Tasked with improving the competitiveness of the region's ETS sector and encouraging businesses in the North West to take advantage of the growing market for environmental technologies, Envirolink Northwest provides:

Provision of market intelligence and sharing of best practice;

Individual technical business support and

Promotion, networking and collaboration to create opportunities to develop technologies and engage with the market.

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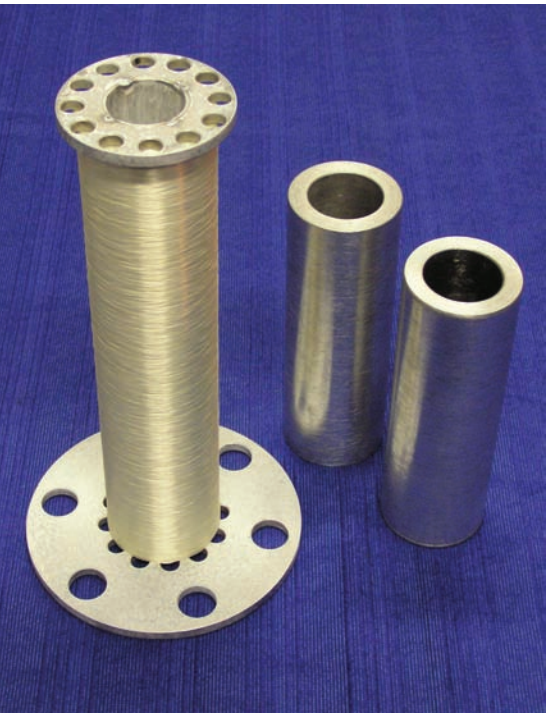
Project:
Lightweight Turbine Gearbox Feasibility Study

Lead Company:
Composite Metal Technology Ltd

Consortium Partners:
David Brown Gear Systems Ltd,
Ricardo MTC Ltd,
Durham University

Weight is a major technical challenge for wind turbine manufacturers. The greater the weight of the nacelle components and rotor, the stronger the tower structure required and the greater the problems of transportation and erection. Approximately 20% of the mass of a wind turbine is associated with the gearbox, the largest single contributor after the blades. Inadequate stiffness in the gearbox casing can result in misalignment of gears and bearings, causing noise, vibration & premature failure.



This project will seek to determine the feasibility of a major reduction in gearbox weight, by replacing the cast iron casing with aluminium, locally reinforced with advanced composite material to provide enhanced strength and stiffness. This should deliver a weight saving of around 45% for the casing, equivalent to over 25% for the complete gearbox – in excess of 4 tonnes for a 2MW turbine. In addition, the project will investigate weight reduction opportunities in the rotating components, such as the planetary gear carrier. Use of the aluminium matrix composite (AMC) material will also produce an increase in local stiffness to reduce the misalignment of bearings and gears under load, improving durability.

The technology delivered by this project will provide significant competitive advantage to a manufacturer of turbine gearboxes. David Brown has identified the offshore wind market as of strategic importance to its future growth plans and is driven both to enter this market with new build product and support the industry long term via its aftermarket operations. By pursuing lightweight gearbox assemblies, David Brown will develop a competitive advantage that can be leveraged together with its location within the Northern supply chain area. Local suppliers will benefit from this strategic development, for example in the manufacture of aluminium castings for gearbox casings. The majority of the workforce for the assembly plants will be recruited locally, as will the engineering staff

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Project:
Bearing Reliability Test Rig

Lead Company:
David Brown Gear Systems Limited

Consortium Partner:
Design Unit - University of Newcastle upon Tyne

Failure of bearings account for a significant proportion of current wind turbine down time that results in poor efficiency and increased operating costs. Whilst for onshore applications this is serious enough, for offshore turbines where access is difficult the costs are much more substantial.

This project addresses this issue by establishing a state-of-the-art bearing test rig to specifically support the offshore wind industry in the North of England. The test facility will enable accelerated life testing of full scale bearings under realistic conditions (e.g. duty loading, speed, lubrication and temperature) independent of the wind turbine, thus enabling quick and cost effective characterisation of bearing performance. This unique facility will be operated by the Design Unit of the University of Newcastle upon Tyne, an established, independent laboratory specialising in transmission systems where all necessary ancillary support services are already in place. The output from this test rig will allow improved understanding of bearings for wind power applications and will provide competitive advantage to facility users by providing improved reliability to the turbines being developed for critical offshore applications. This will enable the development of improved bearings and bearing arrangements that David Brown will then incorporate into its new design of Wind Turbine Gearboxes that it is introducing into the Offshore Wind Turbine market.

