EnergieKontor

Glenvernoch Wind Farm

Environmental Impact Assessment Report
Volume I
Chapter 3: Project Description and Construction Methods

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3 PROJECT DESCRIPTION AND CONSTRUCTION METHODS

Introduction

3.1 This chapter provides an outline description of the Proposed Development, the Site, and its surroundings. It also describes the issues and constraints that have influenced the layout of the Proposed Development and the evolution of the design.

3.2 Details of the construction, operational and decommissioning phases of the Proposed Development are also considered in this chapter.

3.3 Details of the iterative design process that resulted in the final design as set out in this chapter are detailed in Chapter 4.

3.4 The Proposed Development will consist of the construction, 35 year operation and subsequent decommissioning of up to 13 wind turbines including associated development.

The Site and Its Surroundings

3.5 The Proposed Development is located in Dumfries and Galloway, Scotland. The Site is centred at approximately easting and northing co-ordinates (E)235247, (N)573276. The closest settlements to the proposed turbines are the village of Glentrool, located approximately 2.8km north of the Site, and the town of Newton Stewart which is located approximately 7km south-east of the Site. The nearest main highway is the A714 which runs adjacent to the eastern boundary of the Site. The Proposed Development is located immediately north of Penninghame Forest and 0.3km east of Loch Ochiltree. The topography of the Site is gently undulating, with the lowest points being located adjacent to the A714 at approximately 50m AOD. There are pockets of small hills within the central areas of the Site rising to 90m AOD, 100m AOD and 105m AOD, before the land rises in the north west of the site at Butter Cairn (164m AOD) and Top of the Fell (184m AOD). The Site covers an area of approximately 780ha incorporating grassland and modified bog. The Site is principally used for grazing.

3.6 The nearest ecological designations to the Site are the Galloway Oakwoods Special Area of Conservation (SAC) and Wood of Cree Site of Special Scientific Interest (SSSI), approximately 0.4km south east of the Site, and the River Bladnoch SAC approximately 0.8km west of the Site. Other ecological designations within 10km of the Site include Ring Moss SSSI (4.4km south of the Site), Glentrool Oakwoods SSSI (5.2km north east of the Site), Blood Moss SSSI (5.3km west of the Site), Kirkcowan Flow SAC and SSSI (6.6km west of the Site), and Merrick Kells SAC and SSSI (8.5km north east of the Site).

3.7 There are a number of wind farms, either operational, approved or within the planning system, within 10km of the Site. Most notably these include Blair Hill Wind Farm (2km south east of the site) which is being scoped for 22 turbines at 250m tip height. Further afield are the operational Kilgallioch Wind Farm (5.8km west of the Site), the consented Kilgallioch

Wind Farm extension (5.3km west of the Site), the operational Airies Farm Wind Farm (7.9km west of the Site), and the consented Gass Wind Farm (10km south west of the Site).

Description of Proposed Development

3.8 The Proposed Development is illustrated on Figure 3.1 and would consist of the following principal components:

- 13 turbines up to 200m to blade tip;
- Associated turbine transformers;
- Associated turbine foundations;
- Hardstanding areas for erecting cranes at each turbine location;
- On-site tracks connecting each turbine;
- Underground cables linking the turbines to the substation;
- Borrow pits for the extraction of stone on-site;
- A temporary construction compound;
- On-site substation;
- Battery storage;
- A new access onto the A714; and
- Off-site highway works.

3.9 The Proposed Development would be time-limited to 35 years from the first date of final commission. The construction phase would last approximately eighteen months and decommissioning would last approximately six months.

3.10 The Proposed Development would provide up to 86MW of installed capacity, depending on the turbine model chosen. It is estimated by Energiekontor UK Ltd that this installed capacity could generate approximately 242 GWh of renewable electricity each year. This represents a site capacity factor of approximately 32.2%, which compares very favourably to the UK average onshore capacity factor of 26.34% over the period 2018-2022[1].

