2 PROPOSED DEVELOPMENT

2.1.1 The Proposed Development is located on the Dalnessie Estate, approximately 13 km to the north-east of Lairg in the Scottish Highlands, near the A836–A838 Junction. The location of the Proposed Development site is shown in **Figure 1.1**.

2.2 Need for the Development

2.2.1 The UK and Scotland's current climate change ambitions are amongst the highest in Europe. The Scottish Government declared a climate emergency in May 2019 and has recently passed the Climate Change Bill which has passed into law the requirement for a 100% reduction in CO_2 emissions by 2045 and an interim target of 70% reduction in emissions by 2030.

2.2.2 Looking beyond to 2030, the Scottish Energy Strategy target for 50% of total energy demand (including from heat and transport) from renewable sources implies a further substantial increase in delivery of renewable energy. As such, the Scottish Government has encouraged all forms of renewable and low carbon solutions for meeting these energy target.

2.2.3 The Scottish Government's Onshore Wind Policy Statement 2017 recognises both the continuing important role of onshore wind and the challenges it now faces in a subsidy-free environment. Further detail relating to the Energy Strategy, Onshore Wind Policy Statement and ongoing demand for renewable energy generation is provided in the separate Planning Statement accompanying the application.

2.3 The Developer

2.3.1 ESB Asset Development UK Limited, part of ESB, Ireland's premier energy company, established in 1927 is a leading independent power generator in the UK market. ESB has a track record of over 20 years as a successful investor in the UK since commissioning one of the first independent power generation plants at Corby in Northamptonshire in 1994. ESB owns and operates wind farms across the UK and Ireland with a current generating capacity of 600 MW.

2.4 Development Description and Surrounding Land Use

2.4.1 The Proposed Development is located on the Dalnessie Estate. The land is currently used as a sporting estate and for rough sheep grazing. Surrounding land uses include commercial forestry, agriculture, sporting and recreational uses.

2.4.2 There are two residences on site, one that is used occasionally by the landowners and guests, with the other being a full-time residence for the Estate Manager. There are several other agricultural buildings on site near the residences. Vehicular access to the property is gained via an access track to the west. The track is owned by the landowners of the Dalnessie Estate, with the land to either side of the access track owned by Forestry and Land Scotland (FLS).

2.5 Site Selection Rationale

2.5.1 The applicant identified potential sites for large scale onshore wind energy development throughout Scotland through a constraints-based approach, with sites being evaluated against the following criteria, in no particular order:

- Avoiding 'Group 1' areas from Scottish Planning Policy (SPP);
- Avoiding SPP 'Group 2' national and international designations;
- Development Plan policy;
- Landscape character;
- Distance from dwellings;
- Cumulative impact with other wind farm developments;
- Exposed sites with good wind speed;
- Feasibility of grid connection;
- Area topography, including gradients, exposure, watercourses and land use;
- Feasibility of access for abnormal indivisible loads (AIL); and
- Compatibility with aviation interests.

2.5.2 An essential element of the search for potential sites is the interest of landowners in onshore wind energy development. In that regard, and taking the criteria above into account, the Proposed Development site initially became a viable proposition for ESB following discussions with the landowners, who were interested in exploring the possibility of harnessing such a development on their estate.

2.5.3 The Proposed Development area was confirmed as a good site for development following further feasibility assessments.

2.6 Consideration of Alternatives

2.6.1 According to the EIA regulations, the EIA Report should include: "a description of the reasonable alternatives studied by the developer, which are relevant to the development and its specific characteristics, and an indication of the main reasons for the option chosen, taking into account the effects of the development on the environment."

2.6.2 With respect to the Proposed Development the alternatives considered were as follows:

- different turbine and infrastructure layouts/locations within the Proposed Development site,
- different turbine heights/dimensions,
- different access routes to and from the Proposed Development site in terms of delivery of AIL.

2.6.3 The Proposed Development design and layout was adapted and altered in response to environmental constraints and consultation feedback. The Proposed Development went through a series of four design iterations. Changes to the layout included decreasing the number of turbines, reducing turbine height to blade tip and changing turbine positions.

2.6.4 A summary of the layout iterations is included within **Section 2.7**.

2.6.5 In considering turbine heights and dimensions, a maximum turbine tip height and approximate rotor diameter has been selected for the purposes of design and assessment of impacts. However, it should be noted that a single candidate model of the turbine has not been specified. For the purposes of assessment therefore, where relevant for each technical assessment turbine models that adhere to the limits of stated dimensions, and provide the realistic relevant worst-case impact, have been assumed.