Primarily the project will improve the reliability and performance of Wind Turbines and thus produce competitive advantage for the Northern Way region. Secondly this investment will result in a regional World Class expertise in this critical wind turbine component that will enhance the local supply chain and the Narec facilities. This will follow the successful model that the Design Unit has followed to become a World Leader in gearing that supports industry as a whole and produces data trusted worldwide for incorporation in international standards and in-house industry practice.

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DAVID BROWN
Engineered around you

Project:
MultiLife™ Bearing for Offshore Turbines

Lead Company:
Ricardo UK Ltd

Consortium Partners:
University of Sheffield, bearing manufacturer

The array of bearings within a turbine gearbox are subject to subtle yet critically different operating regimes and installation constraints leading to a diversity of failure modes and many more hypotheses for solutions – none of which have yet provided the full 20 year design life. This project will develop prototypes of a new concept from Ricardo UK Ltd to increase bearing life. Its effectiveness will be tested against standard wind bearings under accelerated test conditions, ahead of series production.

One unavoidable category of installation sees a unidirectional radial load that acts upon the same forty degrees or so of the circumference of the inner race. This situation leads to localised fatigue damage and premature failure of the planet bearings in the epicyclic stages of the gearbox. One pragmatic solution involves rotating the "fixed" inner race every-so-often such that the wear is distributed around the full circumference of the race. This ensures that the fatigue damage never reaches a critical condition during the turbine life. The bearing's name, MultiLife™, will be appropriate if testing proves the 5-fold increase anticipated. A suite of mechanisms to achieve this were devised and the best were patented before presentation by Ricardo at the Offshore Wind Conference in Stockholm in 2009. The challenge came in inventing a solution that was practical for application to relatively standard bearings in both old and new gearboxes - the former being a large market of fault-prone gearboxes in existing turbines that will be re-conditioned.

Detailed estimates have been made for the commercial case for the device and the jobs that would be created in the supply chain. Ricardo has already brokered discussions with the demand chain to create the "pull" for the product and will continue this during the project to ensure seamless transition to the next phases of commercialisation after the end of the NWIP project.

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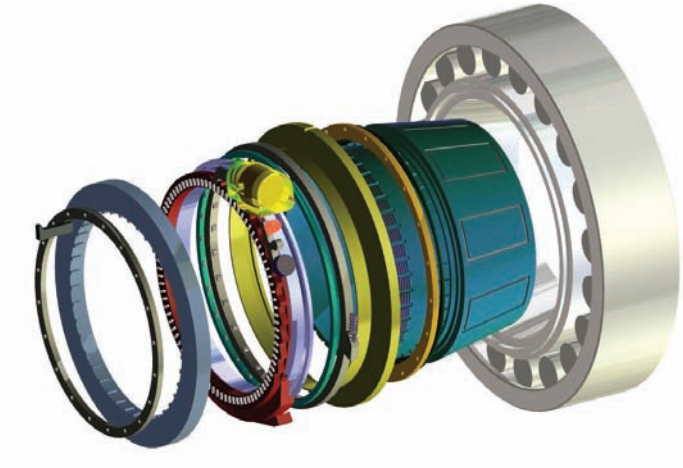

RICARDO

Project:
Understanding bearing reliability in wind turbine permanent magnet generators

Lead Company:
Romax Technology Ltd

Consortium Partner:
University of Sheffield

The rapid growth of the global wind energy industry is encouraging the development of alternative concepts for wind turbine drivetrains, examples of which include the use of direct drive and medium speed generators. These machines offer advantages over conventional designs and their successful development has the potential to help the UK meet emissions and renewable energy targets. If direct drive machines are to become a key supplier of low carbon energy to the UK, research into the effectiveness and reliability of this technology is vital and assessments must be made of the ability of direct drive turbines to meet the demands of off-shore sites, where reliability and availability are of crucial importance.

Romax Technology and The University of Sheffield are collaborating to address this need and their project aims to increase the understanding of wind turbine generator reliability, relating particularly to bearing reliability and system dynamics.

"As leading global experts in wind turbine gearbox, bearing and drivetrain design, Romax is pleased to be collaborating with researchers in the Electrical Machines and Drives Research Group at The University of Sheffield. The NWIP funding will enable our consortium to establish valuable knowledge and expertise in the UK, assist in the development of new generation wind turbines and support the development of beneficial relationships between industrial and academic partners in the UK.