3.11 The renewable electricity generated by the Proposed Development could power over 74,700 homes on average each year[2]. This could save up to 104,060 tonnes of CO2 each year[3] for the operational life of the wind farm.

3.12 The carbon payback time of the Proposed Development is calculated to be 1.2 years. This has been calculated by comparing the loss of carbon from the site due to the wind farm development with the carbon-savings achieved by the wind farm in displacing electricity generated from fossil fuels.

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1 Based on Digest of UK Energy Statistics (DUKES): renewable sources of energy (updated July 2023)

[2] Based on an average annual UK domestic electricity consumption figure of 3,239KWh as set out in the BEIS publication "Subnational Electricity and Gas Consumption Statistics" (2024)

[3] [3] *Based on BEIS's standard carbon dioxide savings figure of 430g/kWh*

3.13 It should be noted that at the time of writing (October 2024), there is a technical fault with the online Carbon Calculator, and so under the circumstances the Carbon Calculator for Wind Farms on Peatlands spread sheet has been used in lieu of the online tool to present the carbon payback period of the Proposed Development. Once the online version of the tool becomes available, the Applicant will upload the data to the online version and publish the online reference code and results on the Energy Consents Unit portal.

3.14 The planning application includes an allowance for micrositing of the wind farm infrastructure. If planning permission is granted, the Applicant will commission detailed ground investigations and geotechnical surveys to determine the ground conditions. A 100m micrositing allowance is sought for the wind turbines (with restrictions in place to safeguard constraint buffers as applicable), and all other new elements of the Proposed Development.

3.15 The construction and decommissioning of the wind turbines, ancillary equipment and on-site infrastructure are described in more detail in the following sections of this chapter and within Chapter 4: Design Evolution. The principal elements include:

- **Wind turbines** – 13 wind turbines up to 200m to blade tip. The co-ordinates of the turbines are given in Table 3.1 below.
- **Turbine foundations** – The foundations of the turbines could be either reinforced concrete gravity structures or piled foundations. This would be dependent on the ground and hydrological conditions at the turbine location which would also determine the overall size of the support structure. Typical foundations for the size of turbine proposed are shown in Figure 3.3.
- **Crane hardstandings** – To provide a level and firm base for the cranes at the location of each turbine. Each would include an area of hardstanding for the cranes and ancillary cleared areas for working and storage (see Figure 3.7 for a typical crane hardstanding layout).
- **Site tracks** – To provide access for construction and maintenance vehicles from the Site access to the substation and wind turbines. These would be constructed at the commencement of the construction phase and would remain until the end of the decommissioning phase. They would have a running width of approximately 5m, the final width dependant on turbine supplier requirements. The tracks would feature local widening on corners and would be surfaced with coarse aggregate (see Figure 3.4 for typical track cross sections). New sections of track across areas of peat deeper than 1m would be floated.
- **High voltage and control cables** – To form power and control circuits linking each turbine to the on-site substation, cables would be placed in trenches (dimensions to be determined by the ground conditions but typically 0.5m wide by 1m deep) routed alongside the tracks (see 3.8 for typical cable trench construction details).
- **Upgraded watercourse crossings** – Following detailed pre-construction surveys there may be a requirement to upgrade existing watercourse crossings to accommodate construction traffic. The design of each crossing would be informed by detailed surveys as part of the pre-construction process and final details could be secured via a planning condition (see Figure 3.5 for a typical watercourse crossing).

- **Construction compound/storage area** – The compound to facilitate construction of the Proposed Development, and would also provide a storage area for plant and materials (see Figure 3.6 for a typical compound design);
- **Substation / switchgear housing building** – A 132kV substation is included to export the generated power via the off-site grid connection. The substation would be provided within a compound measuring approximately 72m x 50m. Two control rooms would be included within the compound, one for the wind farm operator and one for the network operator, and various items of electrical infrastructure would also be located outdoors within the compound (see Figure 3.9 and 3.10 for a typical substation / switchgear housing).
- **Energy Storage Compound** – An energy storage facility would be provided within the construction compound area. The final design would be confirmed following selection of the wind turbines; however, indicative details are provided on Figure 3.11. This illustrates that the energy storage equipment could be housed within ISO shipping containers within a compound area located within the construction compound.
- **New site access** – a new site access would be provided onto the A714. This would link the internal wind farm track network with the wider highway network.
- **Off-site access works** – Temporary highway accommodation works would be required to facilitate turbine component transportation to Site.