2.7 Design Evolution and Development of Preferred Option

2.7.1 The Proposed Development has gone through four principal iterations of the layout, which have been developed at different stages in the project design process:

- Layout A – A 20-turbine Scoping layout each of a maximum height of 200 m, representing a wind optimised layout.
- Layout B – A 16-turbine layout each of a maximum height of 200 m, informed by early results of on-site surveys, Scoping responses, a formal pre-application consultation process undertaken with The Highland Council (THC) and statutory consultees Scottish Environment Protection Agency (SEPA) and NatureScot, and consultant inputs. Includes the preliminary design of access tracks.
- Layout C – A 16-turbine layout each of a maximum height of 200 m, responding to detailed peat probing and an advanced landscape appraisal, alongside further design of ancillary infrastructure.
- Layout D – Final layout: a 16-turbine layout with 12 turbines of a maximum height of 200 m and four turbines of a maximum height of 180 m, informed by detailed multidisciplinary assessment and further consultation with SEPA and THC, and including all ancillary infrastructure. Corresponds to **Figure 2.2**.

2.7.2 Each of these layouts is shown in **Figure 2.14a**. Indicative wirelines showing how Layouts A to D may appear from viewpoints in the vicinity of the Proposed Development are shown in **Figures 2.14b** to **2.14f**.

Layout A – Initial Layout

2.7.3 The first design was developed prior to any detailed site-specific surveys being completed. The layout was based on site information available at the time, including a minimum 1.5 km buffer from the two residential properties on the Dalnessie Estate, and known technical constraints, including turbine separation distances of approximately 5 and 3 rotor diameters in downwind and cross wind directions respectively (based on a 163 m rotor) and the anticipated wind variation over the site with topography. The layout comprised 20 turbines of up to 200 m tip height, which represented the maximum physical capacity of the turbine area from a wind resource perspective prior to the establishment of detailed constraints. Layout A was used for Scoping consultation.

Layout B

2.7.4 Following the formal EIA Scoping Request, a number of constructive comments on design were submitted by consultees, which were considered. This was supplemented by a pre-application meeting with THC and other key consultees on the 24th June 2020 and the resulting advice pack, which was issued on the 22nd July 2020. This pre-application advice helped refine the environmental baseline and key constraints. Landscape and visual impacts and deep peat were highlighted as key design considerations. The design objectives, agreed with the relevant stakeholders to mitigate these potential impacts, were developed during this meeting and over the course of further consultation and are detailed below.

2.7.5 Following Phase 1 peat probing and habitat surveys, further consultation with SEPA was undertaken to review the current design and to agree design objectives. The following design objectives were agreed with SEPA:

- the applicant should seek to design the site to avoid development on deep peat and clearly demonstrate that peat disturbance has been minimised. However, taking into consideration the characteristics of this specific site and taking a pragmatic approach, avoiding development on peat > 1.5 m deep seemed a realistic and achievable aim in this case;
- floating tracks will be considered where deep peat cannot be avoided by design;
- shorter access tracks are generally preferred – even if it means more watercourse crossings – if crossings are well-designed; and
- the existing access track to the Dalnessie settlement will be kept as far as possible, so as to avoid unnecessary disturbance of peat.

2.7.6 Additionally, NatureScot and THC were consulted following Scoping and agreed the following design objectives:

- siting turbines on the highest ground and upper hill flanks on the ridge between Sron Leathad Chleansaid and Creag Dubh, along the northern edge of the site will be avoided. This will help to contain the Proposed Development behind this ridge in the Sweeping Moorland and Flows Landscape Character Type (LCT)[1], in views south from the Ben Klibreck Wild Land Area (WLA)[2];
- the applicant will seek to position turbines on a similar elevation within the core of the site, avoiding the highest ground to the north so that the turbines sit lower in the landscape in key views, including views around Lairg, the A836 and the Struie Viewpoint (B9176) overlooking the Dornoch Firth;
- turbine options (rotor diameter and hub heights) will be considered which reflect and respond to the landscape scale and surrounding cumulative context, including the consented Lairg II Wind Farm with turbines up to 200 m to tip;
- as far as possible, a coherent single grouping of turbines will be designed, which avoids outliers and reads as a compact single group. It was noted that this would be especially important in sensitive and elevated views from where it will not be possible to design out visibility;
- as far as possible, visibility of turbine in views at the head of the valley from Strath Brora will be reduced and contained;
- the site boundary and alignment of the Allt nan Con-uisge watercourse create a north-west to south-east axis through the site. As far as possible, the appearance of more formal rows of turbines either side of the watercourse will be avoided, which could lead to an incoherent and contrasting turbine layout in views looking along this axis; and
- the applicant will seek to agree a reduced lighting scheme (using fewer lights on cardinal turbines and/or proximity activated lighting) to minimise effects on dark skies and explore hub heights which maximise the use of the landform for screening hub lighting.

