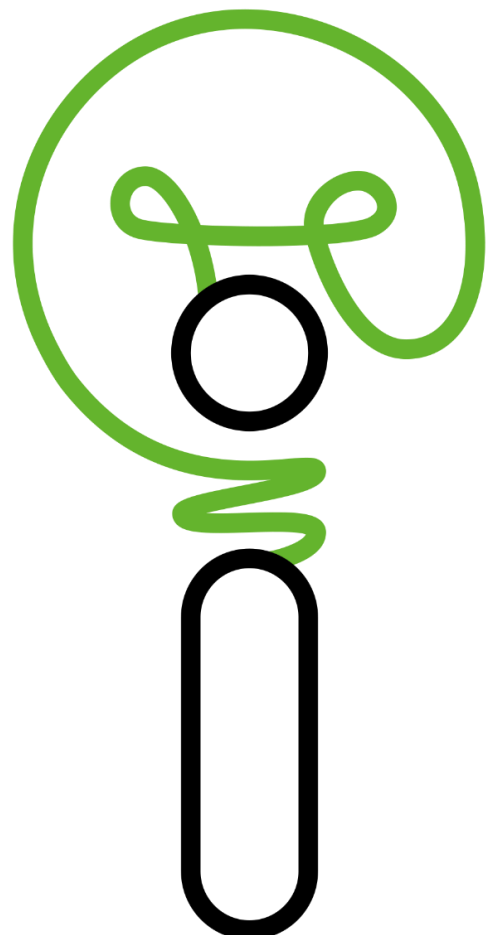


EV108

Sofia ground model developed by NGI

Not confidential



154 - Synthetic CPTs from Intelligent Ground Models based on the integration of geology, geotechnics and geophysics as a tool for conceptual foundation design and soil investigation planning

CF Forsberg, T Lunne and M Vanneste
Norwegian Geotechnical Institute, Oslo, Norway

L James
Forewind, UK/RPS, UK

TI Tjelta
Forewind, UK /Statoil, Norway

A Barwise
Statkraft UK Ltd. / RWE Innogy UK Ltd

C Duffy
Forewind, UK/Statkraft UK Ltd.

Abstract

Early phase soil investigation campaigns do not as a rule include all the locations where infrastructure is to be placed on the seafloor. However, background information on geology, bathymetric and seismic data may be available across the area at an early stage. The combination of these datasets thus provides the basis for developing a ground model of the development area. The inclusion of geotechnical data in such ground models is not always straightforward since geotechnical properties may vary laterally and with depth. In this paper we present an "Intelligent Ground Model", developed at NGI, and used at several large wind farm projects. The model combines interpreted seismic horizons with geological understanding and acquired CPTU data to allow synthetic CPTUs to be generated at any location within the investigated area. In the Dogger Bank wind farm area, synthetic CPTUs were generated at numerous locations to guide initial evaluations of foundation requirements and to group locations with similar synthetic profiles.

The model was tested by removing known CPTU data from the database and comparing them to synthetic results from the same locations. The results show reasonably good matches.

1. Introduction

Offshore windfarms occupy large areas (tens to hundreds of square kilometres) in relatively shallow water (around 20 m). This means that the sites have been subjected to a variety of geological processes related to waxing and waning of ice age glaciers and changes in relative sea level and climate. A given location may for instance have experienced tundra like conditions, subaerial exposure and shallow marine conditions during the course of the late Quaternary period. Heterogeneous properties of the seabed sediments should therefore be expected.

An offshore windfarm is often comprised of more than one hundred turbines, each with an individual foundation. During the early conceptual phases or during a pre-bidding phase of windfarm development, it is unrealistic to have detailed geotechnical information from each of the turbine locations. We here

present an automated method developed by The Norwegian Geotechnical Institute (NGI) for Forewind in connection with investigations of the Dogger Bank area. The method combines geophysical, geological and geotechnical information to produce synthetic CPTU (cone penetration testing with pore pressure measurements) profiles at any location within an investigation's boundaries.

2. Database

2.1 Prerequisites

The method does not run without initial human input. Some interpretations need to be performed ahead of running the scripts to establish the model database (Figure 1). The seismostratigraphy and its relation to geological units should be properly established. Each borehole / CPTU must be interpreted to identify if and at which depths the transitions in units occur. The input data thus consists of depth converted gridded seismic horizons (depth grids), a table with the depths

at which geological units appear in each borehole/CPTU and the CPTU data themselves. The bathymetry must exist as a separate grid.

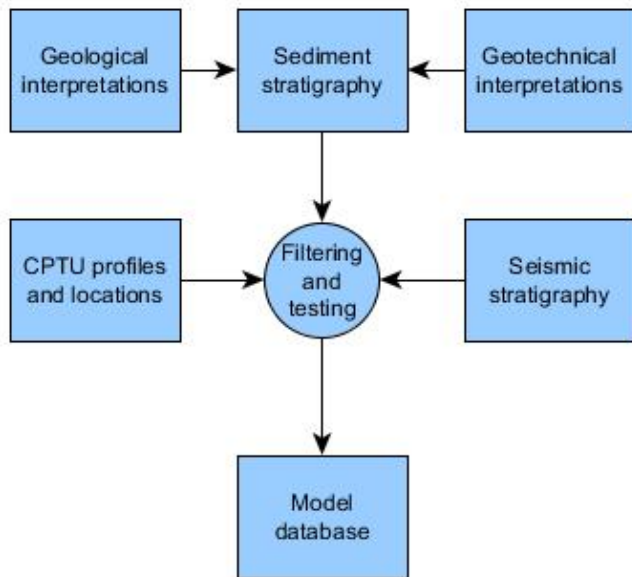


Figure 1 Inputs to synCPT database

2.2 Database construction

The database consists of a series of grids containing depths to the base of the layers identified in the boreholes/CPTUs and the corresponding parameters associated with each of these. Areas where units are absent are taken into account during the interpolation process by blanking the grids in such regions.

Interpreted seismic horizons guide the interpolation of the depths to the top and base of the units. If a unit boundary is not associated with a seismic horizon, the depths are guided by combining unit thickness variations with neighbouring units' boundaries.

2.3 CPTU interpretations

A prerequisite for the model database is that the sedimentary unit boundaries have been identified in the CPTU profiles. For each CPTU these boundaries must be given a depth or classified as not present or not penetrated. The latter indicates that the boundary is likely present below the penetration of the CPTU. Interpolation across a CPTU location where a layer is absent is not allowed whereas it is permitted where a boundary is not penetrated. A separate layer is automatically introduced for the first 2 m of penetration below the seafloor due to the differences in CPTU often seen in records from this interval compared to those deeper down due to low confining stresses.

The unit boundaries are used to associate different parts of the CPTU records with appropriate sedimentary units. The CPTU data within each of

these sedimentary units are classified into smaller layers of either sand or clay according to whether they belong to one of the Robertson (1990; B_q vs Q_t) groups of 4 and above or below respectively. These subsets are separated in the database. Linear regression is applied to each of the two subsets in order to parameterise the curves. Thus, for each sediment unit in a CPTU, 13 different parameters are gleaned from the input curves:

- the relative content of sand and clay layers;
- the relative number of points within the sand layers with a q_t value above 20 MPa;
- the slope and intercept of the linear regression of the three data curves (q_t , B_q and F_r) for both sand and clay;
- the standard deviation of the q_t , B_q and F_r curve residuals after linearization;
- the depths to the top and base of each layer.

The application of several automated tests assures that spurious and erroneous results (e.g. spikes and initial part of CPTU strokes) are excluded from the data.

2.4 Interpolations

The parameters derived from the different CPTU subsections as described in the previous section are interpolated across the study area through minimum curvature gridding (*surface* program from the Generic Mapping Tools collection, Wessel et al., 2013) and later used for the construction of synthetic CPTUs. Values are removed from the grids in regions that are more than a maximum distance (set as an input parameter) from CPTU data and in areas where the seismic units associated with the sediment units being treated are absent. A grid is therefore produced for each of the parameters listed above. These grids are the main database for the program.

2.5 Interrogation of database

Synthetic CPTUs are constructed for a given location on a unit by unit basis. The top and bottom of the units are taken from the depth grids. CPTU profiles are constructed by calculating the appropriate parameters from the slope and intercept grids at the depths corresponding to the unit boundaries. Again, sand and clay parameters are calculated separately. While the database contains the relative content of sand and clay in a unit, it does not record the depths of sand and clay intervals within a given unit. The synthetic CPTU plot thus contains both sand and clay curves for mixed intervals, but only one of them where a single soil type is predicted to dominate. The relative content of

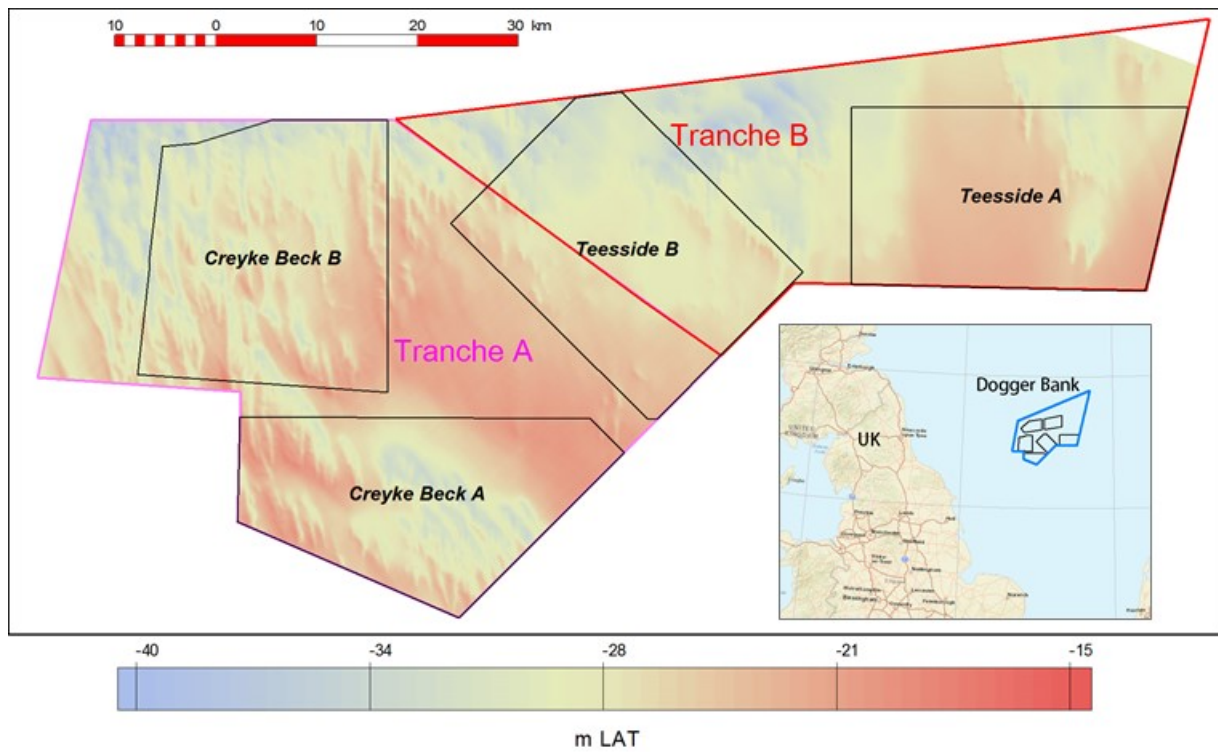


Figure 2 Bathymetry (seafloor elevation relative to Lowest Astronomical Tide, LAT) of Tranches A and B of the Dogger Bank windfarm area. Polygons indicate Project areas, and Tranches A and B. All six Dogger Bank project areas within the concession round 3 region are shown on the index map.

sand and clay layers is, however, printed on synthetic output curves.

3. The Dogger Bank case

3.1 location of study area

The Dogger Bank area was the largest of the British Round 3 wind farm concession areas. The work presented here was conducted within Tranches A and B (Figure 2).

3.2 Seismic interpretations

The seismic data available is comprised of a regular grid of 2D sparker lines with SW-NE trending lines with a 100 m spacing and crosslines with a 500 m spacing. The line density means that track charts

appear as a colour fill on maps with the same scale as Figure 2. The interpretations of the seismic lines were performed cooperatively by the British Geological Survey (BGS) and Forewind who provided digital grids of selected horizons (Table 1) that were input into the geomodel (e.g. Figures 3 and 4).