Table 3.1: Proposed Wind Turbine Coordinates (subject to a 100 m micrositing allowance)

Turbine	Easting	Northing	Tip Height (m)
1	236,168	571,679	200
2	235,498	571,188	200
3	235,649	571,858	200
4	235,584	572,437	200
5	234,878	572,026	200
6	234,640	572,479	200
7	235,346	572,861	200
8	235,065	573,190	200
9	234,360	572,903	200
10	234,908	573,677	200
11	234,198	573,322	200
12	234,463	573,898	200
13	233,856	573,713	200

Construction Methodology and Programme

3.16 This chapter provides an outline description of the methodology and programme that would be employed during the construction phase of the Proposed Development.

Anticipated Construction Programme and Timescales

3.17 It is estimated that the construction of the Proposed Development would take 18 months and would consist of the operations set out below in Table 3.3 and described later in this chapter.

3.18 The programme of construction deliveries shown in Table 3.3 has taken into account all that is currently known about the Site and Proposed Development. The precise duration and timing of each activity may be modified, as necessary, to take into account the findings of the pre-construction works and surveys. The use of construction method statements through a planning condition will provide the detail design and time frames.

Table 3.3: Indicative programme of construction activities

Activity	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
Site Mobilisation / demobilisation																		
Construction compound and access																		
Track and hardstanding construction																		
Construction of turbine foundations																		
Substation construction																		
Excavating tranches and laying electrical and communication cabling																		
Turbine delivery and installation																		
Site restoration																		
Turbine fit out and grid connection																		
Turbine commissioning																		

Construction Works

3.19 Construction works include:

- Highway modifications to enable vehicles to access the Site from the strategic and local highway network;
- Installation of construction compound / storage area for Site office facilities and storage of materials and components;
- The excavation of the borrow pits and extraction of aggregate for new tracks and hardstandings;
- Construction of new permanent Site tracks and the upgrading of existing sections;
- Installation of hardstandings and outrigger pads for the support of the cranes that would be used for the erection of the turbines;
- Construction of foundations for the support of the turbine structures;
- Wind turbine delivery and erection;
- Installation of transformers in separate housings alongside each wind turbine (if required);
- Installation of on-site High Voltage (HV) cabling, communication cabling and earthing underground adjacent to access tracks;

- Installation of Supervisory Control and Data Acquisition (SCADA) system;
- Construction of substation compound and control buildings;
- Commissioning of Site mechanical and electrical equipment; and
- Reinstatement, landscaping and habitat improvement, removal of temporary site offices, reseeding verges, borrows pit and areas around turbine bases.

3.20 The works would mainly follow the order detailed above, but many would be carried out concurrently to reduce the overall length of the construction programme. There would be construction phasing, with civil engineering works progressing in some areas whilst turbines are being erected elsewhere. In order to minimise disruption to land use, site restoration would be undertaken as early as possible in development areas.

3.21 Should planning permission be granted then it is likely that construction hours would be restricted via means of a planning condition imposed by the Energy Consents Unit (ECU) as part of the consent.

3.22 At this stage it is proposed that construction activities on site shall only take place between the hours of 07:00 to 18:00 on Monday to Friday inclusive and 07:00 to 13:00 hours on Saturday, with no construction works on Sundays or Bank Holidays, unless otherwise agreed with the ECU. Outside of these hours, there may be a requirement to take advantage of low wind speeds for the erection of turbines. In addition, turbine erection works cannot suddenly cease – in the event of a delay or complication it may be necessary to continue works beyond normal hours until they can end safely. Other activities that may take place outside these hours are limited to emergency works and dust suppression, unless otherwise agreed in writing by the ECU.

