Mid Moile Wind Farm

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

December 2021

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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 fifteen wind turbines with tip heights between 200 m and 230 m including associated ancillary infrastructure such as access tracks and a control building.

Consultation

3.5 A wide range of stakeholders have been consulted on the Proposed Development, and the feedback received has been considered during the iterative design process described in Chapter 4 and documented in each topic area where relevant and incorporated into the design wherever possible.

The Site and Its Surroundings

3.6 The Site is located within the Dumfries and Galloway (DGC) administrative area and consists almost entirely of commercial forestry. It lies across the low hills of Mid Moile and Brockloch, which are set back on rising ground from the eastern side of Loch Ryan.

3.7 Glen App wind farm is located immediately to the north of the site, within South Ayrshire, and the consented Stranoch wind farm lies around 2km to the east.

3.8 The nearest settlements are Cairnryan (2.5km west) and Stranraer (9km south). The surrounding landscape is scattered with farms and other rural dwellings.

3.9 The north-west corner of the Site abuts part of the Rhins Coast Regional Sceneic Area and the Glen App Coast & Hills Local Landscape Area extends north from this into South Ayrshire. There are no nationally designated landscapes in close proximity to the Site.

Description of Proposed Development

3.10 The Applicant is seeking to construct, operate and decommission a wind farm comprising up to 15 wind turbines along with associated ancillary infrastructure.

3.11 The Proposed Development would be operational for a 35 year period after which it would be decommissioned and the land restored, unless the landowner requests continued use of tracks and pads which would then be subject to agreement with DGC.

3.12 The Proposed Development layout is illustrated in Figure 3.1 and would consist of the following principal components:

- Up to fifteen turbines, of which eight would be up to 230m to blade tip and seven up to 200m;
- 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;
- New watercourse crossings;
- Up to three borrow pits for the extraction of stone onsite;
- A temporary construction compound;
- On-site substation;
- Localised 'keyhole' and other infrastructure forestry felling; and
- New and upgraded site access onto the A77.

3.13 The construction phase would last approximately twelve months and decommissioning would last approximately six months.

3.14 The Proposed Development would provide up to ~99MW of installed capacity, depending on the turbine model chosen. It is estimated by Energiekontor UK Ltd that this installed capacity could generate approximately 374 GWh of renewable electricity each year. This represents a site capacity factor of approximately 43%, which compares very favourably to the UK average onshore capacity factor of 26.6% over the period 20012-2016[1]. The renewable electricity generated by the Proposed Development could power over 96,000 homes on average each year[2]. The Carbon Balance and Generation Report at Technical Appendix 3.1 provides further details on the carbon saving benefits that the Proposed Development could deliver.

3.15 Final turbine selection would be made following the granting of consent and the EIA has been undertaken on the basis of a candidate turbine design consisting of the following:

- Horizontal axis type with a rotor consisting of three blades;
- Maximum height of the vertical tip blade of up to 200m and 230m;
- Turbines would generate power for all wind speeds between circa 3 m/s and 25 m/s; and

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1 Based on Digest of UK Energy Statistics (DUKES): renewable sources of energy (updated July 2017)

2 Based on an average annual UK domestic electricity consumption figure of 3,889KWh as set out in the BEIS publication "Energy Consumption in the UK" (2017)

- At wind speeds greater than 25 m/s the turbines would shut down for self-protection.

3.16 The application for consent includes an allowance for micrositing of the wind farm infrastructure. If consent is granted, the Applicant will commission detailed ground investigations and geotechnical surveys to determine 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 elements of the Proposed Development.