3.3 CPTU interpretations

The interpretation of the CPTU data (Figure 5) was an iterative process involving NGI, Forewind and

Table 1 Sediment units associated with interpreted seismic horizons. Interpolations of intermediate sediment units are guided by the seismic stratigraphy shown here. Units without associated seismic grids are guided by adjacent grids

Unit_base_name	Seismic Horizon grid	Comment
2_m	None	Special grid for uppermost 2 m
Holocene	Base_Top_SAND	Base Holocene sands
BBC	None	Base Botney Cut.
BBC_channel	BBC_channel.grd	Base Botney Cut in channels
Bchannel	Base channel fill	
BolBk	None	Base Bolders Bank
BDB1	None	Base Upper Dogger Bank (sand)
Lacu1_2	Base_upper_lake	Tranche B, upper lacustrine sediments
Tran1	None	Sandy transition between Upper Dogger Bank (sand) and Upper Dogger Bank.
Lacu3	Lower_lake	Tranche B, lower lacustrine sediments
BDB2	H05.grd	Interface between Upper and Lower Dogger Bank formation/Tran2
Tran2	None	Sandy transition associated with BDB2
BDB3	Top_Eem_bLAT.grd	Also Base Lower Dogger Bank Formation

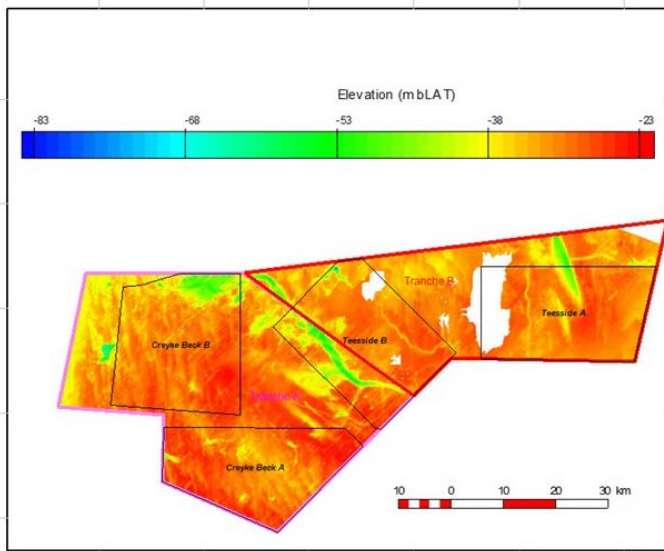


Figure 3 Elevation of the base of the seafloor sands

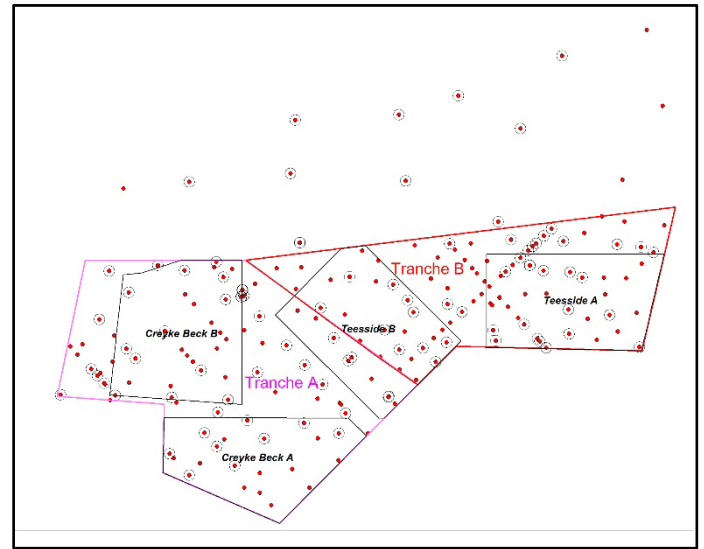


Figure 5 Locations with CPTU data. Ringed dots are sites with a sub-seafloor penetration of greater than 30 m.

BGS and developed as the understanding of the geological history and the geotechnical properties of the sediments in the Dogger Bank area improved (Cotterill et al., in press). This interplay of geotechnical, geological and geophysical inputs was paramount to the evolution of the model. The stratigraphic interpretations (e.g. yellow boundaries on Figure 6) provided the framework by which the CPTU data were subdivided and parameterised as described above. In the cases where no seismic horizon has been associated with a unit, its top and base are interpolated using its thickness and the bases of adjacent grids. The CPTU results are interpolated as for other units.

The grids of the interpolated CPTU parameters (e.g. Figure 7) define the Dogger Bank database.

3.3 Synthetic CPTUs

The synthetic CPTUs are calculated from the database grids on a layer-by-layer basis by extracting val-

ues at the desired locations from the grids in the database. The first values to be extracted are the tops and bases of the layers as these values are needed to calculate depth dependent values such as q_t . The other parameters are extracted, appropriate values calculated and plotted on the profiles (e.g. Figure 8). In order to check the validity of the predicted CPTU values several recorded CPTU profiles were left out of the

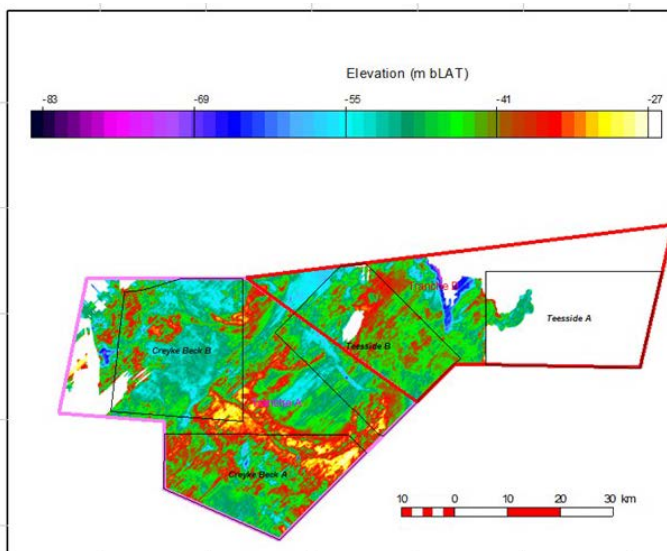


Figure 4 Elevation of the H05 horizon that separates the Upper and Lower Dogger Bank units (Table 1)

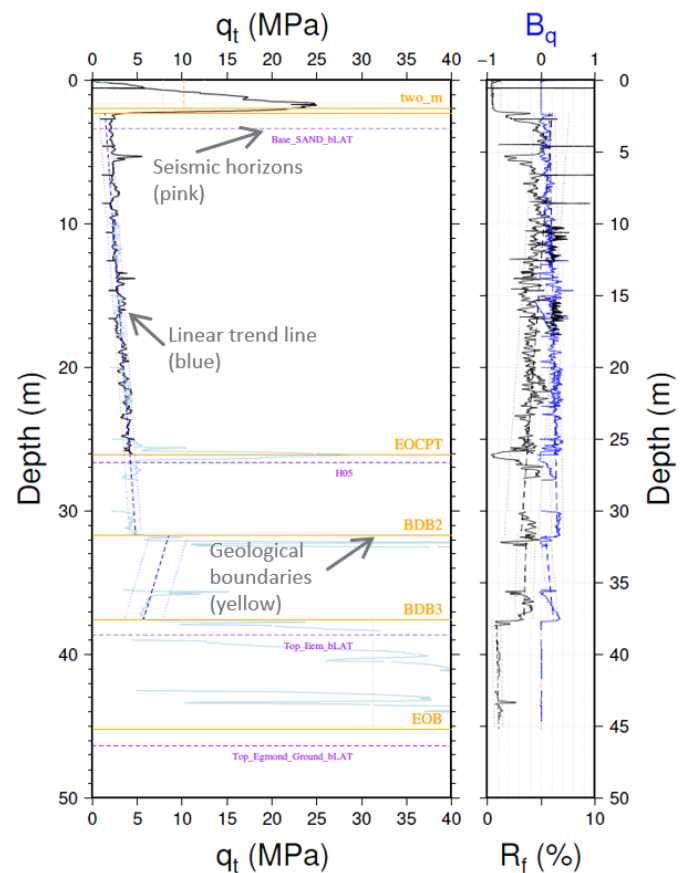


Figure 6 Parameterisation of the CPTU data by linear trend fitting is done on a layer-by-layer basis. Yellow horizontal lines show the interpreted unit boundaries whereas the pink lines are depths corresponding to seismic horizons

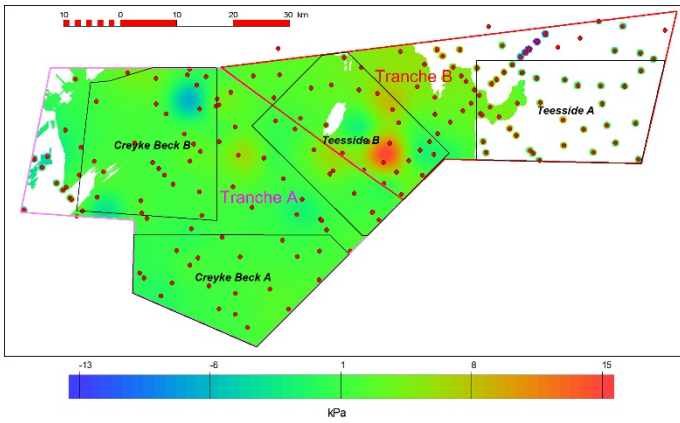


Figure 7 Example of interpolation by gridding for the sea-floor intercept of the parameterised CPTU data from the Upper Dogger Bank Unit. Black polygons show Project areas, Tranche A and B borders are pink and red respectively and locations with CPTU data are red dots. In CPTUs where the unit has been interpreted to be present, but not recognized on the seismic interpretations, the CPTU locations have a coloured "halo"

there were obvious discrepancies between the predicted and actual CPTU records. This emphasises that the predicted CPTU records may be used during conceptual studies, and that real data from specific locations should be acquired before final design and installation.

3.4 Grouping of results into categories

For windfarms the number of wind turbine locations usually greatly exceeds the number of sampled and/or tested locations, at least during early stages of a project. One way to proceed is to generate a network of synthetic CPTUs and to compare and categorise these according to criteria reflecting different foundation solutions. This has been done subjectively for the two project areas within Tranche A in the Dogger Bank area (Figure 9). The categorised synthetic profiles mostly cluster in groups that can allow the definition of similar regions and thereby regions within which certain foundation designs may be preferable.

database and its input data. The locations of the omitted data were used as input for the generation of synthetic CPTUs allowing a comparison of real values with predicted values at these locations (Figure 8). While the comparisons were quite favourable in most cases (e.g. Figure 8), there were also cases where

The example in Figure 9 shows an absence of synthetic CPTUs near the periphery of the Tranche A area and reflects the distribution of acquired CPTU data (Figure 5) of which only a few are near the perimeter. This suggests that for windfarms an emphasis

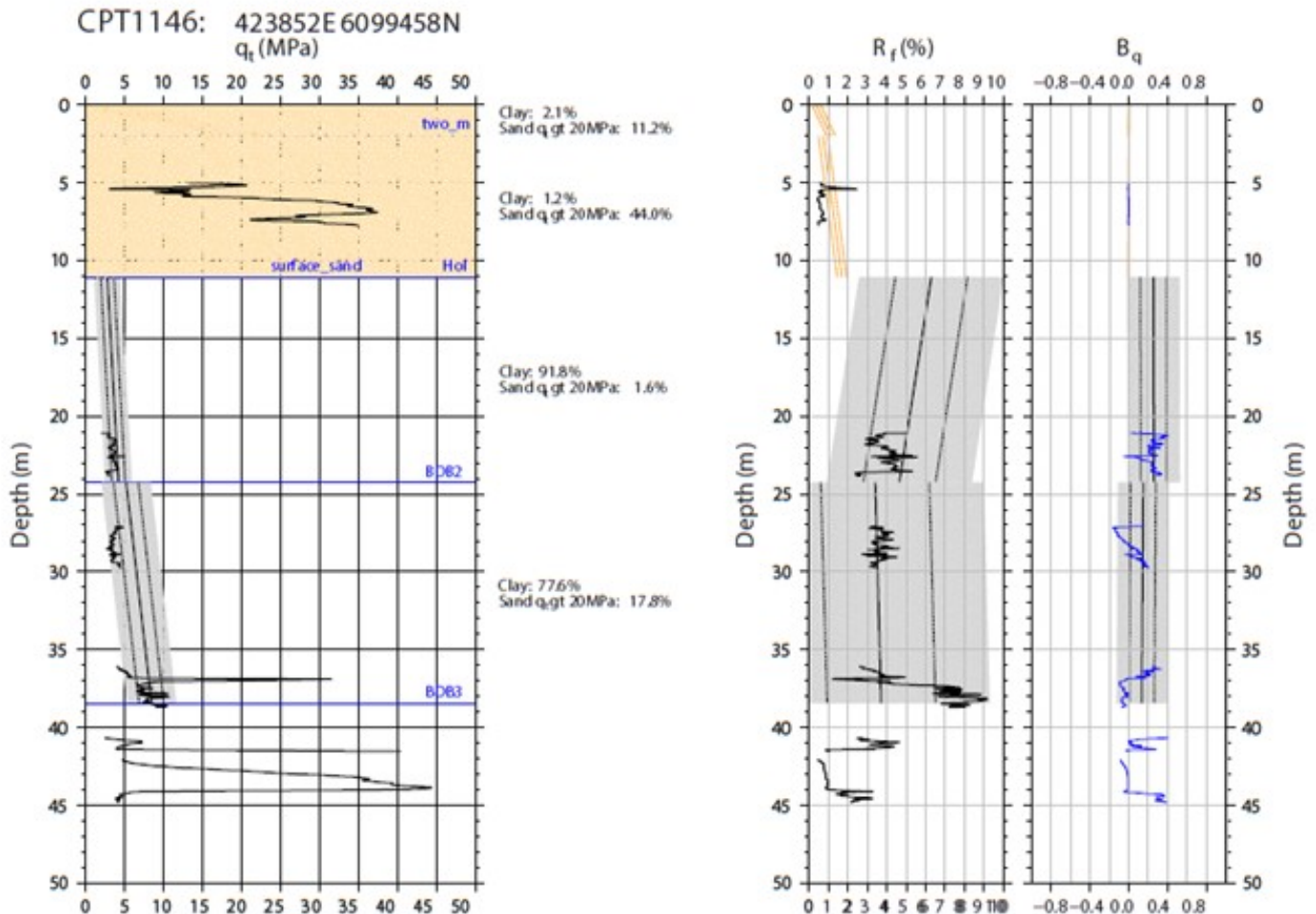


Figure 8 Comparison of predicted and measured CPTUs. The synthetic CPTU results with error margins are shown by the shaded regions. Black/blue "oscillating" curves are the measured results at the location where the predictions were performed. These measurements were excluded from the database for the comparisons

Wessel P, Smith WHL, Scharroo R., Luis J, Wobbe F. (2013) Generic Mapping Tools: Improved version released. *EOS, Transaction of the American Geophysical Union* 94(45), 409-410.

