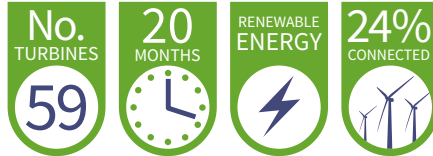




Dorenell

Wind Farm Project - Renewable Energy



Scope of work and major design considerations:

In May 2008 Infinergy Ltd applied to the Scottish Government for planning permission for the construction of Dorenell Wind Farm. The wind farm is to occupy an area of land on the Glendfiddich Estate

The windfarm development:

- ▶ Construction of 59 turbine bases and crane pads
- ▶ Construction of 34km of new site roads, upgrading of 2.2km of forestry track and 5.3km of existing site tracks
- ▶ Construction of a substation compound with a footprint of approximately 150m X 75m comprising 2 substation buildings
- ▶ Construction of approximately 40km of cable trenches
- ▶ Installation of 59 3MW turbines with a maximum tip height of 126m

Dorenell wind farm is connected to the SHETL distribution network via 2 132kV overhead lines, approximately 22km in length, which connect to Blackhillock Primary substation on the outskirts of Keith, Moray.

Project Facts and Figures:

- ▶ Number of turbines: 59
- ▶ Wind turbine capacity: 3 MW
- ▶ Totalled Installed capacity: 177MW
- ▶ Connection Voltage: 132kV
- ▶ Connection to Grid: SHETL distribution network at Blackhillock primary.
- ▶ Size of site: 35km²
- ▶ Energy for 109,112 households *
- ▶ Length of onsite access tracks: 42 km
- ▶ Length of onsite 33kV cabling: 240km

Wind Farm project timings:

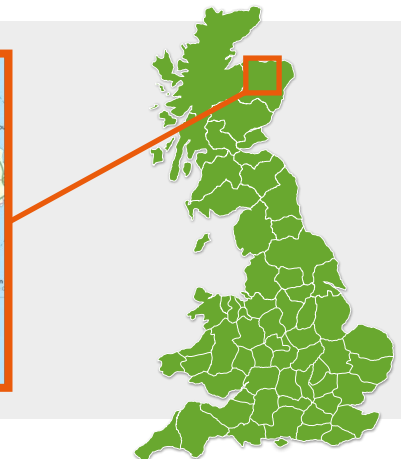
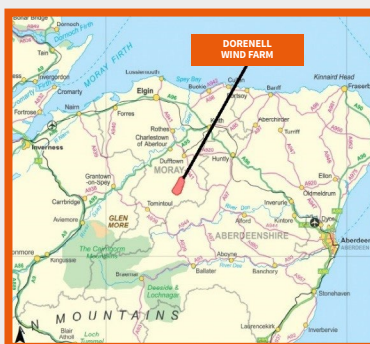
The first turbines were erected and began generating in August 2018. The final 59th turbine was constructed in December 2018 and the farm has been fully operational since 20th December 2018, all construction works were completed by the 31st December 2018.

The 177MW wind farm will generate sufficient energy to power approximately 109,112 homes and will contribute to the Scottish Governments target to ensure that 100% demand for Scotland's electricity is to come from renewable energy sources by 2020.

The project saw the installation of 59 Vestas V90 3.0MW turbines with a tower height of 81m and hub diameter of 90m and a planned operating life of 25 years.

EDF have committed to contribute over £8m to the local community fund over the life span of the wind farm in addition to a range of improvements to regenerate the Cabrach area and strengthen tourism.

The 59 3MW turbines generate at 33kV and are arranged over 7 Arrays which feed into the wind farm substation. The voltage is then increased to 132kV by 2 120MVA 33/132kV transformers prior to connecting to the SHETL 132kV distribution network.





What the client wanted:

EDF Renewables develop, construct and operate wind farms, solar and battery storage projects. They are focused on the development, construction and operation of onshore and offshore wind farms and already operate more than 965MW of wind farms within the UK.

How Powersystems helped:

Powersystems UK were appointed as the wind farm Balance of Plant (eBoP) contractor with responsibility for the design, build, commissioning and energisation of the entire wind farm electrical infrastructure works from the 132kV connection to the DNO through to the final electrical and fibre optic terminations to the Vestas V90 turbines.

Powersystems worked with EDF engineers to fine tune the employer's concept designs and produce detailed general arrangements and technical designs for all aspects of the project – these were then taken through to construction.

The list of responsibilities as the main electrical contractor are extensive for such a large project but can be summarised as follows:-

Design works

- ▶ 132kV compound – produce 132kV Compound Equipment general arrangement drawings, produce 132kV equipment plinth details, provide 132kV support structures designs & 132kV overhead busbar layouts.
- ▶ Windfarm substation 33kV switchgear – specification of 33kV switchgear and full design specifications for control and protection systems.
- ▶ Control Building – Provision of equipment GA's, small power & lighting layouts, Fire and security layouts.
- ▶ STATCOM Compound – produce general arrangement drawings, equipment plinths designs, cable containment / ducting system layouts.
- ▶ 33kV cable arrays – design of the cable trenches (with respect to the track layouts), Array SLD's, cable sizing and loss calculations, trench cross sections.
- ▶ 132kV and 33kV Earthing system design – Produce full earthing design studies (based on soil resistivity readings taken from site), produce earthing designs for the turbine foundations and substation compound.
- ▶ Protection Systems – Design of the 132 and 33kV protection equipment schemes including the design of protection SLD's, relay panels & schemes, protection coordination studies and relay settings / logic files.
- ▶ Control cabling – design of all small power and equipment control wiring