Associated Development

3.17 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** – Fifteen wind turbines (see Figures 3.2a,b for typical wind turbine elevations). 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. Depending on the turbine model chosen it would be surfaced with coarse aggregate (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 associated infrastructure and wind turbines. These would be constructed at the commencement of the construction phase and would remain until the end of the decommissioning phase. The tracks would feature local widening on corners and would be surfaced with coarse aggregate (see Figure 3.4 for typical track cross sections). Site tracks include new sections of track and upgrading of existing access tracks. New sections of track across areas of peat deeper than 0.5m would be floated.
- **Temporary construction compound / storage area** - to provide a secure area for site office facilities and storage of materials and components. The compound will adjoin the access track, and would also provide a storage area for plant and materials and is temporary during the construction phase (see Figure 3.6 for a typical construction compound design);
- **Transformer housings** - the transformers to step up the voltage exported from each turbine would either be placed within the wind turbines themselves, or in a small secure external transformer housing placed next to each wind turbine tower, depending on the final turbine choice;
- **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 x 1m deep) routed alongside the tracks (see Figure 3.8 for typical cable trench construction details);
- **Substation** – as the connection point for the electricity generated, a 60m long x 40m wide compound comprising a single storey substation building together with external electrical equipment and transformers (see Figure 3.9, 3.10 for a typical substation / switchgear housing and layout);

- **New/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);
- **Areas of forestry felling and replanting** – 'Keyhole' felling would be required around the turbine positions. There would be felling required along the access tracks within the Site to allow turbine delivery (see Chapter 13 for further details);
- **Site access** – A new and upgraded site access would be provided onto the A77 at its junction with the U152W leading to Little Laight (as illustrated on Figure 3.1a). A new access track would lead from this access point towards the wind farm, providing a more suitable gradient for construction traffic and turbine deliveries than the U152W (which forms part of / and leads to Core Path 429, Loch Ryan Coastal Path) which is steep in places. The Proposed Development seeks consent for this new and upgraded site access, together with the associated access track, to remain in perpetuity after the wind farm has been decommissioned so that it may be used for future timber extraction activities by the operators of Loch Ree Forest.

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

Turbine	Easting	Northing	Turbine Height to tip
1	208348	571355	200 m
2	209065	570903	200 m
3	209480	570658	200 m
4	209737	570202	200 m
5	209923	569750	200 m
6	209002	572057	200 m
7	209231	571655	200 m
8	209628	571366	230 m
9	210093	571136	230 m
10	210309	570661	230 m
11	210547	570198	230 m
12	209630	572192	230 m
13	210149	571930	230 m
14	210798	571418	230 m
15	211206	570377	230 m

Construction Methodology and Programme

3.18 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

3.19 It is estimated that the construction of the Proposed Development would take 12 months and would consist of the operations set out below in Table 3.2 and described later in this chapter.

Table 3.2: Indicative programme of construction activities:

Activity	1	2	3	4	5	6	7	8	9	10	11	12
Site Mobilisation / demobilisation												
Construction of construction compound and access point												
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												

3.20 The programme of construction deliveries shown in Table 3.2 has taken into account all that is currently known about the Site and the 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 (CMS) through a consent condition will provide the detailed design and time frames in addition to a Construction Environmental Management Plan (CEMP).

Construction Works

3.21 Construction works include:

- Temporary highway modifications to enable vehicles to access the Site from the highway network;
- Installation of construction compound / storage area for Site office facilities and storage of materials and components;
- The felling of existing areas of forestry to make way for ground infrastructure, with suitable buffers to allow normal operation of the wind farm;
- 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 existing access tracks;
- Installation of Supervisory Control and Data Acquisition (SCADA) system;
- Construction of substation;
- Commissioning of Site mechanical and electrical equipment; and
- Reinstatement, landscaping, removal of temporary Site offices, reseeding verges

3.22 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.

3.23 Should consent be granted then construction hours would be restricted via means of a planning condition imposed as part of the consent. 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 DGC.

3.24 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.

3.25 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 DGC.

Pre-Construction Works

3.26 A detailed CMS would be produced by the construction contractors and agreed with DGC prior to the commencement of works. The CMS would typically include a description of:

- General 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 (TMP);
- Noise and vibration management; and
- Public liaison.