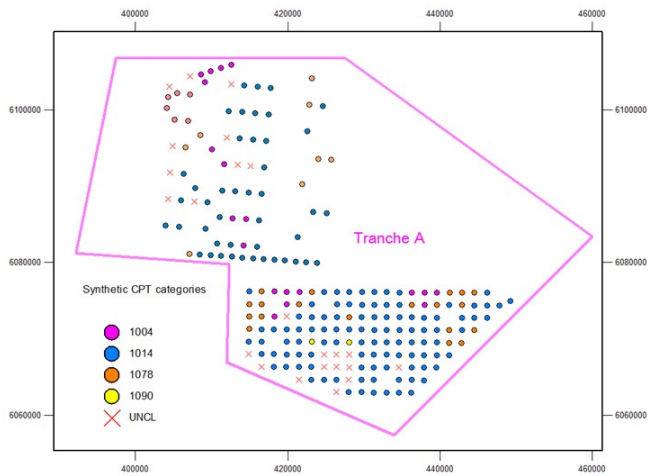


Figure 9 Example of categorisation of synthetic CPTUs (see figure 8 for example) in Tranche A. The classification is based on the subjectively evaluated similarity to real CPTU records (the site numbers used are shown next to the symbol legend). UNCL means unclassified. The layout used for this example is from regular grids, but real wind turbine layouts can also be used.

on obtaining ground truths from the peripheral regions may be needed at an early stage of the projects.

4 Conclusions

For windfarms in particular there are often more locations at which foundations are required than there are investigated sites. There is therefore a need to interpolate that acquired data.

A tool to interpolate CPTU data between investigated locations using seismic interpretations and geological information as guidance has been developed.

Synthetic CPTUs can be generated at any point within the study area.

The synthetic CPTUs compare favourably with real data at test sites on the Dogger Bank, but inconsistencies occur that indicate that the curves should only be used for conceptual studies, not actual design.

Subjective grouping of the synthetic CPTU curves allows subdivision of the study area into regions in which different foundation designs may be preferable.

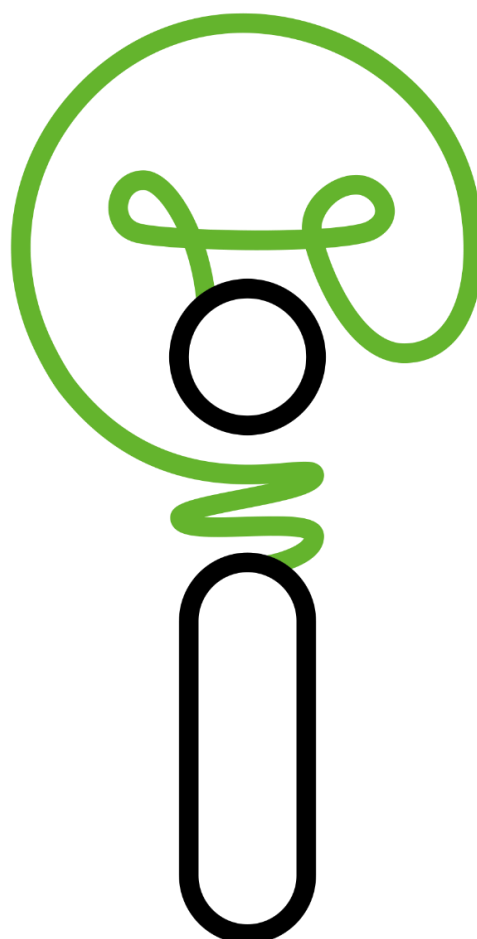
5 References

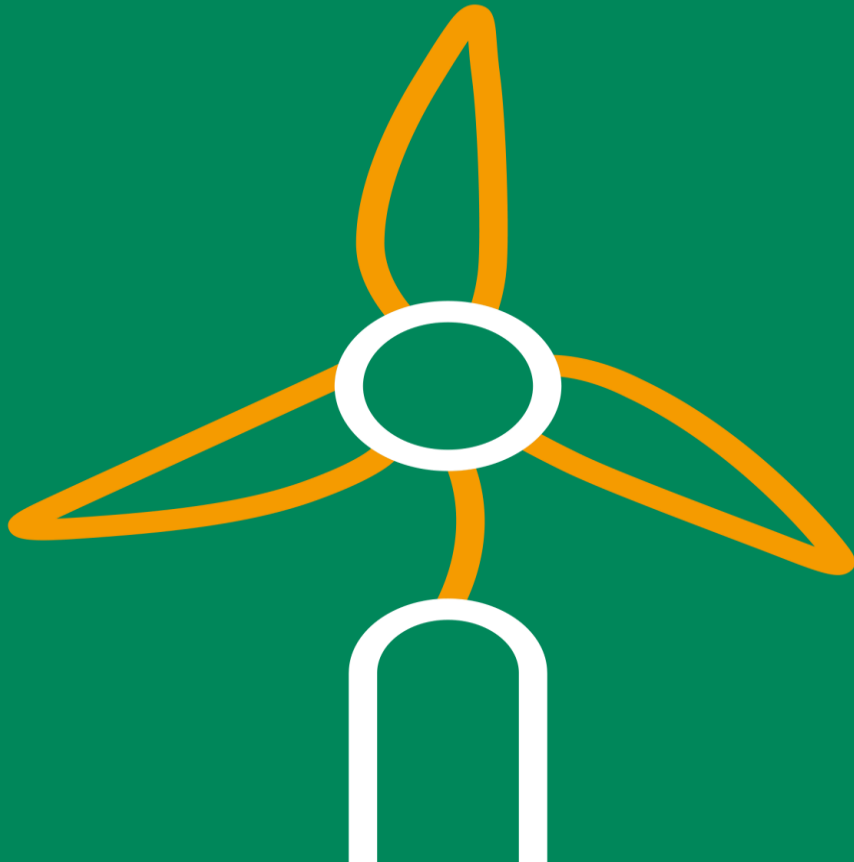
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EV111

Global Offshore Wind 2018 innogy presentation

Not confidential





Renewables @innogy

innogy SE · John Kane Project Procurement Manager·
GOW2018 19 June 2018

We have set up our Renewables business so that it is ideally positioned

Operational excellence

A white line-art icon of a wind turbine with three blades, positioned to the right of the text.

Growth in European core markets

A white line-art icon of a globe with latitude and longitude lines, positioned to the right of the text.

Entry into new markets and Solar technology

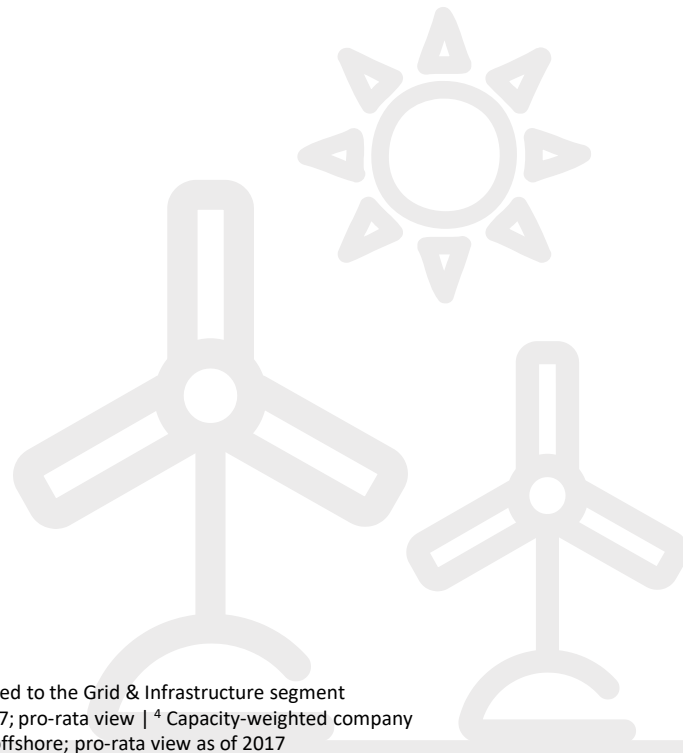
A white line-art icon of a solar panel with rays emanating from it, positioned to the right of the text.



Renewables at a glance



- Significant and diversified renewable portfolio of 3.4GW¹ (pro-rata) across Europe
- Experienced developer and operator; #5 worldwide in offshore wind²
- Significant pipeline of 7.8GW³ in development
- Stable financial profile with ~60% quasi-regulated income (2017) and ~13 years average remaining wind support tenor⁴



¹ As of 31st December 2017; pro-rata view. innogy has further renewable capacity of 0.4GW in consolidated participations related to the Grid & Infrastructure segment

² By capacity | Source: Bloomberg New energy finance; asset owner database, as of February 2018 | ³ As of 31st December 2017; pro-rata view | ⁴ Capacity-weighted company estimate for offshore and onshore wind farms subject to an unexpired support tariff for ~1.5GW for onshore and ~1.0GW for offshore; pro-rata view as of 2017

Innogy - Delivering offshore wind



Nine - operational offshore projects in Europe



A UK first - Built and operate the UK's first ever commercial scale offshore wind farm, North Hoyle, 2003

Since 2003 innogy has led on the construction of over 2GW offshore projects in Europe

2nd largest - In 2015 inaugurated what was then, the world's second largest offshore wind farm, Gwynt y Môr

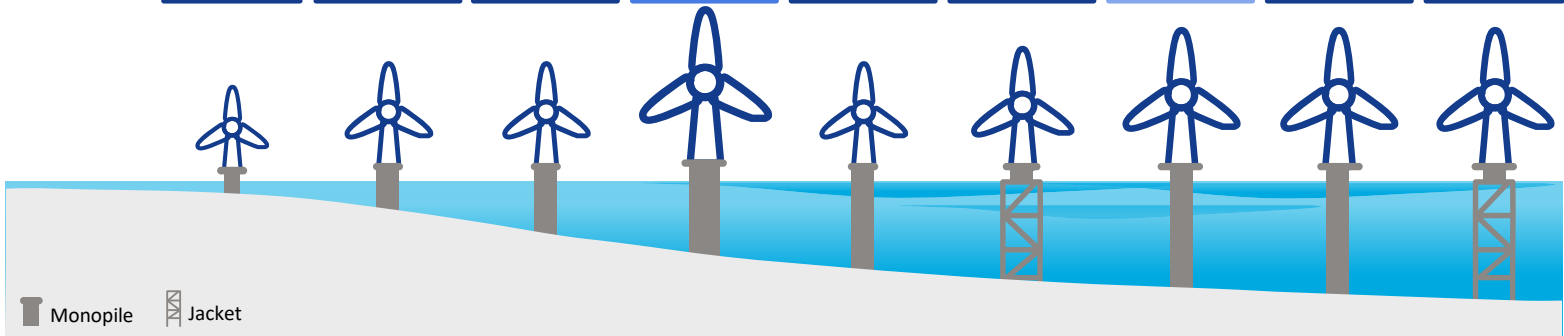
Our largest project - in August 2017 innogy has become sole owner of the 1.2GW Sofia Offshore Wind Farm

Successful in CfDs - Triton Knoll in the UK 2017 auction and Kaskasi in the German 2018 auction



Track record of installing bigger turbines, farther from shore and in deeper waters

Project	North Hoyle ¹	Rhyl Flats	Gwynt y Môr	Triton Knoll	Greater Gabbard	Thornton Bank	Galloper	Nordsee One	Nordsee Ost
(Expected) CoD	2004	2010	2015	2021/22	2012	2009 – 2013	2018	2017	2015
Capacity	60MW	90MW	576MW	855MW	504MW	325MW	353MW	332MW	295MW
Turbines	30 × 2.0MW	25 × 3.6MW	160 × 3.6MW	90 × 9.5MW	140 × 3.6MW	54 × 5 – 6.15MW ²	56 × 6.3MW	54 × 6.15MW	48 × 6.15MW
Water depth	7 – 11m depth	10 – 15m depth	12 – 28m depth	15 – 24m depth	24 – 34m depth	12 – 30m depth	27 – 36m depth	26 – 29m depth	22 – 26m depth
Distance to shore	7 km	8km	13km	32km	23km	28km	30km	45km	60km
Support scheme	1.0 ROC + WS	1.5 ROC + WS	2.0 ROC + WS	UK CfD ⁶	2.0 ROC + WS	WS + Certificate ³	1.8 ROC + WS ⁴	EEG 2014 ⁵	EEG 2014 ⁵