2.7.7 The second design comprised 16 turbines of up to 200 m tip height and was the result of a design workshop with members of the project team. The design workshop processed

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[1] A single dataset containing all of the landscape character assessments at the LCT level is available at https://www.nature.scot/professional-advice/landscape/landscape-character-assessment/landscape-character-assessment-scotland

[2] A map and descriptions of Scotland's WLAs is available at https://www.nature.scot/doc/wild-land-areas-map-and-descriptions-2014

all consultation feedback alongside the findings of ongoing environmental surveys. Wirelines showing the evolving design from key viewpoints were used to appraise the potential landscape and visual effects.

2.7.8 The location and sensitivity of all identified environmental receptors were mapped, and appropriate buffers were agreed between the technical specialists and project engineers. The following design principles and buffers were applied during this design iteration:

- turbine separation distances of approximately 4 and 3 rotor diameters in downwind and cross wind directions respectively (based on a 163 m rotor);
- 50 m buffers from watercourses shown on OS 1:50k base mapping;
- 100 m buffer for tracks and 250 m buffer for turbines and borrow pits from Groundwater Dependent Terrestrial Ecosystems (GWDTE);
- 100 m buffer for tracks and 250 m buffer for turbines and borrow pits from private water supplies (PWS);
- 100 m bat buffer from forestry plantation and watercourses;
- a 1 km buffer from uninvolved residential properties;
- 1.63 km shadow flicker buffer (ten times rotor diameter), except for 100 degrees either side of south;
- avoidance of direct impacts to heritage assets by applying asset-specific buffers based on the significance of the asset (ranging from 10 m to 250 m);
- an 82 m set back from landownership boundaries to avoid turbine blade oversailing;
- the anticipated wind variation over the site with topography;
- avoidance of the most sensitive habitats and protected species;
- avoidance of areas of peat greater than 1.5 m deep; and
- avoidance of slopes greater than 12 degrees.

2.7.9 Three turbines were removed from the Scoping layout to avoid impacts on deep peat. Another turbine was removed to minimise potential impacts on the WLA bounding the site to the north east. Turbines along the ridge between Sron Leathad Chleansaid and Creag Dubh were moved towards the centre of the site to avoid the highest areas and reduce impacts on the WLA. Feedback from Scoping stated that the Scoping layout could be perceived as two rows of turbines which would appear as two separate wind farms in views looking up the River Brora valley, therefore turbines were moved closer together to achieve a more cohesive spacing of turbines in the centre of the array. Turbines were moved to reduce the appearance of distance between turbines from key viewpoints. These changes resulted in a more coherent layout.

2.7.10 An initial access track layout was designed to minimise impacts on peat, to minimise the number of watercourse crossings and to optimise constructability. There were two sections of track where a choice between crossing an additional watercourse or area of deep peat was required. Two optional sections of track were added to the layout so that they could be ground-truthed during a more detailed peat probing exercise. This layout also identified location options for the substation, electrical contractor's compound and the main construction compound.

Layout C

2.7.11 Following the design workshop, detailed peat probing was undertaken across the site and along the proposed access tracks, which provided a greater understanding of the areas of deep peat. The results of this 'Phase 2' peat probing reflected the variability of the peat distribution on the site, with several isolated pockets of deep peat. When surveyors encountered areas of deep peat where infrastructure was proposed, further measurements were taken in the surrounding areas so that alternative locations could be considered. Several of the turbines required relocation.