3.27 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.

3.28 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.

3.29 All of the above will take cognisance of best practice guidance and be agreed with DGC, Energy Consents Unit, Scottish Environment Protection Agency (SEPA) and other interested parties.

Construction Compound

3.30 The temporary construction compound, which would be the hub of construction operations, would be installed at the start of the construction phase.

3.31 The construction compound would be approximately 100 x 50 m. The indicative location (Shown on Figure 3.1) 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.

3.32 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.

Site Access

3.33 A new access track is proposed with a new junction off the A77. The preferred track alignment is shown on Figure 3.1 and will run generally perpendicular to the Loch Ryan Coastal Path before heading north east into the Site. The track would accommodate abnormal loads and would also be used during construction. This application also seeks permission for this new access to remain in perpetuity after the wind farm has been decommissioned so that it can be used by the operators of Loch Ree Forest for timber extraction. The access would be gated at its junction with the A77 and permanently closed when not in use by wind farm or forestry traffic. The junction layout arrangement is shown on Figure 3.1a and provides the necessary visibility splays to ensure it meets highway safety requirements when entering or exiting in a northern or southern direction.

3.34 Construction of the access, temporary traffic control measures and its detailed design and agreed alignment, can be subject to the Traffic Management Plan condition in consultation with the transport authority for the wider development (see Chapter 11 Traffic and Transport). An additional condition to cover the design of track, including any associated landscaping and gate finish and lockable bollards at the A77 junction can also be imposed. Although the track crosses the Coastal path near to the entrance to the main site, this can also be controlled by condition without the requirement for temporary diversion. It is not anticipated that there would be any notable conflict with the use of the Coastal path.

Abnormal load route

3.35 Turbine components would be delivered to an appropriate Port of Entry (PoE) and then transported as abnormal loads, given their size and weight, from the selected Port of Entry (PoE) via the public road network

3.36 Initial assessment has identified the likely PoE for the turbines would be the port at Cairnryan to the south of the site, from where the abnormal load vehicles would navigate onto the A77 trunk road and head north to the Site access point. Abnormal loads may require a police escort and would likely restrict traffic along the route for a short duration of time. An Abnormal Loads Assessment (ALA) report will be prepared post-planning consent which contains further details of the proposed route and mitigation measures required to facilitate the movement of abnormal loads between the PoE and the Site access point from the A77. This can be secured by planning condition.

3.37 The abnormal loads route is shown on Figure 11.3.

Site Tracks

3.38 In summary the Proposed Development requires approximately 13.7km of tracks, which is comprised of:

- The use of and upgrading (where necessary) of approximately 6.7km of existing tracks; and
- The construction of approximately 7km of new track.

3.39 Where new sections of access track are required, whether cut or floating, these would have a running surface of approximately 4.5-5m 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 fundamental aspects of track reinstatement including reuse of peat along verges of floating track is considered within the Peat Management Plan. The crushed stone track would be laid to a nominal depth of up to 350mm and aggregates required for the access tracks could be obtained from on-site borrow pits as well as local suppliers (see Chapter 11 Traffic and Transport). 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 0.5m, 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 Proposed Development to enable maintenance of the turbines.

Borrow Pits

3.47 Three borrow pits have been identified (See Figure 3.1) and could be utilised as a source of aggregate for the construction of the Proposed Development. It is anticipated that a significant element of aggregate could be won on-site, with the remainder imported. However, as a worst-case scenario for the assessment of environmental impacts, it has been assumed that all material will be transported to Site. Further details on traffic movements are provided in Chapter 11: Traffic and Transport.

3.48 The ground investigations necessary for the detailed design of the borrow pits would be undertaken post consent. This will include the depth, orientation, and design of the borrow pits within the search areas. To ensure that the detailed design of the proposed borrow pits are acceptable in terms of noise, landscape and other environmental considerations a planning condition can be imposed requiring a site-specific scheme for the working and restoration of the borrow pits to be submitted for the approval of DGC in consultation with SEPA.