3.23 It is proposed that the delivery of any construction materials or equipment, other than turbine blades, nacelles and towers, shall be restricted to the above hours, unless otherwise agreed in writing by the ECU.

Pre-Construction Works

3.24 A detailed Construction Method Statement (CMS) would be produced by the construction contractors and agreed with the ECU prior to the commencement of works. The CMS might typically include:

- A description of construction methods;
- Pollution prevention measures, including dust, emissions, drainage design and materials management;
- Water quality management and monitoring;
- Mitigation measures;
- Management of construction traffic (typically addressed separately in a traffic management plan);
- Noise and vibration management; and
- Public liaison.

3.25 Prior to commencement of construction, detailed Site surveys would be undertaken to provide data for the final design of the civil and electrical engineering infrastructure for the

Proposed Development. These would comprise detailed topographical and geotechnical surveys.

3.26 The geotechnical survey would incorporate the excavation and sampling of trial holes at each turbine location and possibly boreholes to obtain information about the underlying strata.

3.27 All of the above will take cognisance of best practice guidance and be agreed with the ECU, Scottish Environment Protection Agency (SEPA), and other interested parties.

Temporary Highway Works

3.28 Swept Path Analysis assessments have been undertaken to identify whether the delivery route could accommodate the swept path of the abnormal load delivery vehicles carrying components such as the turbine blades and nacelles. This type of analysis is consequently used to identify any necessary works. The Swept Path Analysis can be found in the Abnormal Loads Assessment at Volume III Appendix 11.1 of the EIA Report.

3.29 The Swept Path Analysis identified two junctions close to the Site where offsite access accommodation works are likely to be required. These junctions are located at the A75 turning north onto the U52W Barnkirk Road and then turning left from U52W Barnkirk Road to head north on the A714.

3.30 The offsite access works required at the A75/U52W Barnkirk Road junction, shown in Volume II Figure 11.4 of the EIA Report, will include a temporary over run area to be used by long component delivery vehicles under traffic management which will include escort vehicles. Access to the area will be restricted via appropriate barrier system to prevent access to regular traffic during the delivery period. This would additionally provide a physical restriction between the A75 and St. Couan's road as a temporary replacement of the existing earthworks bund. A road plate platform system to meet the load capacity requirements will be used and the design will be validated prior to usage. There would be a need to relocate an existing overhead pylon during the construction and transportation phases, with the replacement to be agreed with the asset owner, and existing signage to be removed during the transportation phase which will be re-instated post-use.

3.31 The offsite access works required at the U52W Barnkirk Road/A714 junction, shown in Volume II Figure 11.5 of the EIA Report, will include, a temporary over run area to be used by long component delivery vehicles under traffic management which will include escort vehicles. Access to the area would be restricted by an appropriate barrier system to prevent access to regular traffic during the delivery period, and verge widening will be required to accommodate blade oversail.

3.32 Further detail of these enabling works would be provided in a detailed Traffic Management Plan

Construction Compound

3.33 The construction compound would be installed as soon as possible at the start of the construction phase, which would be the hub of construction operations.

3.34 The construction compound would be approximately 30 x 50m, and incorporated into a total area of 100m by 50m – the remaining space being used for overnight storage of plant vehicles and general storage. The indicative location takes account of the local terrain and its distance from watercourses, and further survey works would examine the efficacy of this location. Space would be provided for 'portacabin' style site offices; welfare and mess facilities; secure containers for tool and equipment storage; an area for the storage of various materials and small components with bunding as required; and car parking areas. The compound would be secured by means of a perimeter fence and lockable gates if deemed necessary.

3.35 On completion of construction, the site compound would be removed and the area reinstated to its former condition in accordance with an approved method statement.