2.7.12 Following identification of all areas of deep peat, Layout C was subject to further design iteration. Turbines and the access track layout were amended to avoid impacts on deep peat. The turbine tracks were amended from T2 to T4 to avoid deep peat; this also allowed T3 to be moved into an area of shallower peat. T15 was also moved to an area of shallower peat. At this stage the turbine layout was assessed by creating photo-visualisations and wirelines from numerous representative viewpoints, routes and other receptors. The following changes were made to the design:

- the layout was altered to improve its appearance in views from Ben Klibreck and the Ord above Lairg;
- T1 was moved slightly further west to increase the distance from the residential properties at Dalnessie; and
- T16 was moved further west, as T14 limited the scope for T15 to move southeast to improve turbine separation distances.

2.7.13 The deepest peat was avoided as far as possible during the design process. Turbines in Layout C were partially screened from important viewpoints, such as from the WLA.

2.7.14 A loop access track was introduced as this meant construction traffic would have a second means of exit, which would reduce the need for more turning heads.

2.7.15 Further discussions were had on proposed locations for borrow pits, substation and construction compounds were added. It was proposed to site the battery storage and control building in the same compound as the substation. This layout identified two different location options for the substation, electrical contractors' compound and the main construction compound.

2.7.16 These locations were designed in accordance with the following design principles:

- avoidance or minimisation of impacts on environmental resources;
- avoidance of impacts on private water supplies;
- location of borrow pits where rock resource is most evident at surface and/or making use of existing ones, limiting the need to remove soil and peat from these areas;
- reduce potential 'trafficking' across turbine area with placement of borrow pits and construction compounds; and
- selecting optimal location for substation and battery storage compound taking account of turbine and infrastructure and potential grid connection.

2.7.17 Otherwise, locations were optimised for construction efficiency and economy.

Layout D – Final Layout

2.7.18 Layout D represents the final stage of design iteration, which included finalisation of turbine locations and siting and design of ancillary infrastructure.

2.7.19 Completed detailed multi-disciplinary assessments and site visits informed this iteration of the turbine layout, with further information on hydrology, archaeology, ecology, ornithology, forestry and noise becoming available. In particular, cultural heritage site surveys confirmed the presence, extent and quality of preservation of a regionally important abandoned farmstead in the north west of the site. T16 was located within the field system associated with the farmstead but designed to avoid the associated buildings so as to minimise impacts.

2.7.20 A second design workshop was held to review Layout C based on the new information available. Minor changes were made to the access track layout and hardstanding orientation of T15 and T16 to minimise impacts on the cultural heritage assets present on site. The heights of T12, T13, T14 and T15 were reduced from 200 m to 180 m. This reduced the magnitude of landscape and visual impacts on key views, particularly from Lairg and in closer proximity, views from the WLA to the north.

2.7.21 The following changes were made to the ancillary infrastructure:

- the location of the substation and construction compound was confirmed next to T1 as the peat was shallower there and the substation would be screened by the forest in views from Dalnessie cottage and lodge;
- the location of the additional construction compound location was moved west so that it was sited just south of the access track spur to T8 to avoid impact on an area of deep peat;
- the location of the second borrow pit was moved slightly east so that it aligned better with the access track; and
- locations for three permanent met masts were identified.

2.7.22 Additional Phase 2 peat probing was undertaken between T11 and T2 to determine whether floating roads would be required and near T7 to confirm peat depth at the alternative location for the second borrow pit.

2.7.23 Following the second design workshop, further consultation with SEPA was undertaken. The purpose was to provide an update on the design iterations since the meeting with SEPA that had informed Layout B. SEPA did not raise any issues in regard to the upgrade of the existing access track or the location of the proposed borrow pits, and confirmed they were happy, on balance, for a smaller watercourse buffer to be applied to T11 so as to avoid an area of deep peat to the east. SEPA also agreed the approach taken to balance impacts on peat with other constraints in the routeing of the access track between T14 and T15. At SEPA's request, the section of track between T4 and T11, which formed part of a circular loop, was removed and the proposed location of met mast 1 relocated to a location along the access track between T3 and T4 to avoid crossing an area of deep peat. This also had the effect of eliminating a watercourse crossing and reducing the overall track length. SEPA also requested that the track from the substation to T4 was re-aligned to avoid an area of deeper peat. This also involved the realignment of T2 hardstanding.

2.7.24 Finally, feedback from THC received prior to submission of the S36 application queried why three permanent met masts were being proposed. The design team further revised the design to include a single permanent met mast with two permanent Lidar locations.