— In operation
 — Under construction
 — FID planned
 Note: WS = Wholesale

¹ In July 2016 innogy SE sold its stakes in the Zephyr portfolio. innogy SE provides O&M services to North Hoyle offshore wind farm | ² Including Thornton Bank 1 – 3: Thornton Bank 1: 6×5MW (gravity foundation), Thornton Bank 2: 30×6.15MW (jacket foundation), Thornton Bank 3: 18×6.15MW (jacket foundation) | ³ Minimum price for offshore wind certificates are 107 € per MWh for the first 216MW of generating capacity, and 90 € per MWh for capacity exceeding 216MW | ⁴ The level of support is granted for 20 years (subject to a backstop date in 31st Mar 2037) | ⁵ EEG compression model: 194 €/MWh; 154 €/MWh; 39 €/MWh | ⁶ Secured price of £74.75/MWh for a period of 15 years

Innogy - Strategy for Growth

- The expansion of renewable energy is one of innogy's main targets and offshore wind plays a vital role. We are already one of the worldwide leading offshore wind companies. And we are growing further – in Europe and beyond. For this our strong operational portfolio and our highly skilled offshore professionals are the backbone.”
- Newly established Offshore Growth Team for new markets



Where will that growth come from

- Innogy are actively pursuing opportunities in the global market
 - America – specifically North America (NE)
 - Asia – Taiwan / India / Vietnam
 - Australasia - Australia / New Zealand
 - Europe – extensions to existing UK Windfarms
 - GyM \ Greater Gabbard \ Galloper
 - Europe – new opportunities including UK
 - Dublin Array \ Sofia \ Dunkirk



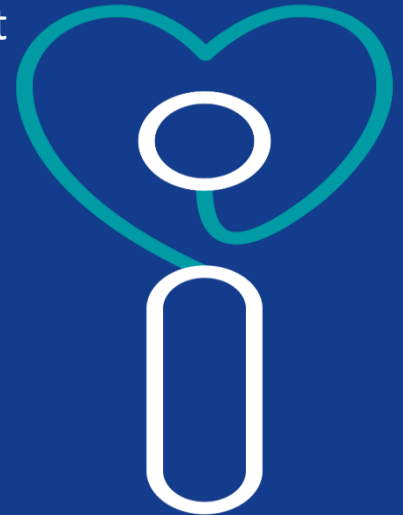
Opportunities within innogy - Supply Chain

- Innogy recognise that a high quality, focused, innovative and bought-in Supply Chain is key to achieving our objectives.
- We are working hand in hand with local businesses to **grow the national and regional supply chain**. Our offshore projects support valuable economic investment and regeneration into coastal infrastructure and areas.
- We have an engagement model that is working well



How does Innogy engage Suppliers

- Innogy recognise that in the current market there are limited numbers of viable Suppliers for key components and that long term relationships are key.
- Supplier Relationship Management (SRM) is integral to our current successes in CfD auctions and to achieving our ambition. Innogy has an active SRM Model in Offshore Wind for Tier One Suppliers.
- Underpinning those relationships with ensuring access to Tier One Suppliers for local and national suppliers is equally vital. Innogy uses an internal Supplier Life-Cycle (SLC) tool to qualify potential Suppliers



Elements of the SRM Process



Establish stronger more co-operative relationships with our key Suppliers (Tier One)

SRM elements within innogy:

- Executive Level Meetings
- Supplier Review Meetings
- Prequalification
- Supplier Performance Evaluation
- Stakeholder Group Meetings

Central storage via Supplier Life Cycle software:

- Results from meetings – minutes and notes from review meetings
- Prequalification results
- Supplier performance ratings – from cross functional teams

Supplier Life Cycle

What is the “Supplier Life Cycle”?

- SLC is our online supplier information system
- SLC is an additional software module and part of our SAP system.
- A database tool to gather and store information.

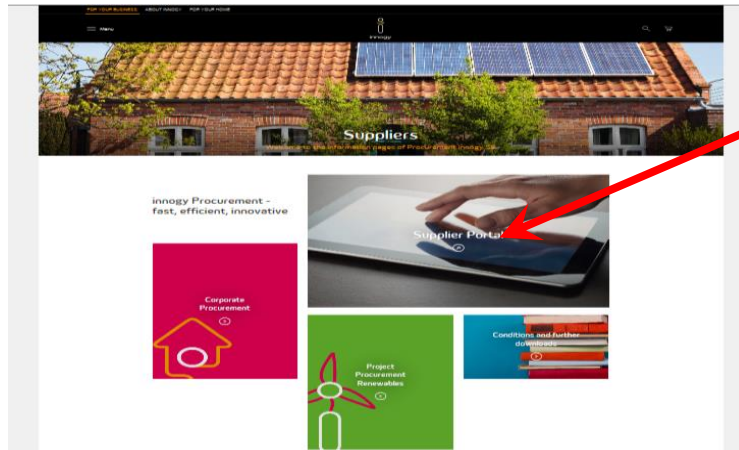
Main processes

- Registration of potential suppliers
- Prequalification of potential suppliers through self-assessment questionnaires, completed and submitted through our online supplier portal.
- Supplier information at a company and project level stored for each current or potential supplier in a database.

Registration with Innogy as a potential supplier

These are the three steps that you need to take, for your company to have details registered with Innogy, and the other areas of our business.

- Go online to register your details with Innogy. The easiest way is to enter “innogy Suppliers” in your internet search engine.
- The top response will probably be “innogy Supplier Portal”. Click on this link and you will be taken to the Innogy supplier page, then click on “Supplier Portal” :

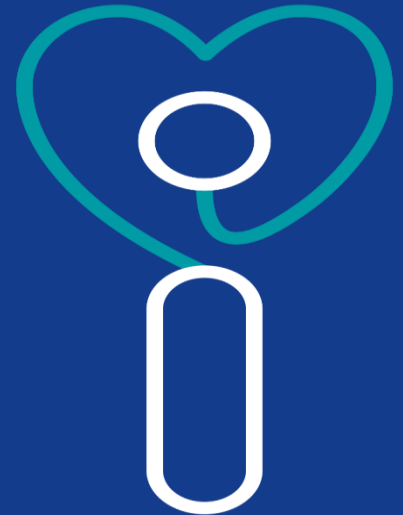


This will take you to the online supplier portal. Click on the “New supplier? Register Box”

Then complete the online Registration form. You will be contacted once your registration is complete.

What does this look like on a Project

- Innogy for each Project set up very early in the Project Lifecycle a specific Supplier Database for interested parties to register their details.
- As the Procurement Strategy matures and is delivered innogy focus on ensuring these Suppliers are connected to the right Tier One Suppliers sufficiently early to allow their inclusion in any tendering process.
- To close the loop innogy also provide all interested Suppliers with the contact details for the procurement function within the Tier One Suppliers.
- Tier One Suppliers are committed to using the database



Example – Preferred Suppliers for Triton Knoll

- **Siemens Transmission and Distribution Ltd (STDL)** - supply and install 1 x onshore substation, supply 2 x offshore substations.
- **J Murphy & Sons (JMS)** – supply and install circa 57km underground onshore cable.
- **MPI Offshore** – transport and install all offshore foundations and two offshore substation foundations and topsides.
- **MHI Vestas Offshore Wind** – supply 90 of its V164-9.5 MW turbines.
- **NKT and VBMS** – supply and install all offshore export and array cables.
- **Smulders Sif Steel Foundations JV** – manufacture monopile foundations for turbines and OSPs
- **GeoSea** – transport and install all offshore turbines.



*“Triton Knoll expects to trigger a capital expenditure investment of around **£2billion** into UK energy infrastructure, supporting up to **3,000** jobs during construction and over **170** during operations.*

*“As we drive towards delivering at **least 50% UK content** from our investment, we expect UK firms to play a key role in delivering the project.”*

Example -innogy projects - Triton Knoll

Supply Chain opportunities and engagement

- Onshore construction – first successful supplier day held earlier this year in Boston
- More events to follow addressing both onshore and offshore phases of the project
- Bulk of contracts will be let via our Tier 1 contractors
- **All Tier One Suppliers receive a regular update of the Triton Knoll database detailing all potential Suppliers who have registered their interest and the Tier One Suppliers are all committed to utilising the database as part of their procurement process when developing tenders**
- **All potential Suppliers who have registered their interest have been provided with the contact details for the procurement lead within the Tier One Suppliers**
- **This is working – our onshore contractors, Siemens Transmission and Distribution Limited and John Murphys and Sons Limited have both selected Suppliers (currently 5 off) introduced by this engagement model**

Example -innogy projects - Triton Knoll

Long term opportunity – operations and maintenance

- Triton Knoll expects to operate from a base in the Grimsby area – port options are currently being considered
- Innogy will be managing Balance of Plant from the time of commissioning onwards, and will be managing Operations and Maintenance from post-warranty period (yr 6)
- innogy O&M will be with the project for 20 years+ and will be looking to procure a range of services for long term O&M – from CTVs to building services, and from accommodation to office support services.
- Make sure you join our Supplier Database – over 500 companies have already done so, and their details are being shared with all of our Top Tier contractors, as they build their supply chains for construction up to 2022.

www.tritonknoll.co.uk/supply-chain/

innogy UK projects - Sofia

innogy's largest project to date at up to 1.2GW

- 2015 planning permission achieved by Forewind partnership within the Dogger Bank Zone
- August 2017 Teesside B announced as 100% innogy project
- **165 km** from shore at its closest point
- Welcome 2019 CfD announcement
- Construction to commence in the 2020s



The future

“The move to cleaner economic growth – through low carbon technologies and the efficient use of resources – is one of the greatest industrial opportunities of our time”

Government industrial strategy, November 2017

- Build-out of offshore wind, to become backbone of the UK’s electricity system by 2050 AND
- Golden global opportunity for competitive, export-led, UK supply chain of goods and services around the world
- Need clarity on post 2019 CfD rounds to ensure continued investment
- Government central to supporting the development of the UK supply chain, cannot be done by developers alone
- Positive discussions to date and imminent Offshore Wind Sector Deal announcement expected

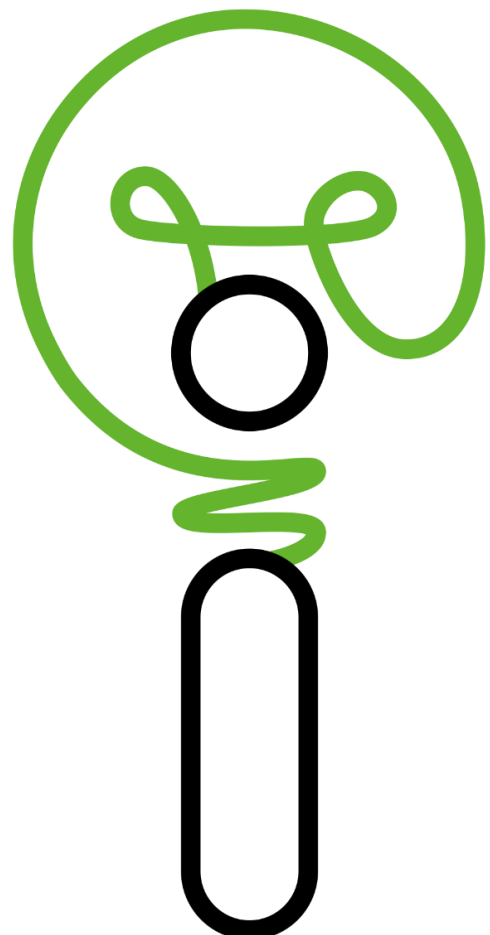


THANK YOU

EV124

Dedicated emergency response units

Not confidential



GWYNT Y MÔR OFFSHORE WIND FARM

The Inception of the Offshore Emergency Response Team

The Project

Gwynt y Môr Offshore Wind Farm has a capacity of 576mw and has been developed and constructed by RWE Innogy UK, the renewables division of energy company RWE.

The Challenge

Before work started on the construction of Gwynt y Môr Offshore Wind Farm, the RWE Senior Management Team set a target that all offshore workers would have access to the same level of emergency response as their onshore colleagues, with any injured or sick individual receiving primary treatment within 20 minutes. Given that the offshore field is 18km off the North Wales coast, beyond the remit of conventional Emergency Services, and covers an area of approximately 80km², this was a challenging target!

The Emergency Preparedness and Response Initiative

In order to fully understand the risk profile, Gwynt y Môr's Management Team gathered information from a variety of sources; past projects (including other operators' experience) and from the RenewableUK database. Shore-side medical facilities were investigated (including areas of expertise such as major trauma or cardiac) and meetings arranged with key emergency services such as Ambulance Services, the Maritime and Coastguard Agency, RNLI and the RAF Search & Rescue Squadron.