Energy Storage Compound

3.36 Either prior to or following the commissioning of the wind turbines, an energy storage facility would be constructed utilising part of the temporary construction compound. The energy storage facility would comprise a range of batteries housed within standard 12.2m x 2.4m ISO shipping containers.

3.37 The final details of the energy storage facility are dependent on the wind turbine model selected for the Proposed Development. However, it is anticipated that the overall capacity will be anywhere up to 10MW. A Power Conversion System (PCS) container, of similar dimensions to the battery containers, would be located adjacent to each battery storage container. The contents of the container would be factory assembled and tested. A transformer located either within the PCS container or externally would transform Low Voltage (LV) to EHV or High Voltage (HV) depending on the voltage of the point of connection to the local network, or vice versa. The battery and PCS containers would be connected via underground cables. If the unit transformer is located externally, underground cables would connect the PCS and transformer. Underground cables would take power to and from the Proposed Development's substation, switchgear, communications and protection equipment would be located within the Proposed Development's control building.

Site Tracks

3.38 In summary the Proposed Development requires approximately 9.5km of tracks.

3.39 The access tracks required, whether cut or floating, would have a running surface of approximately 5m with local widening at bends. The actual running width would be dependent on eventual turbine selection and manufacturer requirements. The routing of new access tracks has been designed to minimise track length, and to avoid environmental and technical constraints such as watercourse crossings and critical slope angles where practical to do so.

3.40 The construction of new cut tracks would involve the stripping and storage of topsoil and peat deposits. Geotextile membranes would only be installed if required. Mineral soil and subsoil excavated during cut track construction would be set aside for re-use in site reinstatement at a later date. The crushed stone track would be laid to a nominal depth of up to 350mm and aggregates required for the access tracks would be obtained from the on-site borrow pits as well as local suppliers. The tracks would incorporate swales to attenuate surface water flow in accordance with sustainable drainage principles.

3.41 In order to prevent any fine, in-situ clayey, subsoil material from migrating into the free draining granular fill of the site track, a geotextile layer may need to be laid on the underlying subsoil beneath the site tracks. General ungraded, granular fill would then be placed on top of the geotextile layer.

3.42 The fill would be placed to a depth corresponding approximately to the original ground level. This would be levelled and compacted by compaction equipment and by the construction traffic that uses the track for access to the various parts of the Site.

3.43 Cross drains would be designed to divert the water at various points along the track alignment and to transmit it underneath the track. As far as is practicably possible, any water collected would be re-distributed to replicate the original surface / sub-surface flows.

3.44 On completion of construction the remaining excavated mineral soil and subsoil would be levelled alongside the access tracks. A typical new track cross section is shown on Figure 3.4.

3.45 Where new tracks are proposed across areas of peat deeper than 1m, floating construction techniques would be used. Generally, the process would incorporate an approximately 7m to 8m wide strip of geogrid laid on the surface of the turf. A layer of approximately 700mm to 1000mm of crushed stone would then be laid on the geogrid to form the track, with the edges of the track forming steep batter slopes raised above the soft surface. The track would incorporate an upper layer of approximately 250mm hard-wearing rock and the geogrid system, which would be designed for floating road construction, would aim to limit the potential for tracks to penetrate into the ground.

3.46 The access tracks would be retained throughout the operational life of the wind farm development to enable maintenance of the turbines.

Crane Hardstandings and Outrigger Pads

3.47 At the location of each turbine foundation a hardstanding area would be constructed to provide support for the cranes used for turbine erection. These hardstandings could also be used for storing turbine components, such as the nacelle, until they are installed. When not being used for turbine erection, the crane hardstanding may also be used as passing places at each turbine location where appropriate.

3.48 The size of turbines proposed for this project would normally require the use of a main crane of up to 1,000 tonnes capacity. A smaller tail crane would also be used to aid lifting of the larger components.

3.49 The layout of the hardstandings for this project is shown on 3.7. Each hardstanding would cover an area of approximately 32m wide by 50m long, although dimensions may vary with turbine selection and manufacturer requirements.

