



66kV 275kV 33kV 11kV 132kV 400kV

CASE STUDY
15274

Dorenell Wind Farm

59 Wind Turbines with a connection capacity of 177 MW capable of powering 109,112 Homes



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 34 km of new site roads, upgrading of 2.2 km of forestry track and 5.3 km of existing site tracks
- ▶ Construction of a substation compound with a footprint of approximately 150 m x 75 m comprising 2 substation buildings
- ▶ Construction of approximately 40 km of cable trenches
- ▶ Installation of 59 No. 3 MW turbines with a maximum tip height of 126 m

The 177 MW 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 3.0 MW turbines with a tower height of 81 m and hub diameter of 90 m 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 No. 3 MW turbines generate at 33 kV and are arranged over 7 Arrays which feed into the wind farm substation. The voltage is then increased to 132 kV by 2 No. 120 MVA 33/132 kV transformers prior to connecting to the SHETL 132 kV distribution network.

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.



Dorenell wind farm is connected to the SHETL distribution network via 2 No. 132 kV overhead lines, approximately 22 km 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: 177 MW**
- ▶ **Connection Voltage: 132 kV**
- ▶ **Connection to Grid: SHETL distribution network at Blackhillock primary**
- ▶ **Size of site: 35 km²**
- ▶ **Energy for 109,112 households ***
- ▶ **Length of onsite access tracks: 42 km**
- ▶ **Length of onsite 33 kV cabling: 240 km**

**132
kV**



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 965 MW 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 132 kV 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

- ▶ 132 kV compound - produce 132 kV Compound Equipment general arrangement drawings, produce 132 kV equipment plinth details, provide 132 kV support structures designs & 132 kV overhead busbar layouts
- ▶ Windfarm substation 33 kV switchgear - specification of 33 kV 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
- ▶ 33 kV cable arrays - design of the cable trenches (with respect to the track layouts), Array SLD's, cable sizing and loss calculations, trench cross sections
- ▶ 132 kV and 33 kV 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 kV and 33 kV 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

Installation Works

- ▶ 132 kV compound - Installation of 132 kV Through Wall bushings, 132 kV busbar support structures and Busbars, 132 kV surge arrestors, 33 kV AIS support structures and busbars, 33 kV cable installation, control cabling between all 132 kV equipment and SCADA / Protection panels
- ▶ STATCOM compound - Installation of 2 Hybrid STATCOM systems comprising 2 STATCOM Inverter containers, 4 off 33/0.4 kV 5MVA Transformers, 4 off 12 MVar 33 kV switched capacitors including offloading of the main components, 33 kV cable installation, control cabling between all components and 33 kV switchgear, STATCOM control panels, SCADA panels
- ▶ 33 kV switchgear - Installation of 19 panel Schneider WS 33 kV 2500A 31.5 kA switchgear, installation of control cabling between switchgear and ancillary equipment / SCADA panels
- ▶ Windfarm Ancillary Equipment - Installation of 132 kV 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
- ▶ 33 kV Cabling - Installation of approximately 236 km of 800/400/240 mm Aluminium 33 kV cables between the main substation and the 7 turbine arrays
- ▶ Fibre Optic Infrastructure - Installation, splicing and OTDR testing of 12 km of 32/16F Pre-ducted fibre optic cable between the main substation and 7 turbine arrays
- ▶ HV Jointing - Installation of 270 33 kV single core straight joints, 51 Pfisterer 33 kV Size 3XL terminations, 420 33 kV bolted T connectors, 18 33 kV outdoor terminations
- ▶ Earthing - Installation of 59 turbine base earth mats, 50 km of horizontal 50 mm bare copper earth conductor (installed with array cables), installation of the main substation earth mat comprising of approximately 6 km of 50x4 mm copper earth tape



Commissioning Works

- ▶ 132 kV Compound - Tan Delta Testing of the 132/33 kV transformers and 132 kV overhead busbars, Functional testing of the 132/33 kV Main transformers control systems, cooling systems, tap changers & trip / alarm testing to protection & SCADA panels
- ▶ Functional testing of the ABB PASS 132 kV circuit breakers including CT testing, VT ratio testing, Interlocking and Trip / Alarm testing to Protection & SCADA panels
- ▶ VLF testing of the 33 kV cables between the main transformers and 33 kV switchgear. Ductor testing of all overhead busbar connections. Ductor testing of all earth mat connections. Commissioning of Transformer bund pumps
- ▶ 33 kV switchgear - Full commissioning of the 33 kV 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 132 kV 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
- ▶ 33 kV Cable Arrays - Sheath Testing, IR / VLF testing of all 33 kV 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 132 kV 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 132 kV 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 33 kV SAP for pre-energisation inspections and energisation / commissioning of the 33 kV STATCOM components. Undertake HV switching / issue safety documentation as required by the STATCOM supplier
- ▶ Provision of 33 kV SAP for testing and energisation of the Array cables, pre-energisation inspections of the turbine 33 kV switchgear and transformers and for energisation of the turbines
- ▶ Provision of 132/33 kV 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.