Gwynt y Môr also sent a delegation to the London Olympic Park to learn from construction experiences there. Led by Lawrence Waterman, the Olympic Park OH&S Team had achieved outstanding results and this experience proved extremely informative for Gwynt y Môr.

Following analysis of the information gathered, it became apparent that health issues would need to be given equal priority to injuries sustained from work related incidents; the number of cardiac related incidents within industry was higher than originally anticipated.

With a good understanding of the anticipated risk profile, the RWE Senior Management Team decided that dedicated Emergency Response Teams (ERT) would be needed to provide the necessary level of response and, following a competitive tender process, Hughes Sub Surface Engineering was chosen to provide the resource.

Profile of the Emergency Response Teams

With expert advice from Hughes SSE, it was decided that for every five Crew Transfer Vessels (CTV) in the field, there would be a dedicated ERT, mobilised on its own CTV. Each ERT consisted of three members, chosen from a variety of backgrounds including Military, Fire Service, Diving, Lifeboat & Rope Access.

Carrying all of the latest equipment in a bespoke trauma rucksack, the team has four main aims:

- Identify life-threatening injuries and provide first aid
- Perform key interventions
- Achieve rapid extrication
- Provide timely transport to an appropriate medical facility

In addition to the standard qualifications required to work offshore, all team members have the following skills and qualifications:

- Immediate Emergency Care (Advanced Trauma Care and Medical Course)
- IRATA Industrial Climbing Qualification
- Swift Water Rescue Technician
- High Risk Confined Space Access and Rescue (City and Guilds)

Communicating the Message

At Gwynt y Môr, all contractors are responsible for ensuring that they have sufficient arrangements in place for emergency preparedness (for their own activities). It was never the intention for the ERTs to replace these existing arrangements.

As contractors were appointed, pre-start meetings were held, during which the project Emergency Response capability was explained in detail.

The initial vision had been that the ERTs main function would be to support construction teams working on assets, i.e. foundations, turbines and offshore platforms. It soon became clear that they could also provide invaluable support to the main construction vessels. Co-ordinated by the Gwynt y Môr project team, the ERTs began familiarisation training with the main construction contractors and visited the various Jack up Barges, Cable Laying Vessels, Heavy Lift Vessels and other Multi-Purpose Vessels employed during construction. The primary aim of these visits was for the ERTs to familiarize themselves with vessel layouts and existing medical arrangements and build a rapport with the vessel and construction crews.



Exercise ARGO

In order to test the project's emergency procedures, a full scale, multi-agency exercise was planned. Exercise ARGO focused on response times and effectiveness of the ERTs, helicopter rescue procedures from a wind turbine foundation, search and rescue capabilities of the emergency services and transit times to medical facilities.

ARGO was a multi-agency exercise, led by Gwynt y Môr's Incident Command and Marine Control Centre and involved around 90 personnel, from a variety of organisations including:

- RWE/Hughes ERTs
- HM Coastguard & MRCC
- MCA (Maritime and Coastguard Agency)
- RAF Valley SAR
- RNLI
- North West & Welsh Ambulance Services

The Exercise evolved three scenarios, which were run simultaneously in April 2013;

- Man over-board
- Rescue of a casualty from within a confined space
- Rescue of a cardiac victim from a wind turbine foundation platform

Although unlikely, the simultaneous application of three scenarios allowed a wide range of emergency responses to be tested (only a few people knew the full detail of the exercise scenarios): RWE/HSSE ERT dealt with the casualty in the confined space, the RNLI dealt with the man over board, and RAF Valley evacuated the cardiac victim.

The exercise was a success and provided key information on transfer options, response times, liaison requirements, communication issues, Next of Kin, PR and Media arrangements.

Lessons learned were communicated to the emergency services, contractors and the Senior Management Team, via a series of briefings, workshops and presentations. Working closely with all parties involved, the actions identified from the exercise were tracked and closed out by the Project HSES Team within agreed times.

Should Other Projects Follow Suit?

The safety record of the project is exemplary; over 9000 people inducted, in excess of 500,000 offshore transfers safely undertaken and over 4.5m man hours worked offshore without a lost time incident. A recent visit by the IOSH Offshore Committee acknowledged the success stating: *"This site has a fantastic health and safety record, which is great to hear. This should be used as an example for other projects in the future."*

During the offshore construction of Gwynt y Môr, the ERT was called upon nearly 40 times, of which, 22 incidents required specialist equipment or skills not covered by standard First Aid at Work training (the majority of these were either health related or a pre-existing condition). Some of the individuals were treated in-field by the ERT, others were quickly taken ashore, involving a joint operation between the ERT and the RNLI or RAF or both. In all instances IPs (injured persons) were receiving initial First Aid or assistance within 15 minutes of reporting. This level of response has instilled confidence in the workforce and a reassurance to them that everybody is a valued member of the project team.

The following quote is from Mr. Morten Holm, Siemens Wind Senior Project Manager:

"On Thursday 13th November, one of our Installation Leads on Wind Solution was evacuated by helicopter to the Glan Clwyd Hospital in Rhyl with severe chest pain. Initial tests indicated that he had suffered a heart attack and a subsequent scan showed a blockage in an artery and doctors decided to operate immediately. The operation was a success and he was discharged from the Hospital on Saturday."

"Can I ask you to extend my thanks to RWE's Emergency Response Team, who were at the scene within 15 minutes of the call and whose knowledge and professionalism made a huge difference, not just to the individual but also to his family, his colleagues and his friends."



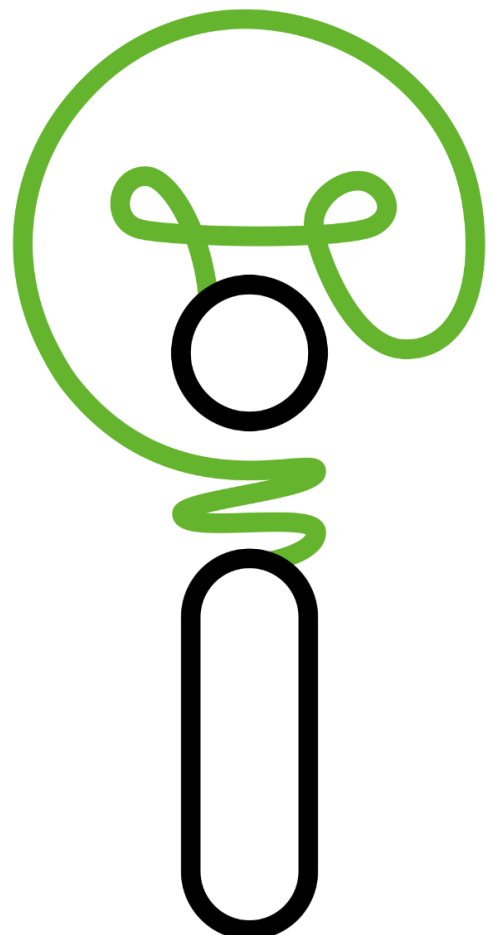
HUGHES
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EV140

CS0016-Multi-Skilling-Control-Room-Staff-at-Gwynt-y-Mor

Not confidential





Multi-Skilling Control Room Staff

Development and Implementation at Gwynt y Môr

Sally Shenton and Conaill Soraghan | June 2017 | CS-0016



Summary

The operator of the Gwynt y Môr offshore wind farm has improved operational effectiveness and increased flexibility through the multi-skilling of its control room staff. This has simplified interfaces for the planning, control and management of maintenance tasks and the associated logistics operations.

Key Findings

- Innogy has successfully integrated a number of control room functions through the development of multi-skilled control room staff, an approach that has improved team-working and simplified operational decision-making. In turn, this has supported an owner-led operations and maintenance (O&M) strategy at the site and helped to deliver maintenance more effectively. The multi-skilling of control room staff has increased job enrichment and flexibility, as well as providing a hub for capturing and sharing knowledge.
- Operational interfaces are managed 24 hours a day through a single point of contact from the local control room at Mostyn.
- The control room function is key to the successful implementation of Innogy's Wind Turbine Safety Rules, which are a key mechanism for safely managing work and controlling activities on-site.
- Working in various roles has instilled the team with a more holistic view of the wind farm, increasing awareness of the risks that need to be managed. The multi-skilling approach has reduced the interfaces between operational control, planning and marine coordination that exist at other wind farms.

Key Success Factors

- Put effort into defining an effective training programme – find good training providers, and create opportunities for work shadowing and mentoring.
- Allow suitable time to train staff and develop awareness prior to commencing operations.
- Formalise the knowledge capture process through the use of operations instructions, led and developed by the control room staff.
- Deliver job enrichment and a wider awareness of wind farm O&M through the introduction of job rotation between the control room and the offshore working environment.
- Build in career progression routes to recognise and reward good performance, and allow for active professional development.
- Ensure that the control room layout facilitates easy access to operational information and the crucial systems needed to track people, maintenance delivery and weather.

Introduction



Gwynt y Môr Offshore Wind Farm Key Facts and Figures

Owner/Operator:	Innogy
Capacity:	576 MW
Turbines:	160
Turbine Model:	Siemens SWT-3.6-107
Full Commission Date:	June 2015

Located eight miles off the coast of north Wales, Gwynt y Môr is one of the world's largest offshore wind farms. It features 160 Siemens 3.6MW turbines, and is owned by a consortium of investors comprising Innogy, Stadtwerke München, the UK Green Investment Bank Offshore Wind Fund, and Siemens Financial Services. It is part of a cluster of wind farms operated by Innogy from the Port of Mostyn.

This case study outlines the approach that was taken towards developing a flexible strategy for resourcing in the local control room, and providing a flexible and knowledgeable workforce within the owner's O&M team. It also looks at how multi-skilled technicians are used by Innogy in the control room, and how they undertake offshore tasks that support the O&M activities at the wind farm.

The Challenge

A set of industry regulations and codes exist that large, transmission-connected offshore wind farms that must be complied with when connected to the transmission system and generating power within the national electricity market. Wind farms must also deliver maintenance activities safely and efficiently within a challenging marine environment, as well as manage interfaces with the offshore transmission owner, the turbine maintenance contractor, and vessel operators.

Weather conditions, such as wind speed, wave height, fog and ice can affect the safe transfer of personnel, prevent safe lifting operations or make it unsafe to work in the turbine nacelle, limiting

the time that offshore wind farm operators have to carry out maintenance. The restrictions imposed by safe weather windows in turn necessitates an irregular working pattern, and requires the wind farm operator to put in place robust controls to manage working arrangements. Competent team members are required to assess weather information and operational requirements in order to make decisions about offshore access so that maintenance work can be safely planned. The wind farm operator must also ensure its team members are available to work offshore when weather windows permit, and therefore flexibility in working arrangements offers a significant advantage.

Figure 2 summarises the operational control tasks required at Gwynt y Môr, covering key O&M processes including maintenance planning, marine coordination, health and safety coordination, and operational control processes. Some of these require interfaces with external bodies (such as National Grid) or are local interfaces including service providers, vessel skippers and trading team.

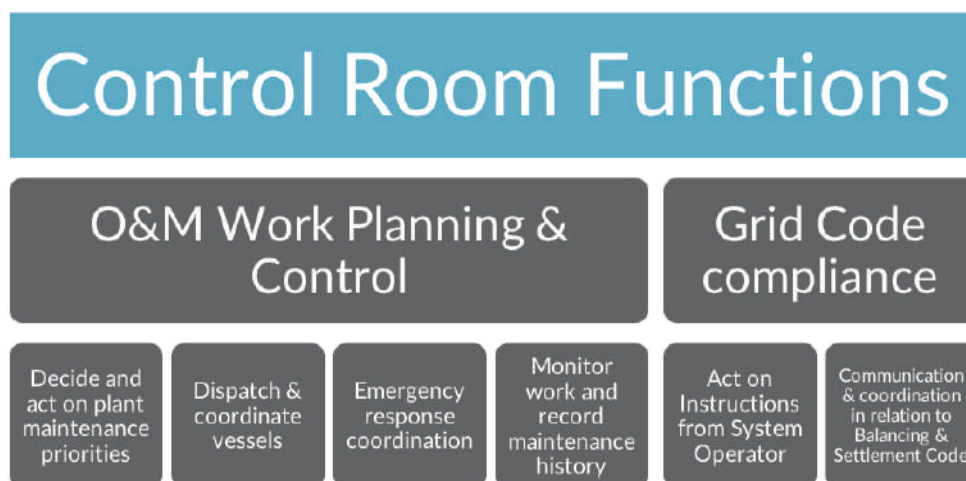


Figure 2: Summary of Control Room Functions

The management team at Gwynt y Môr needed a dynamic and robust team capable of delivering all of the aforementioned control room functions. Basing their O&M strategy on tried and tested approaches used in the thermal power generation sector, they made adjustments where required to suit the different challenges presented by offshore wind. Central to this strategy was the formation of an effective team-working culture which encouraged a strong safety ethos, a sense of ownership, rewarded good performance, and focused on delivering against clear objectives. Given the relatively small team size, it was also important to avoid creating barriers within the owners' team and also between different contractor partners.

The Approach Adopted

Wider O&M Considerations and Strategic Fit

The Gwynt y Môr team takes an active approach to O&M management. The management team were keen to develop an organisation that provided job enrichment and variety. The management

also wanted to ensure that everyone in the organisation understood the drivers and objectives for running the wind farm, and to provide a structure that removed potential barriers to achieving their aims. Given the dynamic nature of decision-making and the remote working environment, knowledge capture and sharing was also a key priority.