3.50 The hardstandings would be constructed using the same criteria and methods as those used for the site tracks. The thickness of stone fill in these areas is normally similar to the site track construction, but may be increased due to the axle loading from the cranes. This would depend on the characteristics of the vehicles used for the erection of the turbines.

3.51 The precise design of the crane hardstandings would be determined by the ground conditions at the turbine locations in a similar way to the design of the site tracks described above. The crane hardstanding would be of cut design.

3.52 Ancillary areas around the crane hardstandings would be cleared and used for storage or as working areas.

3.53 On completion of construction the hardstanding areas at each turbine location would be retained but allowed to re-vegetate naturally. Their retention is so that they are available for use in the event of a major component replacement during the operation of the wind farm and for decommissioning.

Wind Turbine Foundations

Design Principles

3.54 The design of the wind turbine foundations would be a function of the loads from the turbine and the topographical, geotechnical and hydrological Site conditions. For the conditions typically encountered at the Site, the wind turbine foundations would likely be designed as reinforced concrete gravity structures and be subject to a final design depending upon ground conditions. A typical foundation for the size of turbine proposed for this project is shown on Figure 3.3.

3.55 The loads from the turbine, combined with the ground and hydrological conditions at the turbine location would also determine the overall size of the support structure. The underside of the foundations would be located in subsoil at a maximum depth of between 3.0 – 3.5m below ground level.

3.56 The bearing capacity of the ground is usually not critical to the design, which is often driven by the groundwater conditions at the position of the tower.

3.57 Where the groundwater is below the bottom of the foundation, then the structure would be designed for dry and drained conditions, i.e. with no water pressure on the bottom of the foundation. Where there is a high groundwater table (above the underside of the foundation) the foundation would be designed for buoyant conditions arising from water pressure acting upwards on the underside of the structure.

Construction Methods

3.58 The first task in constructing each wind turbine foundation would be to remove any mineral soil to the perimeter of the proposed foundation excavation. The underlying subsoil would then be excavated to the required foundation depth, normally by conventional construction equipment. Excavated materials would be set aside for re-use as backfill around the foundation following completion of construction. Detailed method statements for materials handling would be prepared in accordance with conditions imposed by the ECU on the granting of a planning consent.

3.59 The foundation formation would then be prepared to receive concrete blinding by placing timber shuttering around the edge of the excavation. Concrete blinding would be poured on the foundation formation to level the area in preparation for fixing the steel reinforcement bars. The blinding would be a weak mix of concrete with low slump and would normally be placed fairly dry. Little if any loss of cement would therefore occur during placement of the lean-mix levelling layer.

3.60 A bottom mat of reinforcement would be placed on the weak mix concrete blinding. Additional reinforcement would be fixed to the bottom mat to form the main reinforcement cage for the foundation. Starter bars would then be fixed to the main cage to form the up stand, which would support the bottom tower section. Temporary shuttering would be placed on the reinforcement cage to ensure that there would be sufficient concrete cover to the top layer of steel. Side shuttering would also be positioned around the cage to form the sides of the concrete slab and to prevent loss of concrete and cement paste into the ground.

3.61 Concrete would then be poured to form the main slab either by a concrete pump or by being placed in small hoppers / skips that would be lifted over the area being concreted and then tipped. Conventional concrete lorries of approximately 8m^3 capacity would be used for each foundation. During the pour, the concrete would be compacted using poker vibrators. As the concrete placements are completed, the temporary shuttering on the top steel would be removed, and the concrete tamped and floated to a smooth finish.

3.62 A curing compound is often used to stop the concrete drying out too quickly (which can lead to hairline cracking of the top surface). This is sprayed onto the surface concrete. Plastic sheeting or hessian may also be used to assist with curing of the concrete if considered appropriate. This reduces evaporation of water at the surface of the concrete and also assists in preventing shrinkage of cracking material.