2.7.25 The final layout including ancillary infrastructure can be seen on **Figure 2.2** and **Figure 2.14.**

2.7.26 Individual assessment chapters in the EIA Report will include design input in further detail and respond to specific matters, in particular pertaining to the scale of the proposed turbines and the landscape fit of the scheme.

2.8 Proposed Development

Key components

2.8.1 The Proposed Development infrastructure would include:

- Up to 16 wind turbines, of approximately 6 MW each, 12 with a maximum tip height of 200 m and four with a maximum tip height of 180 m;
- Hardstanding areas at the base of each turbine, with a permanent area of approximately 2156 m^2;
- One permanent meteorological mast and hardstanding areas for up to two permanent Lidars;
- Total length of access tracks is 17,002 m, of which 11,121m is new access track with associated watercourse crossings and 5,881 m is existing access track and watercourse crossings which will need to be upgraded;
- An operations control building with parking and welfare facilities;
- A substation compound;
- An energy storage facility;
- Telecommunications equipment;
- Up to 4 temporary construction compounds;
- 2 borrow pits, to provide suitable rock for access tracks, turbine bases and hardstandings; and
- Underground cabling linking the turbines with the substation;

Wind Turbines

2.8.2 Grid references and maximum heights to tip for the proposed turbine locations are identified in **Table 2.1** below,

Table 2.1: Proposed turbine locations

Turbine	Easting	Northing	Maximum height to tip (m)
T01	261733	915888	200
T02	261561	916303	200
T03	261132	916655	200
T04	260898	917081	200
T05	262092	916456	200
T06	262092	916456	200
T07	262080	916955	200
T08	261628	917134	200
T09	261290	917730	200
T10	260561	918282	200
T11	260593	917771	200
T12	262205	917468	200
T13	261753	917618	180
T14	261315	918159	180
T15	260987	918699	180
T16	260544	918931	180

2.8.3 The proposed turbine locations and ancillary infrastructure would be subject to a maximum micrositing tolerance of 50 m in any direction. In those places where environmental features may be potentially affected by the micrositing, tolerance would be constrained to less than 50 m, and such changes would be managed in consultation with an Environmental Clerk of Works (ECoW) for the Proposed Development during its construction phase. The micrositing constraints relevant to the Proposed Development are set out within each of the technical sections of this EIA Report. Any movement of the turbines from the Proposed Development layout outwith the micrositing tolerance would be agreed with THC and would be in accordance with the mitigation set out in this EIA Report. A summary of the environmental commitments is provided **Appendix 2.1: Schedule of Environmental Commitments.**

Wind Turbine Structure

2.8.4 It is proposed that there will be up to 16 turbines within the project area, with a combined capacity in excess of 50 MW.

2.8.5 The height of the proposed turbines from the ground to the blade tip will be a maximum height of 200 m (for 12 turbines), with four turbines having a maximum height of 180 m.

2.8.6 The turbines would have an approximate rotor diameter of 163 m. The model and actual dimensions of the wind turbines ultimately selected would be influenced by the economic market and technological advances at the time of procurement. However, blade tip height would not exceed 200 m. Indicative elevations are shown on **Figure 2.3**.

2.8.7 The turbines would be three bladed, horizontal axis turbines with solid tubular towers. The blades would be made from reinforced composite materials such as fibreglass. The turbine towers would be made of steel.

Colour and Finish

2.8.8 The wind turbines would be of the same basic appearance and colour. It is proposed that the turbines would be of a matt grey colour finish. Although off-white has been an accepted colour for turbines, more recently constructed wind turbines have been a mid-grey tone, which reduces the distance over which turbines are visible, especially in dull weather or low light conditions. The choice of material and colour for the proposed turbines is an important consideration in terms of visual impact. Finishing would be expected to be agreed by a condition placed on consent.

Turbine Foundations

2.8.9 Turbine foundations would be dependent upon site-specific ground conditions at the turbine locations and the type of turbine chosen. However, it is envisaged that installation of the turbines using a steel reinforced concrete base (gravity foundation) would be suitable.

2.8.10 The concrete gravity foundations would be located underground. A quantity of earth would therefore need to be removed. The amount of earth to be removed would depend upon site-specific ground investigations at each turbine location. Topsoil, peat and other material would be removed from the foundation area and stored so that it may be used later for reinstatement.