The on-site team is responsible for managing day-to-day operations including marine coordination at the site. This includes responsibility for the plant whilst it is operating, planning and coordinating maintenance activities, and releasing the plant for required maintenance tasks. Innogy has implemented the industry-standard Wind Turbine Safety Rules, as well as its own in-house High Voltage Safety Rules at the site. Innogy also provides the control point for the wind farm with National Grid. The O&M team provides regular updates on the operational status of the turbines, and interacts with the Innogy power trading team in order to ensure accurate power forecasts and to minimise imbalance charges.

The wind turbines are currently maintained by the Original Equipment Manufacturer (OEM) under a warranty agreement. Innogy is responsible for managing maintenance of the balance of plant.

What are the Wind Turbine Safety Rules?

The Wind Turbine Safety Rules (the Rules) are a model template of rules and procedures which constitute a formalised industry-standard safety system of work used in the UK (and on some wind farms outside the UK). They are managed and maintained by the trade body RenewableUK through a specialist industry group.

They have been developed by wind farm owners and operators for the purpose of achieving both general safety and safety from the system – a process that safeguards persons from the mechanical and LV electrical hazards on equipment by ensuring it is suitably isolated, blocked or de-energised.

Under the Rules, specific roles have been created and authorised to apply and manage the safe system of work on the wind turbine, including authorised technicians and competent technicians. Safety documents – known as Approved Work Procedures, or AWP – are required, and are typically supplied by the wind turbine manufacturer during the warranty period. AWP are prepared and approved by an authorising engineer who will be familiar with the wind turbine and is responsible for specifying how to safely manage maintenance tasks, which may involve specifying the points of isolation to be implemented before work can start. An operational controller is responsible for releasing the wind turbine from an operational state when maintenance work is required – this is done under a process called Transfer of Control. The wind turbine is placed in a local control mode which prevents it from being restarted until work is complete.

To implement the Rules it is necessary to provide training in their operation to the turbine OEM and owners' team. The owner must also arrange authorisation interviews/panels to enable staff and contractors to demonstrate their competence, and be formally appointed to roles specified in the Rules.

Owners can deliver their own training, and RenewableUK also maintains a list of Approved Wind Turbine Safety Rules Training Providers: external bodies accredited to run the Approved Training Course.



Figure 3: Gwynt-y-Mor Offshore Wind Farm

Operational Control Requirements – Function and Resourcing of the Local Control Room

The local control room is used for marine coordination, providing communications links with the vessels that transfer workers to the turbines. It also acts as a hub for weather information gathered from forecasting services and on-site weather measurements. Each day, vessel movements are planned and teams are allocated seats on the vessels once their induction and training records have been checked. People-tracking software is used to keep a record of where workers are deployed, while CCTV cameras provide further information on conditions offshore.

The local control room is also responsible for the operational control of the wind turbines and for releasing turbines for maintenance through the Transfer of Control process set out in the Rules. This is a formal process which is part of the safe system of work. It is undertaken by the Operational Controller, who must first check that the maintenance work has been properly planned, that there is an Approved Work Procedure, and that risks have been assessed and controlled.

The control room monitors the performance of each wind turbine and ensures that action is taken quickly in the event of a fault. This may require liaison with either the OFTO or the Siemens wind turbine surveillance centre. The control room also ensures that proper records are kept of all maintenance work undertaken at Gwynt y Môr using Innogy's SAP Maintenance Management System. This provides information on historical faults as well as tracking planned preventative maintenance tasks.

Large offshore wind farms such as Gwynt y Môr must comply with the Grid Code, the Connection and Use of System Code (CUSC), the Balancing and Settlement Code (BSC), the conditions of their Generation License, and Grid Connection Agreement.

A key requirement as a generator in the UK is to provide a control point between the National Grid. The O&M base's local control room serves as Gwynt y Môr's, providing an operational interface between the farm and National Grid. To satisfy Grid Code requirements, it must be operational on a 24/7 basis and capable of rapidly complying with emergency instructions to reduce load, de-energise, or take action to comply with a Bid Offer Acceptance as part of the balancing market. Innogy also provides information to National Grid about the expected output from the wind farm in the form of physical notifications. In turn, the control room provides information to the trading team who are responsible, which helps them to accurately predict wind farm power production.

Finally, in the event of an emergency, the control room will provide incident coordination support under the site's Emergency Response Plan.

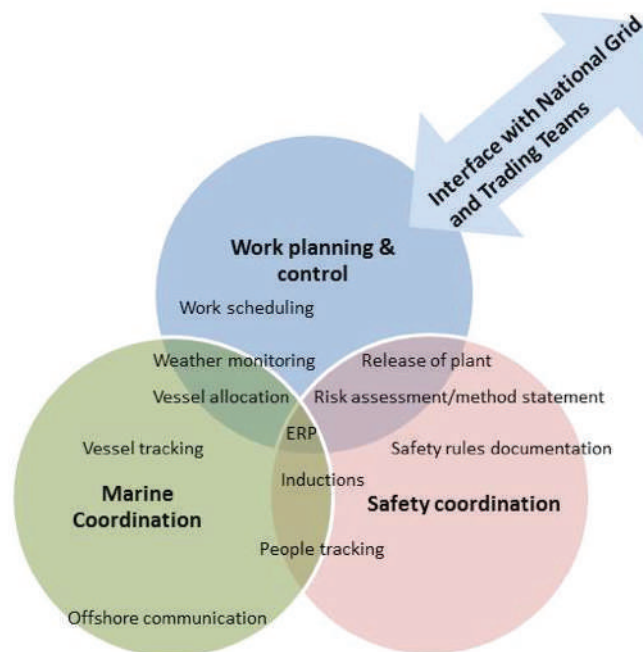


Figure 4: Summary of control room processes relating to the control of O&M

In order to provide the required services, Innogy chose to set up a local control room that would operate on a 24-hour basis. In addition to combining different control room functions into a single role, they also decided that, rather than staff the control room with dedicated onshore personnel, they would create a broader role that included both control room tasks and offshore work – providing greater variety and increased flexibility. Many offshore wind farms utilise separate teams to undertake marine coordination, HV system management and operational control, so this multi-skilled approach is relatively novel – it is currently in use at only a handful of offshore wind farms. The overlapping nature of the tasks and their contribution to the overall “setting to work” process lends itself to an integrated approach, as there is considerable commonality between many of the detailed processes required for marine co-ordination, work planning, operational control and H&S management which are highly related as illustrated by Figure 4. This reinforces the benefits of an integrated approach.

Approach to Recruitment, Training and Competence Development

Staff were recruited from a range of backgrounds including the Innogy Apprenticeship Scheme, the armed forces and maintenance engineers/technicians. Given the wide scope of the role, significant effort was invested in defining and delivering effective training. A training matrix was drawn up that included HV electrical awareness and HV switching, knowledge of the trading environment, Wind Turbine Safety Rules training, IT systems, and marine coordination. It took 9-12 months to deliver training and build sufficient competence prior to formal authorisation assessment panels being held.

Marine coordination was initially undertaken by a separate team, and was phased into the O&M control room functions a short while after operational handover and once the use of construction vessels had ended. Once the site operations had settled down and consisted solely of O&M crew transfer vessel movements, the marine coordination scope was more simplified than during the construction phase, when a larger number of more complex vessels were being used on site. For the O&M team, marine coordination training was considered the most challenging to provide: there was no single training course available, so the team set about creating their own using the skills and knowledge of the local harbour master and an experienced marine coordinator. The training involved developing a familiarity with the Liverpool Bay marine environment, VHF radio training, reading admiralty charts, weather awareness, navigation, and the transportation of dangerous goods at sea.

At the end of the training period, a panel interview was held to assess competence and provide a formal authorisation process. An experienced marine coordinator was also retained for an initial period to provide on-the-job support and mentoring.

“We worked hard to develop a really robust training programme for our offshore technicians and supervisors. We defined detailed training requirements and found excellent trainers. This investment has paid off in creating a strong, team-based culture where staff members feel a real sense of ownership.”

John Porter, power plant manager

Innogy has contracted with Siemens to provide support from an Authorising Engineer who works under the Innogy Wind Turbine Safety Rules. This ensures that the Gwynt y Môr team has access to the correct expertise to prepare Approved Work Procedures. Innogy staff take an active role in work planning and reviewing risk assessments and method statements, along with checking that work orders are authorised to enable maintenance work to be scheduled.

Organising Working Routines and Patterns

Innogy's offshore technicians at Gwynt y Môr spend eight weeks working in the control room, then 15 weeks away from control room duties supporting offshore maintenance activities. They then return for an eight-week period working back in the control room. To prevent skill fade, a one-week familiarisation period occurs prior to starting work back in the control room again.

The rota includes coverage of tasks within the control room on a 24-hour basis. Innogy took care to ensure that employment contracts were developed which facilitated both shift and offshore working.

The design of the rota enabled job rotation, involvement in onshore and offshore working, and also enabled different groups of people to work together – a move which fostered improved team working.

Managing and Using Information

Control room staff at Gwynt y Môr employ a range of IT systems to support them in their various roles and to ensure information from the wind farm is available to inform decision-making. Records of activities and decisions are also recorded and retained in an Operational Shift Log.

The IT systems that support the control room functions are illustrated in Figure 5.

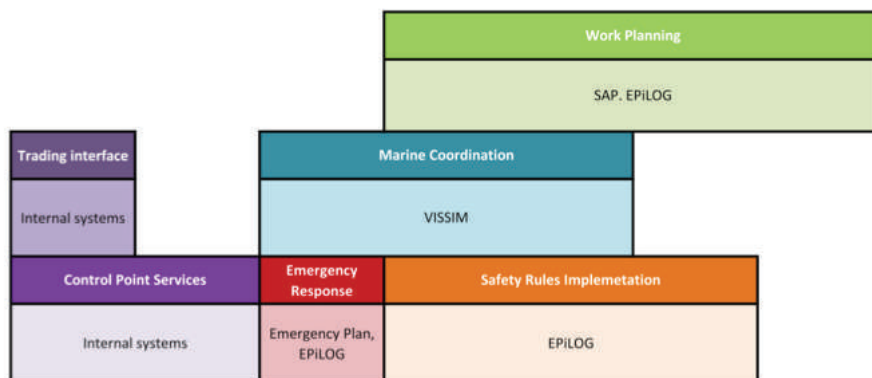


Figure 5: IT systems used at Gwynt-y-Mor

Innogy uses marine coordination software to track vessel movements and maintain an up-to-date picture of the location of workers on the wind farm. The VISSIM system maintains a register of all the people who are authorised to transfer to offshore structures and stores their latest training records. Weather forecasts – including predictions of wind speeds and wave heights – are available, along with data from wave buoys located at the site. Control room staff also have access to a visual feed from an offshore camera mounted on the substation structure. Radio contact is maintained

from the control room allowing communication with vessel crews and offshore workers.

A history of the maintenance carried out on-site is recorded in Innogy's Computerised Maintenance Management System, implemented in SAP. This system also creates work orders, which include references to relevant documentation. Staff can also access the SCADA system, which collects information from each turbine and the electrical balance of plant equipment and provides the ability to remotely operate equipment. A shift log software system, EPILog, records information about site operational activities.

The team is currently developing software to collate information from multiple sources and provide a single tool for monitoring activities and conditions on-site.



Figure 6: The Control Room is based at the O&M building, which is adjacent to the Port of Mostyn

The Results

Delivery of Local Control Room Services

Staff work on a rota that includes periods of time working offshore and periods of control room duties. The rota for the time spent in the control room includes cover throughout the 24-hour period.

The control room function has been operating for more than three years, with marine coordination added to the scope 18 months ago. Coaching was initially provided by an experienced marine coordinator to support the team when a multi-skilled approach was first introduced.

While staff members were recruited from a diverse range of backgrounds, there was a common need to ensure strong IT skills and an ability to work effectively alone – at night, the control room is manned by a single person.

The rota for each supervisor is arranged differently to the technicians' rota so that the same supervisor will not always lead the same team. This adds to job enrichment and facilitates the spread of knowledge around the whole team by creating an organisational overlap.

Job Enrichment

The operational controller role is an important part of delivering maintenance work safely and effectively. There are synergies between the duties of an operational controller and a marine coordinator at an offshore wind farm; both are vital operational roles within the framework used to manage health and safety issues. In addition to these control room-based tasks, Innogy technicians also work offshore, delivering maintenance on the balance of plant and supporting the delivery of turbine maintenance.

“Implementing Innogy’s Wind Turbine Safety Rules has given us more control over the plant. The use of multi-skilled offshore technicians is an effective way to provide an enriched role for operators and focus the team on the delivery of our objectives.”

Mark Grimston, production manager

A key objective of this multi-skilled approach was to provide job enrichment and avoid friction between operations and maintenance teams. Diversity is provided by varying the roles performed and ensuring staff spend periods of time working offshore delivering inspection and first line maintenance, as well as spending time in the control room. This ensures that all staff enjoy a “real-world” view of the wind farm, removing barriers and improving awareness of the issues that need to be managed.