Turbine Delivery and Erection

3.63 Mechanical installation would comprise the delivery and erection of turbine components at the turbine locations. Delivery of the turbine components would be undertaken by specialist contractors using purpose built vehicles, as described in more detail in Chapter 11. Erection of the turbine components is normally undertaken by the turbine supplier using specialist heavy lifting subcontractors and cranes.

3.64 The connection of the tower to the foundation would be made by using holding down bolts or with a short cylindrical steel section embedded in the foundation slab. The choice of holding down system would depend on the wind turbine supplier. The sequence of construction of the connection between the tower and foundation depends on which system is used.

3.65 For a holding down bolt solution, the upstand foundation anchor bolt assembly would be placed, along with additional reinforcement in the upstand following completion of the base slab. At this stage, partial backfilling of the foundation would be undertaken to aid access to the turbine location during the rest of the foundation construction. Once the upstand reinforcement and anchor bolt assembly is complete, timer or steel shutters would be placed to form the upstand of the turbine foundation.

3.66 If the tower is connected to the foundation by a steel cylindrical section then the upstand reinforcement and holding down bolts would not be required. For this holding down solution, there would be only one phase of concrete pour because the embedded section would form a permanent shuttering for the mass concrete inside it.

3.67 Electrical ducts would then be placed through the shuttering and reinforcement (for the holding down bolt solution), or the steel cylinder. These would include conduits for the high and low voltage cables and earthing tapes. The configuration of the ducts and the earthing tape would depend on the turbine model being used and the nature of the electrical layouts. The holding down bolts are held in place within the shuttering by a template which would be fixed to the shuttering. Concrete would then be poured to form the foundation upstand. The upstand concrete would be compacted with poker vibrators in a similar way to that described for the base slab.

3.68 The wind turbine earthing ring and tails would then be placed within the backfill. In some cases, earthing rods would be needed around the foundations. The need for these would depend on the ground conditions at the Site. If required, they would be installed as self-boring rods, drilled into the ground, in contact with the weathered rock. The depth of the rods would depend on the electrical characteristics of the ground. Once the earthing ring is completed, the cable ducts would be extended to the edge of the foundation and backfilling to the top of the upstand would commence.

3.69 The wind turbine foundation would then be backfilled. Weathered rock material from the foundation excavation would be used for the bulk of the backfill. It would then be placed in thin layers and compacted mechanically.

3.70 The bottom section of the wind turbine tower would be placed over the foundation bolts and fixed to the foundation. Cementitious grout would be placed between the bottom flange of the tower and the foundation. The grout would be retained in position by temporary formwork, which would prevent it from spilling outside the foundation. The material would be allowed to cure and the nuts would be tightened to pre-tension the bolts.

3.71 The area around each turbine tower and over the turbine foundations would be reinstated by using topsoil stripped during the foundation construction excavation and other surplus excavated material.

Wind Turbine Transformers

3.72 In order to carry the power generated to the local electricity network each turbine would require a transformer to step up to a high voltage. Turbine transformers can either be located within the nacelle, within the turbine tower or adjacent to the base of each tower, depending on the wind turbine model selected and the supplier's specification.

High Voltage Cabling

3.73 The turbines would be interconnected using armoured underground cables placed in trenches forming a power circuit within the Site. The underground cables would be taken into the on-site substation where the electrical control equipment would interface with the local distribution network.

3.74 The design of the high voltage (HV) cable trenches would be a function of the electrical rating of the cables, the ground conditions and the depth of protection required for the cables. The electrical rating and the ground conditions would provide data to assess the thermal performance of the cables. This would determine the likely spacing between each electrical circuit and therefore the width of the trench. Typical cable trench construction details are shown in Figure 3.8.

3.75 Cable trenches would be excavated using conventional construction equipment. The mineral soil would be dug out and set aside for re-use in the reinstatement of the trenches. The trench would then be excavated to the required overall depth. Subsoil material from the excavation would be temporarily stockpiled alongside the trench, but kept separate from any mineral soil. Detailed method statements for materials handling would be prepared in accordance with a restoration and management plan.