The wind industry is expanding very rapidly and following the recent announcement of The Crown Estate Round 3 Offshore project, the UK has the market and the capabilities to be at the forefront of wind power technology. Funding provided by NWIP is allowing companies like Romax to advance the deployment of innovative technology in the wind energy sector and has the potential to create jobs and commercial opportunities for the UK engineering industry" said John Coultate of Romax.

Dr John Coultate,
Drivetrain Consultancy Team Leader

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Romax TECHNOLOGY

Project:
Future HVDC System Topologies

Lead Company:
Siemens Transmission and Distribution

Consortium Partner:
University of Manchester

The University of Manchester, in collaboration with Siemens Transmission and Distribution, is undertaking a study funded by the Northern Wind Innovation Programme to investigate new energy networks for offshore wind farms. The work builds on the considerable experience of the University in electrical power engineering and is part of the University's 'Manchester Energy Initiative'. The focus of the work is the connection of next-generation offshore wind farms into the UK transmission system.

The use of local, renewable energy will play an important future role in the UK. Its goal is to achieve long-term energy security and to contribute to a low-carbon economy. Wind energy will play a key part of the energy supply mix to achieve this. However on-shore wind farms have a number of problems. In the latest planning round for wind-farms (Round 3), the sites considered have been far-offshore and very high power. State-of-the-art wind turbines are each rated 4.5MW or more (four-and-a-half million-watts, enough to power 1500 homes at full-power). Some of the larger wind-farms planned offshore consist of perhaps a thousand such turbines.

The very large powers under consideration must be brought to shore. However unlike the first offshore sites, which were very close to the coast, some of the larger wind-farms are considerably further away. At distances of more than about 50km-80km offshore, DC transmission becomes the preferred connection system over the more usual AC. The connection of these large wind-farms to shore requires high-voltage DC (HVDC) transmission, and because of the relatively compact size of offshore platforms, this must use the relatively new concept of voltage-source converter (VSC) HVDC. Only a few proof-of-concept installations have been built world-wide and no finalised system concept has yet been agreed upon. The work at Manchester will aim to derive system concepts and connection strategies.

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SIEMENS

Project:
Wind-power Permanent-magnet Generation Systems of High Reliability, Efficiency and Power-Density

Lead Company:
Siemens Wind Power

Consortium Partner:
University of Sheffield

Although doubly-fed induction generators are considered a relatively mature technology in the field, they possess an inherently low power density, low efficiency and relatively low reliability due to the use of brushes and slip-rings. Also, the presence of a gearbox in these wind power generation systems is problematic, as it further reduces system efficiency and increases the risk of failures. These problems can be overcome by employing direct-drive permanent magnet generator technology. However, current permanent magnet counterparts, whilst providing significantly higher power-density and higher efficiency, are not usually designed with fault-tolerant capabilities, and can possess lower operational reliability and availability than present doubly-fed induction generators solutions.
For offshore systems, therefore, a need exists to develop high-power-dense, efficient and fault-tolerant permanent magnet generators and power converters to accommodate short- and open-circuit winding/converter faults and be robust to the effects of demagnetization stemming from exposure to elevated temperatures and overload fault currents.

The project aims to address key technological hurdles for the widespread adoption of reliable, power dense and efficient offshore wind-turbine generation systems, with a view to maximizing their full future exploitation potential. Specifically, the scope of the project includes the research and development of novel, fault-tolerant and fault-accommodating direct-drive permanent magnet generators and associated fault condition monitoring, detection and mitigation systems, in a unified framework.

The outcomes of the project will be the development of novel permanent magnet machines and converter systems that exhibit higher power density and efficiency compared to existing state-of-the-art doubly-fed induction generator solutions, and possesses significantly higher fault-tolerant capability compared to conventional surface-mounted permanent magnet machine counterparts, which will be demonstrated through the commissioning of scaled prototype units during the project.

The project will support the employment of 2 directly funded industrial engineers, 2 research associates and 1 technician. Siemens will actively seek to enhance its existing investment in the region for exploiting the research outcomes. Within 3 years of the start of the project, expected investment will create up to 15-20 further employment positions at the Sheffield-Siemens Wind Power Research Centre (S2WP) at Sheffield from additional and geared funding. Also, Siemens already has significant co-operation with UK manufacturing companies on offshore turbine components and the outcome of this research program will directly impact on the future content of local UK production of turbine components for both on- and off-shore installations.