The multi-skilled nature of the role has reduced interfaces which exist at other wind farms between operational controllers, work planners and marine coordinators. There is also a single point of contact for issues arising in relation to the OFTO and National Grid teams. The use of a single team for all control room tasks and offshore support has led to a sense of ownership which has fostered team working, allowing clear objectives to be set. This sense of ownership and clear focus on delivery has enabled the first annual wind turbine service to be delivered on time. Staff members are encouraged to suggest new ideas for further improvement – a move that has led to the development of better systems for capturing and sharing knowledge.

As their experience and capabilities increase, staff have the chance to progress within a salary scale that recognises good performance to be recognised and rewarded.

“I love my job. We get good variety by moving between control, marine coordination, and offshore working.”

Alisdair Smith, offshore technician

Improvement, Knowledge Capture and Sharing

The team at Gwynt y Môr has developed a number of systematic methods to capture and share knowledge. Firstly, a structured training programme and the use of work shadow and mentoring alongside more conventional training courses enables knowledge to be shared. A suite of operational instructions are in development which are written by team members for their colleagues. These are separate to the Wind Turbine Safety Rules documents – they are managed by the team, and are seen as “how to” guides, covering a range of routine tasks. The operational instructions are now forming a library of information which is seen as the first place to go to understand how processes and systems work.

Information about activities, maintenance work and events is retained in the various IT systems that are used on the site, with the Offshore Technicians both entering data and accessing it. Work is currently underway to develop an integrated data platform using software from a company called Planet-OS, which will pull together information from VISSIM (used for marine coordination), SAP (used to record maintenance work), EPILog (used to record events) and the plant SCADA systems (for both wind turbines and HV balance of plant). This system was in a pilot phase at time of publishing.

Recommendations

The Innogy team has been operating Gwynt y Môr for several years and continue to develop and refine their approach to both operations and maintenance. To develop and implement an approach that uses multi-skilled technicians working both offshore and in the onshore control room, the following advice is offered:

- Start planning early. It takes 9-12 months to deliver effective training once a training plan has been developed.
- Define training requirements in detail and find good trainers. Employ a blend of external training, in-house delivery, shadowing and mentoring.
- Ensure employment contracts are flexible enough to accommodate shift work and offshore working patterns.
- Develop rotas that encourage staff to work together in different teams. Varying supervisors will increase variety and improve knowledge sharing.
- Ensure time within the rota for refresher training – especially important when technicians are returning to the control room after a period of working offshore.
- Develop ways to recognise and reward good work, and provide development opportunities.
- Build practical skills in marine coordination and employ experienced marine coordinators as mentors.
- Ensure the layout of the O&M building supports the way that organisations and team members work together.



Figure 8: A number of the Control Room processes are required on a continuous basis, and the local control room at Gwynt-y-Môr has been set up for 24-hour operations.

Appendices

Author Profiles



Sally Shenton is the Managing Director of the offshore wind O&M consultancy Generating Better. Prior to this, she held the position of Operations Manager for various offshore wind farms.



Conaill Soraghan is a Project Engineer, O&M Systems at the Offshore Renewable Energy Catapult. He has a background in applied mathematics and completed a PhD in wind turbine design. Conaill's main area of interest is the management and optimisation of operational assets and he has extensive experience in the design and development of benchmarking systems and data/knowledge sharing for the offshore wind industry.

Contributors

John Porter is the power station manager at Gwynt y Môr and is responsible for all O&M activities. Prior to working at Gwynt y Môr, John worked at various thermal power plants including Eggborough, Didcot A, Didcot B, Aberthaw and Thessaloniki in Greece.

Mark Grimston is production manager at Gwynt y Môr. Mark previously worked at Rhyl Flats for Siemens Wind Power and prior to this was in the Royal Air Force.

Adrian Emanuel is implementation manager for O&M Services. Adrian has worked in the wind industry for 15 years supporting both onshore and offshore wind developments. He is part of a team that undertakes projects to prepare new sites for operational readiness.

Recommended Reading

[Wind Turbine Safety Rules](#)

[Marine Coordination Guidance](#) (also available in Danish and German)

[Grid Code](#)

About the O&M Case Studies series



This is one in a series of offshore wind O&M-focused case studies, supported by ORE Catapult's O&M forum and funded by The Crown Estate and the Offshore Wind Programme Board. These studies aim to highlight game-changing O&M projects, and promote the dissemination of knowledge among the offshore wind O&M community.

Disclaimer

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ORE Catapult

Inovo
121 George Street
Glasgow
G1 1RD

+44 (0)333 004 1400

National Renewable Energy Centre
Offshore House
Albert Street
Blyth
NE24 1LZ

+44 (0)167 035 9555

Fife Renewables Innovation Centre
Ajax Way
Leven
KY8 3RS

+44 (0)167 035 7649

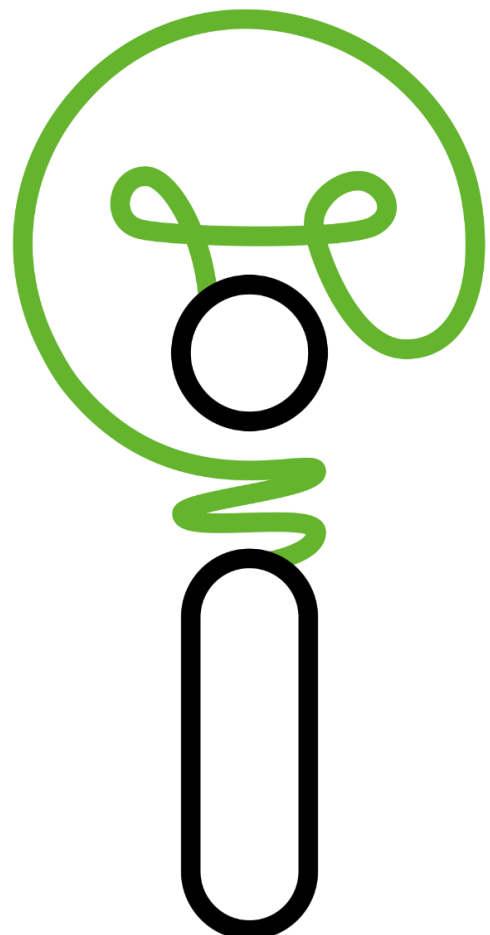
Email: info@ore.catapult.org.uk

Web: <http://ore.catapult.org.uk>

EV144

Triton Knoll opportunities for local suppliers flyer

Not confidential



Triton Knoll Offshore Wind Farm: Supplier Opportunities

INVITATION TO PARTICIPATE

31st January 2018 | 8:00am - 12:00 midday

Venue: Boston College, Skirbeck Road, Boston, Lincolnshire PE21 6JF | Free Parking

Triton Knoll is a flagship offshore wind farm in the latter stages of development, and is owned by innogy, one of Europe's leading renewables businesses. Located 20 miles off the east coast of Lincolnshire, the project will provide 860MW of electricity from 90 wind turbine generators and will take up to 4 years to complete.

The project team wants to maximise opportunities for Lincolnshire businesses to be involved in the construction of the project's electrical system, which is due to start this summer. Triton Knoll, working together with the Business Lincolnshire Growth Hub, is organising this key 'meet the contractor' event to highlight the prospects for supply and employment.

At the event, businesses will be able to hear about the project and meet in person the contractors responsible for delivery. J Murphy & Sons has been appointed to deliver the onshore underground cable circuits from near Anderby Creek through to Bicker Fen; while Siemens Transmission and Distribution Ltd will be responsible for the construction of the onshore substation at Bicker Fen. Both of these contractors have provided a 'shopping list' of local services that they are likely to require, and this can be found listed on the next page.

Businesses can drop in at any time during the morning for an informal chat, or book a one to one meeting with one of the contractors by contacting ray.newell@bizlincolnshire.com. An appointment time will be allocated in advance of the event. Booking for a one to one appointment is essential.

As well as the contractors, the Business Lincolnshire Growth Hub will be present to answer any of your questions regarding the support available to help you engage with this project.

Businesses should complete the supplier registration database on the Triton Knoll website before arrival: www.tritonknoll.co.uk/supply-chain/suppliers-form. Businesses unable to attend this event can still register their interest in supplying Triton Knoll Offshore Wind Farm and its contractors by using the same form.

The Triton Knoll database of registered contractors will be shared with all the project's main contractors, including Murphys and Siemens.

Agenda

08:00-09:00 – Bacon rolls

OPENING ADDRESS

09:00 by Councillor C Davie LCC

TWO PRESENTATIONS BY TRITON KNOLL OFFSHORE WIND FARM

09:00 and 11:00

STANDS

Triton Knoll Offshore Wind Farm
Siemens Transmission and Distribution Ltd
J Murphy & Sons
Business Lincolnshire Growth Hub

Tea and coffee available throughout the morning

Opportunities for local suppliers



Murphys

- Hedgerow clearance
- Accommodation - hotels, B&B, caravan sites
- Sand, stone
- CBS deliveries
- Security
- Land drainage
- Horizontal directional drill
- Plant hire
- Hauliers
- Low loader movement
- Traffic management
- Soil testing
- Ground investigation
- Surfacing contractors
- Road sweepers
- Fencing contractors
- Builders merchants
- Catering
- Butty vans
- Office cleaning
- Grocery supplies
- Milk deliveries
- Key fuel garages
- Local labour



Siemens Transmission and Distribution Ltd - requirements

- Hedgerow clearance
- Accommodation - hotels, B&B, caravan sites
- Catering
- Butty vans
- Grocery suppliers
- Canteen staff
- Security
- Plant hire
- Builders merchants
- Road sweepers
- Office cleaning
- Receptionist office manager
- Communications providers
- Taxi service
- Local labour



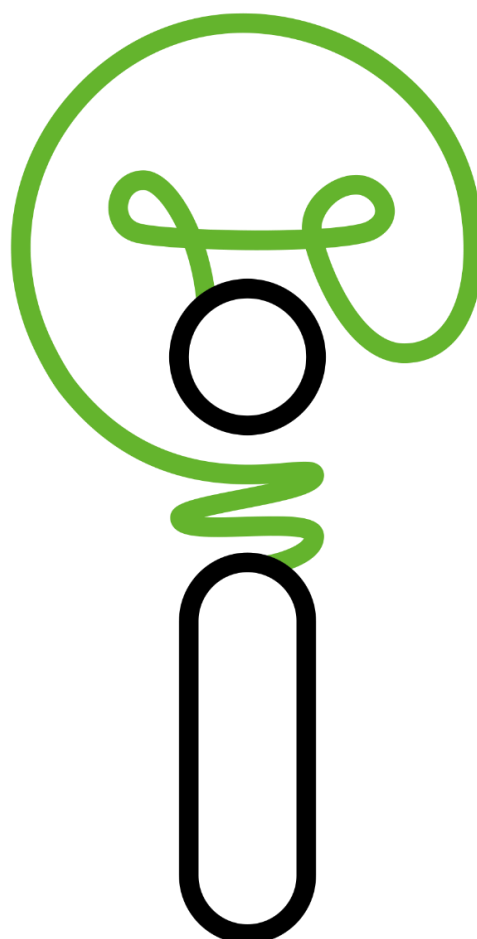
We look forward to seeing you on 31st January 2018, please RSVP to:

ray.newell@bizlincolnshire.com

EV146

Triton Knoll supports Humber UTC open day

Not confidential



TRITON KNOLL PRESS RELEASE

RELEASE date: Friday 17 March 2017

Triton Knoll supports Humber UTC open day

Triton Knoll is delighted to be supporting Humber University Technical College student open day on Saturday, 18 March, and to demonstrate our continued support through our sponsorship of its Electrical Workshop.

So far, in our first six months, we've set the students a circuit-maker challenge to help them begin to understand some of the challenges the sector faces day to day, and we were delighted with the results.

Looking ahead, we will be setting more challenging tasks, so that students have a chance to learn more about the sector which offers so many opportunities for the future.

Renewable energy is a significant industrial growth sector in the UK, producing critical energy infrastructure and with the potential to unlock extensive opportunities for long term, high skilled engineering jobs in both construction and operation of facilities across the sector.

Triton Knoll is delighted to be supporting the open weekend and will be there in support on Saturday, 18 March, between 10 and 2pm. So if you're in the area. Come and say hello to Triton Knoll and find out more about this exciting project.

For more information about the project, please visit: www.tritonknoll.co.uk

Ends

Contact

Mark Fleming
Triton Knoll Communications Manager



EMBARGOED until: 00.01am, Monday 19 December, 2016

Triton Knoll supports Humber University Technical College to help grow local talent base

Triton Knoll Offshore Wind Farm has joined forces with Humber University Technical College (UTC) to help support the growth of a highly-skilled local workforce that would help underpin the future success of the renewables industry.

Over the next three years, Triton Knoll will sponsor the college's Electrical Workshop, and is also preparing to launch a new engineering challenge that will give the college's students experience of the industry and the challenges it faces.