Forestry Felling

3.49 Forestry within the Site comprises a mixture of mostly mature forestry. A degree of forestry felling would be required to allow new sections of access track, turbines and other infrastructure to be constructed.

3.50 Where turbines are to be sited within or near to mature forestry, there exists the potential for wind blow should the coupe only be partly felled. As a consequence, affected coupes may be required to be felled completely and replanted back to a certain radius around each turbine. Replanting would take place in-situ as far as possible. Turbines which are located within or near to young forestry only require keyhole felling of a radius that would be determined on turbine selection.

3.51 Further information of areas to be felled and replanted is provided in Chapter 13.

Crane Hardstandings and Outrigger Pads

3.52 At the location of each turbine foundation a hardstanding 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.

3.53 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.

3.54 The layout of the hardstandings is shown on Figure 3.7. Each hardstanding would cover an area of approximately 1,925m^2, although dimensions may vary with turbine selection and manufacturer requirements.

3.55 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 depending on the axle loading of the cranes. This would depend on the characteristics of the vehicles used for the erection of the turbines.

3.56 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.

Wind Turbine Foundations

Design Principles

3.57 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 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.

3.58 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 – 3.5 m below ground level.

3.59 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.

3.60 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

3.61 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 on the decision consent.

3.62 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.

3.63 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.

3.64 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.

3.65 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

3.66 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: Traffic and Transport. Erection of the turbine components is normally undertaken by the turbine supplier using specialist heavy lifting subcontractors and cranes.

3.67 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.

3.68 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.

3.69 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.

3.70 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.

3.71 The wind turbine earthing rund 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.

3.72 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.

3.73 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 buts would be tightened to pre-tension the bolts.

3.74 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

3.75 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

3.76 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.

3.77 The design of the 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.

3.78 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.

3.79 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

3.80 Monitoring and controlling the performance of the wind turbines would be achieved by way of a sophisticated 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

3.81 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. A security slab of reinforced concrete can be incorporated into the roof construction. In most cases, cable ducts and trenches are formed in the slab of the building. The trenches can be up to 1.5 m deep depending on the electrical requirements and the layout of the Site, and also on whether the switchgear in the control building utilises top or bottom entry cables. A typical substation building is illustrated on Figure 3.9 and Figure 3.10.

3.82 The proposed substation building would be constructed in the location shown in Figure 3.1. The new substation building would be a single storey building, a maximum of 15 m long x 10 m wide with a standard ridge height. It would be constructed using locally sourced materials in a style to complement the local vernacular. The external finishes to the substation building would be subject to the approval of DGC prior to construction. The substation would house switchgear and control equipment needed for the grid connection and would also provide some secure storage space that may occasionally be required for the wind farm. The building would not be permanently manned as the wind farm would be controlled remotely from a central control facility. External electrical equipment and transformers would be included within the substation compound.

Grid Connection

3.83 An off-site grid connection would be required to take the power generated from the wind turbines into the local electricity distribution 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 local Distribution Network Operator (DNO) at a later date and may be subject to a separate design and consent process.

Commissioning of Mechanical and Electrical Equipment

3.84 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 would be required, and it only entails the use of small vehicles.

Reinstatement and Removal of Temporary Works

3.85 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 in accordance with a Construction Management Plan.

Wind Farm Operation

Operational Timescales and decommissioning

3.86 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, or alternatively, a further planning application could be made to extend the period of operation.

3.87 If a further application is not submitted, decommissioning would involve the total removal of above-ground infrastructure. This would involve retention of existing access tracks for forestry operations. Reinstatement of the Site would be carried out in accordance with an approved method statement. A decommissioning bond would be agreed with DGC and this is expected to be enforced by way of an appropriately worded planning condition.

Maintenance

3.88 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.

3.89 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.

3.90 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.

3.91 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.

3.92 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.