2.8.11 Turbine foundations would be set down to the depth of suitable bearing strata with an approximate diameter of 25 m and circular or octagonal shape (see **Figure 2.4 'Indicative Turbine Foundations'**). Should geotechnical investigations demonstrate that the required bearing capacities are not achievable; a piled foundation design would be adopted using the same overall design footprint.

2.8.12 An anchor ring and foundation bolts would be cast into a central column onto which the turbine tower would be fixed. Concrete for the foundations would either be delivered to the Proposed Development in a "ready mix" form or processed in a concrete batching plant located on site within a construction compound.

2.8.13 For the purposes of this EIA Report, a maximum (worst case) scenario of a 3 – 4 m deep (with no slope from middle to outside edge), 25 m by 25 m circular or octagonal footprint foundation has been assumed. The concrete bases would be allowed to cure (reach its design strength) before turbines are fitted.

Turbine lighting

2.8.14 Air Navigation Order Article 222[3] requires turbines exceeding a tip height of 150 m to display aviation lighting to indicate their presence. Dispensations for reduced lighting schemes can be agreed with the Civil Aviation Authority (CAA), according to the guidance provided in CAP-764[4]. For the Proposed Development, the CAA has agreed to a reduced lighting scheme whereby only five cardinal turbines require to be lit with visible lighting (2000 candela, reducing to 200 candela in good visibility) on the hubs. Additionally Infra-red (IR) lighting would be installed on peripheral turbines to meet the requirements of the Ministry of Defence (MOD). Subject to the evolution of CAA policy, the applicant would also consider the installation of an aircraft detection lighting system (ADLS) on the Proposed Development. This would switch on the visible lights only when an aircraft passes within specified horizontal and vertical distances from the wind farm.

2.8.15 Further information on aviation turbine lighting is provided in **Chapter 13 Aviation and Radar**, in particular **Section 13.7 Mitigation**. Further discussion of the way turbine lights would be perceived is provided in **Appendix 6.2 Aviation Lighting Assessment**.

Turbine Erection

2.8.16 The Turbine components would be delivered to the relevant storage area for each component, whether it be to a specific turbine hardstanding or to a storage area located at one of the construction compounds, until weather conditions are appropriate for turbine erection. The bottom turbine tower section would firstly be fixed to the anchor ring and foundation bolts imbedded into the central column of the foundations, followed by the upper turbine tower sections being crane lifted into place. The cranes would then lift the nacelle into place on the top section of the turbine tower. Blades would then be fitted to the rotor hub, either on the ground before lifting altogether onto the nacelle, or otherwise individually lifted for connection to the rotor hub *in situ*.

Turbine Hardstandings

2.8.17 Level hardstanding areas are required adjacent to each turbine base for the operation of a heavy lifting capacity crane, and a smaller service crane, used for assembly of the turbine components. They would also be used as storage areas for the turbine components. The hardstandings would be to the same general specification as the turbine access tracks that they adjoin, but a slightly greater depth of construction is envisaged.

2.8.18 It is anticipated that each hardstanding will be 77 m x 28 m with a 5.5 m wide track running along the length of the hardstanding. Two blade fingers, each 20 m x 4 m, may be

[3] UK Statutory Instruments 2016 The Air Navigation Order Part 8 Chapter 2 Article 222. Accessed at: https://www.legislation.gov.uk/uksi/2016/765/article/222/made [accessed March 2022]

[4] Civil Aviation Authority. 2016. CAP 764: Policy and Guidelines on Wind Turbines. Accessed at: https://publicapps.caa.co.uk/modalapplication.aspx?catid=1&pagetype=65&appid=11&mode=detail&id=5609 [accessed March 2022]

required on the track side of the hardstanding. The cut-and-fill batters on the hardstandings will be dictated by detailed Site Investigation.

2.8.19 In addition to the hardstanding for the main assembly crane, up to two additional temporary crane pads may be required for crane assembly. These crane pads are shown on the Typical Turbine Hardstanding Arrangement drawing at **Figure 2.5.**

2.8.20 Each turbine supplier has their own hardstanding configuration, including associated laydown areas, working areas, crane pads and blade fingers. Therefore, the exact configuration of the hardstanding will not be determined until the turbine supplier has been chosen. However, for the purposes of the EIA, the most onerous hardstanding arrangement has been chosen.

2.8.21 The hardstandings would be constructed using suitable surplus material generated from the excavation process elsewhere within the development area and from borrow pits where possible. Topsoil and peat would be excavated, and stone laid and compacted to the required depth. The depth of the hardstandings would be dependent on the ground conditions at specific locations.