Dorenell



Installation Works

- ▶ 132kV compound – Installation of 132kV Through Wall bushings, 132kV busbar support structures and Busbars, 132kV surge arrestors, 33kV AIS support structures and busbars, 33kV cable installation, control cabling between all 132kV equipment and SCADA / Protection panels.
- ▶ STATCOM compound – Installation of 2 Hybrid STATCOM systems comprising 2 STATCOM Inverter containers, 4 off 33/0.4kV 5MVA Transformers, 4 off 12MVar 33kV switched capacitors including offloading of the main components, 33kV cable installation, control cabling between all components and 33kV switchgear, STATCOM control panels, SCADA panels.
- ▶ 33kV switchgear – Installation of 19 panel Schneider WS 33kV 2500A 31.5kA switchgear, installation of control cabling between switchgear and ancillary equipment / SCADA panels.
- ▶ Windfarm Ancillary Equipment – Installation of 132kV Protection Panels, AVR panels, Switchgear remote indication / operating panels, 110V Battery Chargers, Auto Changeover panels, STATCOM control panels, Control cabling between substation equipment and control panels.
- ▶ Windfarm control Building – Installation of small power & lighting, Fire and security systems.
- ▶ 33kV Cabling – Installation of approximately 236km of 800/400/240mm Aluminium 33kV cables between the main substation and the 7 turbine arrays.
- ▶ Fibre Optic Infrastructure – Installation, splicing and OTDR testing of 12km of 32/16F Pre-ducted fibre optic cable between the main substation and 7 turbine arrays
- ▶ HV Jointing – Installation of 270 33kV single core straight joints, 51 Pfisterer 33kV Size 3XL terminations, 420 33kV bolted T connectors, 18 33kV outdoor terminations.
- ▶ Earthing – Installation of 59 turbine base earth mats, 50km of horizontal 50mm bare copper earth conductor (installed with array cables), installation of the main substation earth mat comprising of approximately 6km of 50x4mm copper earth tape.



Commissioning Works

- ▶ 132kV Compound – Tan Delta Testing of the 132/33kV transformers and 132kV overhead busbars, Functional testing of the 132/33kV Main transformers control systems, cooling systems, tap changers & trip / alarm testing to protection & SCADA panels.
- ▶ Functional testing of the ABB PASS 132kV circuit breakers including CT testing, VT ratio testing, Interlocking and Trip / Alarm testing to Protection & SCADA panels.
- ▶ VLF testing of the 33kV cables between the main transformers and 33kV switchgear. Ductor testing of all overhead busbar connections. Ductor testing of all earth mat connections. Commissioning of Transformer bund pumps.
- ▶ 33kV switchgear – Full commissioning of the 33kV switchgear including connections / signals to external equipment & SCADA including AC pressure tests, ductor testing, VT and CT ratios, functional testing (including interlocking), relay testing, 61850 relay communications to SCADA.
- ▶ Protection / AVR panels – Full commissioning of the 132kV Transformer protection panels and voltage regulation panels including protection relay functional testing, secondary injection and 61850 interface testing to SCADA.
- ▶ Wind Farm Control Building – testing of the small power & lighting, fire & security systems.
- ▶ 33kV Cable Arrays – Sheath Testing, IR / VLF testing of all 33kV Array Cables to all turbines.
- ▶ FO Infrastructure – OTDR testing of the fibre optic infrastructure to all turbines.
- ▶ Earth Testing – Soil Resistivity and earth Resistance testing of the Main Substation compound and the 59 turbine bases followed by an overall site earth resistance test.





Energisation Works

- ▶ Provision of 132kV SAP to attend site meetings with the client and Scottish and Southern Electricity Networks (SSEN) Distribution Network Operator (DNO) to discuss and finalise the energisation program of works and produce Energisation plans and switching schedules.
- ▶ Provision of 132kV SAP to attend site to provide supervision and undertake pre-energisation inspections and issue safety documentation prior to first energisation of the site. SAP attendance for energisation of the 132/33kV equipment.
- ▶ Provision of 33kV SAP for pre-energisation inspections and energisation / commissioning of the 33kV STATCOM components. Undertake HV switching / issue safety documentation as required by the STATCOM supplier.
- ▶ Provision of 33kV SAP for testing and energisation of the Array cables, pre-energisation inspections of the turbine 33kV switchgear and transformers and for energisation of the turbines.
- ▶ Provision of 132/33kV SAP to support the client and turbine supplier with HV switching works as required during the commissioning phase of the turbines through to handover to the clients appointed HV operations team.



The results:

Dorenell Wind Farm was completed in December 2018 after a very short construction period for a project of its given size and complexity. The project was completed in line with the clients construction program with no delays.

The project is the EDF Renewables largest onshore wind farm constructed to date and signals a continued working partnership with Powersystems UK



For more information

T 01454 318000

www.powersystemsuk.com