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SIEMENS

Project:
BearInspect: Novel Integrated Condition Monitoring System for Wind Turbine components

Lead Company:
TWI Ltd

Consortium Partners:
University of Sheffield, CMR (UK) Ltd, SKM, James Walker & Co Ltd, Applied Inspection Ltd and Le Carbone (GB) Ltd

The BearInspect project will support the effort of the wind power generation industry in the North of England by delivering efficient wind energy not only to the North of England but also to the whole of Europe by achieving better reliability standards and reducing corrective maintenance costs through accurate condition monitoring of wind turbines.

The BearInspect project will implement an integrated condition monitoring system which will combine the use of acoustic emission and vibration sensors in conjunction with electronic bolting monitoring, oil temperature sensors and oil particle counters to evaluate the overall operational condition of the turbine's generator, gearbox bearings, main shaft and yaw bearings. Integration of the aforementioned sensors will allow the full assessment of the condition of the wind turbine mechanical components through the application of a single monitoring system. The implementation of the BearInspect system will result in a noteworthy reduction of inspection times when compared with existing state-of-the-art procedures. It will also minimise the need for corrective maintenance thus leading to a substantial decrease of the overall operational and maintenance costs. Furthermore, by fusing and analysing the data obtained through the different sensors, it will be made possible to quantify the faults detected by the system and enabling the wind farm operators to update the maintenance schedule accordingly.

The BearInspect consortium intends to contribute profoundly in the improvement of reliability within the wind power generation industry in the North of England by delivering the technology required in order to substantially reduce unexpected wind turbine failures and unnecessary costs that result from them. By increasing the reliability of the North England wind turbine fleet the wind farm operators will be able to improve their maintenance strategies, minimise operating costs leading to a reduction of the cost per MWh produced, improve their efficiency and increase public confidence in renewable energy sources. Moreover it will allow the use of the financial resources recovered as a direct result of the reduction of operating costs for the improvement of existing infrastructure and the construction of new wind farms throughout North England. The long-term implication is that it will be possible to plan the economic future of the region on the basis of known and predictable cost of electricity, derived from an indigenous energy source free of all the security, economic and environmental disadvantages associated with oil and gas.

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TWI Technology Engineering

Project:
FabFound – Rapid Fabrication of Optimized Marine Wind Turbine Foundations

Lead Company:
TWI Ltd

Consortium Partners:
RCID at Newcastle University, SEtech Ltd, Parsons Brinckerhoff Ltd, McNulty Offshore Construction Ltd, VattenFall Wind Power, Scottish Power Renewables UK Ltd and Clipper Windpower

It is anticipated that there will shortly be a market for offshore turbines that significantly outstrips the current manufacturing capacity. The FabFound project aims to use a new and innovative fabrication process for wind turbine foundations in order to allow the necessary production capacity to be met.

Currently, several foundation concepts are being considered, including monopiles, tripods and braced jacket structures all of which are manufactured from steel tubular sections.
The largest of these are fabricated by rolling thick plate and welding longitudinally. Rolling thick plate (>100mm) requires specialist rollers and hence incurs capital expense and limits the number of facilities capable of carrying out the process. It is also a time consuming process and the length of each ring is restricted by the width of the rollers, commonly to approximately 3 metres. The novel multifaceted design proposed in the FabFound project is fabricated from strips of flat plate welded together, hence eliminating the rolling step.
This allows sub-assemblies of perhaps 10m in length to be manufactured, reducing the number of on-site welds necessary in the tower construction. This approach is enabled through the use of rapid thick section welding techniques for the longitudinal seams.

Over the next 12 months, the project will generate new foundation designs (optimized for rapid manufacture) that can be fabricated from readily available flat steel plate with only minimal processing required prior to joining by novel high speed welding techniques. The designs will be examined structurally and geo-technically and will be qualified for use. The entire production route will be examined (facilities required, metal supply, joining processes, materials handling etc) in terms of performance, logistics and economic viability.

The aim of the project is to increase the foundation manufacturing capacity of the UK, and specifically to position the consortium and other fabrication/supply chain companies in the Northern Way regions to be ready to address the requirements of an emerging market for high power (>3.6MW) marine wind turbine foundations.