Triton Knoll Project Director James Cotter said: *"We are absolutely delighted to have this opportunity to support the University Technical College. Triton Knoll is committed to becoming a catalyst for skills growth in the region, and we can think of no better way than helping develop today's students to be the engineers of tomorrow."*

"There are great opportunities in this area for young people to consider a career in offshore wind, which is a strong and growing industry. We believe that the UTC's curriculum is well placed to successfully prepare students for the jobs and opportunities that could be realised not just for our own project but from across the wider industry."

The Electrical Workshop is part of a suite of specialist workshops at the college, which is based in Scunthorpe, where students typically spend part of their 9am - 5pm working day learning practical engineering and Science, Technology, Engineering and Maths (STEM) related skills. The skills they will learn are highly transferable; with specialisms in renewable technologies increasingly valued amongst employers looking for those best able to support the specific needs of the industry.

Andrew Downing, Principal at the Humber UTC, said: *"We are both pleased and excited by the support Triton Knoll is providing to the students of the Humber UTC, showing the project's desire to develop engineers of the future. The Humber UTC has a simple aim, to provide outstanding education, while providing the necessary technical and employability skills that will help transform life chances. Triton Knoll's commitment to developing a highly-skilled workforce is a natural fit with this ambition and the sponsorship of this 'state-of-the-art' workshop is just one example of the wealth of knowledge, expertise and support that the project is offering to our students."*

Triton Knoll Offshore Wind Farm will be located approximately 32km off the Lincolnshire coast and 50km off the coast of North Norfolk. It is being developed as a joint venture between Innogy Renewables UK Ltd⁽²⁾ (50%) and Statkraft (50%), with innogy managing the project on behalf of the partnership. With a capacity of up to 900MW, the wind farm has the potential to power up to 800,000⁽¹⁾ UK homes once fully operational.

If you would like more information about the Triton Knoll project, please visit the website:

www.tritonknoll.co.uk

Contact

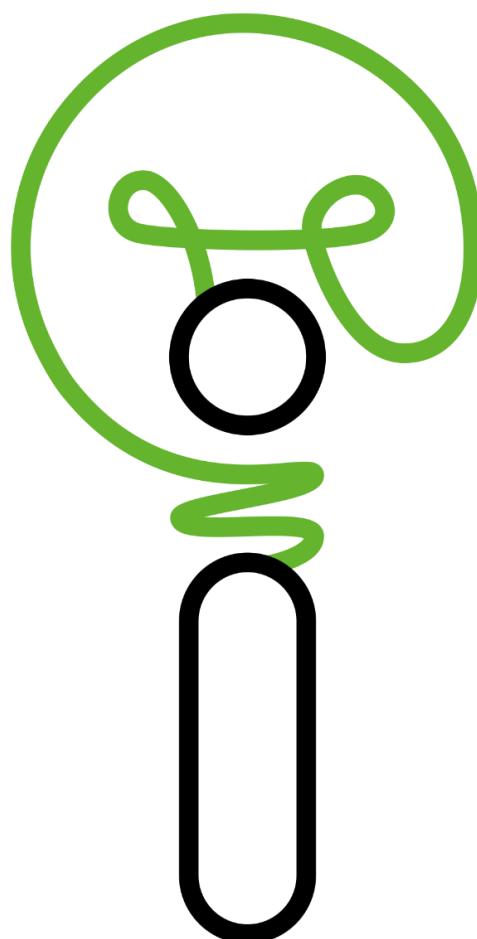
Mark Fleming – Triton Knoll Communications Manager



EV148

Lincolnshire business and skills plan

Not confidential



TRITON KNOLL PRESS RELEASE

RELEASE date: Monday 16 January, 2017

Triton Knoll to focus on business opportunities in Greater Lincolnshire

- **Triton Knoll is working with Greater Lincolnshire Local Enterprise Partnership to engage with businesses and schools**
- **Potential local opportunities in both construction and across a wide range of support services.**

Triton Knoll Offshore Wind Farm is urging Greater Lincolnshire companies to register interest online to stay ahead of the game, when it comes to possible contract opportunities with the £multi-billion east coast renewables project.

This 'Call to Action' is central to a skills and employment plan, which aims to maximise opportunities for local businesses during the construction of the project's Electrical System.

The project will need a range of contractors to help construct the almost 60kms underground electrical connection that will stretch from Anderby Creek to Bicker Fen, near Boston. Opportunities will include earthworks, construction, equipment supplies, hire services and manpower provision, but Triton Knoll also expects that many local businesses such as taxi firms, hotels and restaurants will also benefit from the additional business created by the large infrastructure project.

Triton Knoll developed its plan in discussion with Boston Borough Council and East Lindsey District Council, the Greater Lincolnshire Local Enterprise Partnership and the Business Lincolnshire Growth Hub, to help ensure opportunities are well targeted, locally. Although it will be some time before many of the contracts are released, the Triton Knoll team hope that starting the process early will allow businesses every opportunity to gear up and be ready to compete successfully.

Triton Knoll Project Director, James Cotter, said: *"We want local businesses to be able to take full advantage of opportunities that the project could bring to the local area. So for organisations that register, we will provide regular project updates and timely visibility of suitable potential contracts in order to encourage local firms to prepare and bid for business on Triton Knoll. We firmly believe that Lincolnshire companies can successfully compete for contracts on the project and as a result we hope to see local firms, employing local people, and delivering investment back into their communities."*

Triton Knoll's project team has already begun by setting up an online database at www.tritonknoll.co.uk/supply-chain and is urging Lincolnshire firms that believe they could play a part in the project to submit their company details. The website includes a 'Potential Supply Chain Opportunities' brochure to help local firms identify where their skills could potentially support the project. Businesses that register will be kept regularly informed of developments and their details will be shared with the project's main contractors when they are appointed. The main contractors will be responsible for procuring most of the goods and services for the project.

Chair of the Greater Lincolnshire Local Enterprise Partnership (LEP), Ursula Lidbetter, said: *"We have worked with Triton Knoll to develop a plan for engaging with local businesses and schools and are pleased to see that this engagement has started. There is more to do if the area is to benefit from this development, and we encourage local businesses to find out more about the contract opportunities that*

this brings. Further information about registering for opportunities can be found at our Business Lincolnshire Growth Hub www.businesslincolnshire.com "

The wind farm team also proposes to work with schools and colleges on the cable route to help spotlight the huge value of Science, Technology, Engineering and Maths (STEM) skills within the renewables sector.

Triton Knoll Offshore Wind Farm would be located approximately 32km off the Lincolnshire coast and 50km off the coast of North Norfolk. It is being developed as a joint venture between Innogy Renewables UK Ltd⁽³⁾ (50%) and Statkraft (50%), with innogy managing the project on behalf of the partnership. With an installed capacity of up to 900MW, the wind farm will have the potential to power up to 800,000⁽¹⁾ UK homes once fully operational.

For more information about the project, please visit: www.tritonknoll.co.uk

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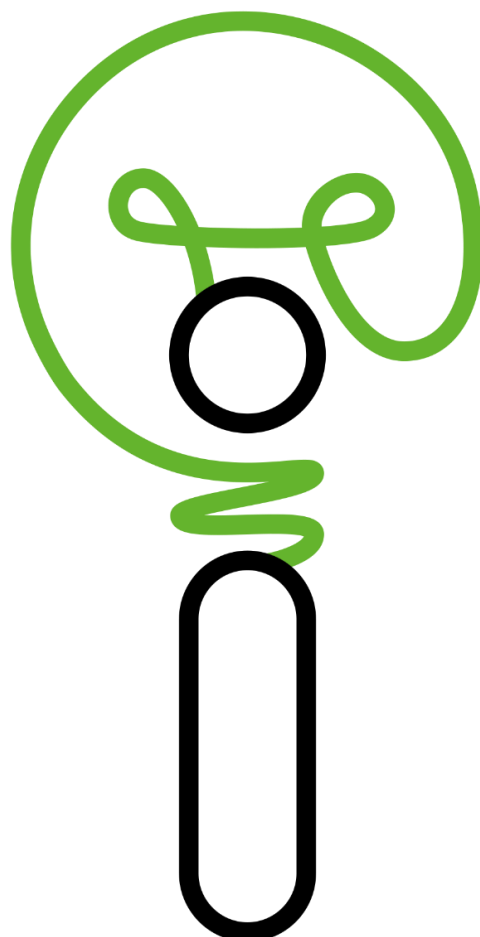
Contact

Mark Fleming
Triton Knoll Communications Manager

EV149

New Way of Working (NWoW) Skills development

Not confidential



It's here: registrations are now open for the new digital professional development programme.

How would you like a change from your day-to-day routines that is not only fun but will also help with your professional advancement? Do you enjoy fascinating sessions with digital technology and hands-on workshops? Now's your chance to join innogy in shaping the digital transformation – with the digital professional development programme offered by People Development. Make a start by checking out what's in the module [here](#).

Brief summary of the digital professional development programme

Around 30 digital courses in total are offered, each focusing on different aspects. A wide range of topics is covered, from agile working methods to data analysis and process automation. The courses are open to all employees, regardless of their experience with digital technology. The courses are structured by level of difficulty, with basic courses for beginners and workshops for those with more experience. To participate in the modules, you only need to arrange it with your managers. More detailed information about the concept underlying the digital professional development programme is available [here](#).

Interested? Access the HR portal [here](#)!

NWoW Academy

Communicating skills effectively

October 02, 2018



NWoW, the New Way of Working, has supported innogy employees and managers in acquiring the necessary skills for the future as part of the overall transformation programme. The aim: improve leadership and the overall organisation, make customers more satisfied and, ultimately, make more money for the company. The work of our NWoW colleagues includes workshops on new, standardised and agile ways of working, supporting employees and implementing an active feedback

culture.

After more members have joined the NWoW Academy, it has now become an independent team within the NWoW community. The main objective is to provide the NWoW community with the necessary knowledge to implement and anchor the NWoW principles within the organisation for the long term.

The training sessions delivered by the NWoW experts are intended to convey a basic understanding of NWoW and also deal with topics such as collaborative leadership, the Big 5 and change management.

"I would recommend taking part in the workshop to my colleagues. In particular, I liked the fact that the trainers were native speakers. That really is a big advantage. The training included 'lean' essentials and the trainer was well prepared." (Quote by a participant in the 'Lean practitioner week'.)

The current portfolio comprises four different learning journeys:

- Lean
- Agile
- Change
- Innovation

The 'lean' and 'agile' journeys are already well developed. Training pilots for the 'change' journey will be offered from October. You can already book the different courses via Success Factors.

The NWoW Academy also offers external certification for all aforementioned learning journeys. Again, this is already available for 'lean' and 'agile'; 'change' and 'innovation' are being developed.

The next available dates for the 'change' training pilots:

- Emotional Competence (deepening inner capacities): 22/23 October
- Change Competence - Foundation Training: 24/25 October

In addition, the NWoW Academy also offers on-site training. If an NWoW team wants to hold one of the courses from the Academy portfolio on site, an Academy trainer can deliver the course there.

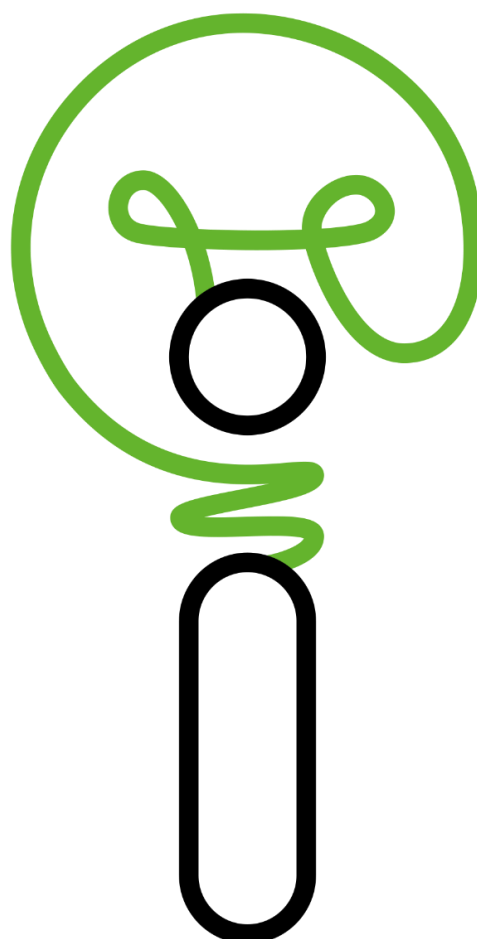
Link to the Academy calendar with an overview of the various training courses. From there, you can book your course directly in Success Factors!

Should you have any questions, simply email the NWoW Academy directly:

EV150

Gwynt y Môr and Galloper extensions

Not Confidential



From: Muir, Claire
Sent: 31 May 2018 10:17
To: Willison, Josh
Subject: Gallper and Gwynt-y-Môr extensions applications

Morning Josh,

To confirm, the applications for the proposed extensions to both Galloper and Gwynt-y-Môr have been received. 3 emails in total, as per the below.



Galloper Extension Application Part 2 of 2
Galloper Extension Application Part 1 of 2
Gwynt y Môr Extension Application

We'll be in touch in due course,

All the best,
Claire

Claire Muir
Contract Manager



1 St James's Market, London, SW1Y 4AH
Tel: +44 (0) 20 7851 5155

www.thecrownestate.co.uk 

Please think - do you need to print this email?