3.76 The cable would be placed on a bed of previously dug stone free excavated soil material. The trench would then be backfilled with excavated subsoil taken from the temporary stockpile alongside the trench and the top of the excavation reinstated with topsoil. Cable tiles or a warning marker tape would be laid in the trench during backfilling at a pre-specified depth. Any surplus excavated material would be stockpiled at an agreed location and used later in the reinstatement of the Site.

Supervisory Control and Data Acquisition System

3.77 Monitoring and controlling the performance of the wind turbines would be achieved by way of a sophisticated Supervisory Control and Data Acquisition (SCADA) system. The SCADA system would gather data from all of the turbines and provide the facility to control them from a remote location. Communication cables connecting to each turbine would be buried in the electrical cable trenches (described above) to facilitate this.

Site Substation

3.78 A 132kV on-site substation would be created in a compound area measuring approximately 72m x 50m. Fencing would be included around the perimeter of the compound to prevent unauthorised access. The compound would include various items of outdoor electrical infrastructure and two control buildings, one for the wind farm operator and one for the grid network operator. Wind farm substation buildings are typically of conventional masonry construction, on concrete foundations with a pitched roof constructed of trussed rafters finished in slates or tiles. The external finishes to the substation buildings would be subject to the approval of the ECU prior to construction. The buildings would not be permanently manned as the wind farm would be controlled remotely from a central control facility. A typical substation building is illustrated on Figure 3.9.

Grid Connection

3.79 An off-site grid connection would be required to take the power generated from the wind turbines into the transmission network. The final details of the grid connection including the precise route and an assessment of any impacts on the environment would be determined by the Transmission Network Operator (TNO) at a later date and may be subject to a separate design and consent process.

Commissioning of Mechanical and Electrical Equipment

3.80 The testing and commissioning of a wind farm is normally undertaken by the turbine supplier. It involves a series of tests on the high voltage electrical network, the electrical equipment in the turbines and control building and the SCADA system. No construction activities are required and it only entails the use of small vehicles.

Reinstatement and Removal of Temporary Works

3.81 On completion of construction, all temporary fencing and the temporary construction compound would be removed from Site and all areas disturbed by the works would be reinstated. Reinstatement works would be subject to a Construction Method Statement to be approved by the ECU.

Wind Farm Operation

Operational Timescales and Decommissioning

3.82 Following construction and commissioning, the Proposed Development would be operational and generating electricity for a period of approximately 35 years, after which it would be decommissioned and removed. Any alternative course of action, for example life extension or repowering, would require the submission of a new application which would be considered in accordance with whatever planning legislative and policy context was in place at the time.

3.83 If a further application is not submitted decommissioning would involve the total removal of above-ground infrastructure in accordance with an approved method statement. A decommissioning bond would be agreed with Dumfries and Galloway Council and this is expected to be enforced by way of an appropriately worded planning condition.

Maintenance

3.84 Wind farm maintenance would be carried out by the turbine supplier and later by suitably qualified contractors to carry out regular inspections and maintenance activities.

3.85 Routine maintenance and servicing would necessitate monthly visits to the Site by a maintenance crew (if necessary), typically two persons in a small van or similar sized vehicle. Maintenance staff would be able to park on the crane pad for each turbine and would utilise access tracks for maintenance visits to the substation.

3.86 Routine servicing would include the performance of tasks such as maintaining bolts to the required torque, adjustment of blades and inspection of welds in the tower. In addition, oil sampling and testing from the main gearbox would be required and oil and components replaced at regular intervals.

3.87 In the event of any unexpected breakdowns on-site, such as the failure of a generator, appropriate maintenance works would be carried out as soon as practicable. The replacement of major components may require a crane and heavy transport vehicles.

3.88 On-going track maintenance, if required, would generally be undertaken in the summer months when tracks are dry. Safe access for maintenance purposes would be maintained all year round. Maintenance for other purposes, for example landscaping, habitats or fencing, would be carried out all year round as required.