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TWI Technology Engineering

Project:
Improved Splash Zone Coatings for 40-Year Design Life (IMPCOAT)

Lead Company:
TWI Ltd

Consortium Partners:
University of Manchester, Monitor Coatings, McNulty Offshore, VattenFall Wind Power

There are strong economic drivers to increase the effective life of the steel structures, which support the offshore wind farms, to 40 years. To achieve this, the turbines require foundations that withstand splash zone corrosion without maintenance. Designers currently “manage” corrosion by material allowance and organic coatings, but these methods are inadequate for extended life due to prohibitive increases in structural mass and limited coating durability, exemplified by high-profile coating failures on several recently-constructed wind farms. Current multi-layer, splash & tidal zone organic coating formulations are vulnerable to mechanical and environmental damage, commonly resulting in coating failure and structural corrosion well within the 20-year structural design life. Standards require additional structural steel thickness allowance of 0.3mm steel per year of service. Splash zone maintenance requires expensive coffer dams. The challenges are to develop improved, rapidly-deposited, low-cost coatings and to develop service-validated, quantitative corrosion rate measuring techniques for these coatings, which can predict with confidence extended 40-year coating lifetimes.

The successful outcome of the project will bring technical and economic benefits to the industrial partners, ultimately the wider offshore wind turbine construction community in the North of England, and energy consumers nationally through:

- Reduced on-site coating repair and maintenance costs and lower life cycle costs
- Extended corrosion design life with extended maintenance intervals
- Reduced structural mass and lower associated material costs
- Reduced coating costs during fabrication
- Increased foundation production rates
- Lower electricity unit prices

Twenty-five years of oil sector experience indicates thermally-spayed aluminium (TSA) coatings provide longer term protection. Switching to TSA coatings could reduce coating application and maintenance costs significantly, whilst reducing coating application times. Improved coatings based on TSA, modified-TSA compositions and novel sealants will be developed in this project. Demonstration of the compatibility of TSA with regulation high-visibility topcoat formulations is also critical. In addition, quantitative coating corrosion measurement techniques will be employed and a ruggedized coating performance monitoring unit will be validated at an offshore site. The data will provide confidence that coatings can be applied with a 40-year life expectancy. The results will be applicable to:

- All top-side, subsea and seabed structures susceptible to corrosion, including large monopiles, turbine support towers, and steel generator elements (e.g. stators)
- Other foundation designs e.g. piled tripod and lattice jackets
- Foundation appurtenances e.g. access ladders, platforms and J-tubes

EurIng David Harvey (MEng CEng FWeldI)
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TWI Technology Engineering

Project:
FASTWIND: Optimum North England Offshore Wind Turbine Assembly & Installation Factory

Lead Company:
Xanthus Energy NE Ltd

Consortium Partners:
Able UK Ltd and Ekspan Ltd

The Round 3 wind farm build programme requires a much more rapid installation method, typically 200 per annum for each wind farm to ensure the full numbers of turbines are installed by 2020 to meet the UK renewable energy targets. This means the method of installation has to change as there are real limits to the availability of vessels and installation teams using the current approach, even with new vessels entering the market. The biggest goal of this project is to reduce the supply and installation costs per MW installed.

This project aims to deliver a realistic plan for an accelerated offshore wind turbine assembly and installation factory with an optimized onshore assembly process using Xanthus Energy's unique and patented self-installing foundation system. A key deliverable of the project will be a validated lower cost basis of building offshore wind farms based on SeaBreeze(tm) foundations which use a single trip installation process. This buoyant concrete gravity base supports the fully assembled wind turbine as it is towed to site by a standard offshore tug and is ballasted into position on the seabed.

Whilst concrete foundations have already been used for offshore wind farms, none have used onshore assembly. In addition the installation can be accelerated since it uses a single stage process as all the assembly has been done onshore. This means the wind farm can start generating electricity much earlier (up to 12 months faster) than is possible with the offshore assembly method used today.

During the project design, modelling and test work will be carried out focusing on the requirements for an offshore wind farm typical to the UK Round 3 offshore wind farm zones. The method of construction, assembly and factory layout will be developed. Installation method will be proven using simulation and model testing.

As a result of the project over two hundred jobs will be created in manufacturing and assembly and installation of the foundation and WTG structures, ultimately preparing the way for a North England offshore wind farm supply business. It also provides a costed and proven method for a new way to build offshore wind farms.

The project consortium members include Xanthus Energy Ltd who have developed their unique self-installing foundation system based on their offshore engineering expertise, Able UK Ltd who are significant landowners and port operators on the English East Coast, and Ekspan Ltd who have broad engineering and heavy fabrication experience in the construction and offshore industry.

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