Transformer Houses

2.8.22 Each wind turbine would be expected to have an associated transformer. External transformers would be located within weather-proof housing which would have indicative dimensions of 5.5 m by 3.0 m by 3.0 m. Transformer housing would be colour finished to blend in with the surrounding landscape.

Site Entrance and Access Tracks

2.8.23 The access route to turbines will be made up of a total of approximately 17.0 km of new and upgraded track.

2.8.24 The following principles have been applied in the design of the on-site access tracks:

- Tracks make use of existing infrastructure and track/disturbed ground where possible;
- Track length is kept to a minimum to reduce construction time, the requirement for stone, and land-take;
- Gradients are to be kept to acceptable levels to accommodate the requirements of delivery vehicles and also to allow construction plant to move safely around the Proposed Development area;
- Tracks are routed to avoid sensitive hydrological, ecological and archaeological features as far as practicable and to keep watercourse crossings to a minimum;
- Tracks are routed to avoid areas of deepest peat;
- Tracks are designed to minimize the required cut-and-fill quantities; and
- Horizontal and vertical alignments of tracks are designed in such a way as to comply with Turbine Supplier requirements, for example minimum turning radius and vertical curvature on both the tracks and hardstandings.

2.8.25 The access track would generally be unpaved (stone surface) and of 5.5 m running width, with a 1 m shoulder verge to either side and 2:1 side slopes. The track could be up to 7 m wide on bends. The access tracks are shown in **Figure 2.6**.

2.8.26 Approximately 11.121 km of new access track would require construction. Turning heads of sufficient size to accommodate articulated vehicles would also be provided at several locations, as indicated on **Figure 2.2.** Some further widening would be necessary along the access track route to allow for passing places/temporary lay down areas, approximately every 500 m, with the locations subject to detailed design.

2.8.27 In general terms, the construction method would see topsoil, including peat, being removed and stored adjacent to the construction area until required for reinstatement. Excavated peat would be transported to an allocated reuse location as soon as practicable following excavation, as discussed in the Peat Management Plan (**Appendix 10.2**) Excavations would continue to expose a suitable horizon or bedrock on which to construct the track.

2.8.28 The tracks would be constructed in layers, with a geo-textile membrane if required, overlain by a base of coarse stone, and subsequent layers of higher graded crushed stone. Each layer of stone would be compacted and shaped to provide a profile and surface finish of a quality suitable for the turbine construction vehicles. The estimated depth of stone would be 750 mm, though the final thickness used would be dependent on local ground conditions and load capacity.

2.8.29 The requirements for access track drainage would be determined at detailed design stage and on-site during construction. The access tracks would have a suitable cross-fall to drain run-off and, where gradients are present, lateral drains would intercept any flow along the road. The dimensions of the lateral drains would be matched to the estimated water flow and outlets would be suitably located with erosion protection as required.

2.8.30 Where ground conditions are of a permeable nature, swales would be utilised alongside the access tracks to allow natural filtering of surface water into the ground. Where areas are less free draining, land drains or drainage ditches would be installed as topography and ground conditions dictate. Drainage filters would be installed at suitable locations to remove silts from the run-off.

2.8.31 Post construction, the vegetated turf layer will be used for reinstatement. This will allow re-establishment of natural vegetation to the area. Reuse of the turf layer is the preferred option over seeding the edges of the access track, as seeding rarely gives a representative cover and has been known to encourage deer grazing on verges.

Watercourse Crossings

2.8.32 As part of the access track construction and associated hardstanding works, six new watercourse crossings will be required, locations identified on **Figure 10.5.5** in **Appendix 10.5**. Bridges and bottomless culverts will be used for the main watercourse crossings. Closed culverts may be used for minor drainage channels.

Borrow Pits

2.8.33 The Proposed Development will require crushed stone to construct new tracks, create hardstanding areas for the cranes and lay the turbine foundations.

2.8.34 The total estimated required quantity of stone is approximately 300,000 cubic metres, the majority of which is expected to be won from on-site borrow pits, as shown on **Figure 2.2**. However, it is anticipated that approximately 12,000 cubic metres will need to be brought in from off-site sources to build the initial section of access road leading to the first on-site borrow pit as well as the turbine foundations. However, for purposes of assessing worst-case, **Chapter 12 Traffic & Transport** assessment will also consider the scenario where 100% of the stone requirement would be brought in from off-site sources.

2.8.35 Locations for up to two borrow pits have been carefully sited in areas with rock exposure. As a result, the volume of topsoil/peat that would need to be removed in order to access the stone from borrow pits is limited. Further detail on the location and extent of the borrow pits is provided in **Appendix 10.3.**

2.8.36 During borrow pit excavation activities, blasting may be required. Blasting operations at the borrow pit (BP1) nearest to Dalnessie should take place under strictly controlled conditions with the agreement of the Highland Council, at regular times within the working week, that is, Mondays to Fridays, between the hours of 10.00 and 16.00. Blasting on Saturday mornings should be a matter for negotiation between the contractor and the local authorities.

Substation Compound

2.8.37 The indicative layout and elevations of the substation compound is shown on **Figure 2.7a** and **Figure 2.7b**. The substation compound is split into two separate compounds, an Independent Power Producer (IPP) compound (to be used by the applicant) and a Transmission Network Operator (TNO) compound (to be used by Scottish & Southern Energy Networks Transmission). A separate control building will be located in each compound.

2.8.38 The substation compound will measure approximately 75 m x 100 m and will contain a storage yard/laydown area. The substation compound will be enclosed by palisade type fencing. Lighting will be kept to a minimum and will be limited to working areas only and will comply with health and safety requirements. Lighting will be down lit and linked to timers and movement sensors so that light pollution is kept to a minimum.

IPP Compound and Control Building

2.8.39 The IPP compound will contain a 132 kV (kilovolt) to MV (medium voltage) grid transformer (with over the fence connection to the TNO 132 kV AIS switchgear bay), a house transformer, a Neutral earth Resistor (NER) and possible a harmonic filter or VAR (volt-ampere reactive) support unit.

2.8.40 A single storey control building will house MV switchgear, control and protection equipment, SCADA (supervisory control and data acquisition) equipment, LV battery systems, welfare facilities (toilet, washing and basic food preparation area), workshop and offices. The approximately 18.3 m x 11.3 m control building is shown in **Figure 2.9**. The control building welfare facilities will include a suitably sized foul waste holding tank, which would be emptied by tanker and removed from the project area on an appropriate timescale for disposal at a suitably licensed off-site facility or a composting toilet, and bottled water or a small water bowser. The details of the system to be put in place will be agreed with THC.

2.8.41 Cable arrays from the turbine transformers will converge at the IPP compound control building.

2.8.42 The IPP control building will be constructed in keeping with the local built environment. The final designs for the building and compound will incorporate sustainable design features and will be agreed with THC.

TNO Compound and Substation Building

2.8.43 The TNO compound will contain a 132 kV AIS switchgear bay to which the 132 kV underground grid cable will connect at one end. At the other end of the 132 kV AIS switchgear bay an over the fence connection to the IPP grid transformer will be facilitated.

2.8.44 The TNO control building will likely comprise of a single storey modular unit measuring approximately 12.5 m x 10 m as shown in **Figure 2.8**. The control building will house control and protection equipment, SCADA equipment, LV battery systems, stores and welfare facilities.

2.8.45 The TNO control building will be constructed in keeping with the local built environment. The final designs for the buildings and compound will incorporate sustainable design features and will be agreed with THC.

Energy Storage

2.8.46 It is the applicant's intention to retain the construction compound located immediately adjacent to the substation for purpose of potentially hosting a permanent co-located energy storage facility. This is anticipated to comprise a lithium-ion battery technology solution, with modular elements comprising a number of battery housings (either standard ISO containers, electrical-houses ('eHouses') or otherwise) with associated 'heating, ventilation and air-condition' ('HVAC') systems, along with paired power conversion systems ('PCS') comprising bi-directional inverters and transformers, as well as central switchgear, metering and transformer, and space for access and operations.

2.8.47 This area of technology is currently fast-evolving in terms of:

- technological advances in battery energy density and performance;
- the design and existence of various potential service markets for providing revenues; and
- opportunities for time-shifting of wind farm generation.

2.8.48 For this reason, indicative designs for the installation have been provided in **Figures 2.10** and **2.11** based upon certain parameters, which form the basis of the EIA presented in this EIA Report. These indicative parameters are considered to represent the realistic worst-case scenario in EIA terms. The battery technology type for the Proposed Development will meet all the relevant safety and environmental standards. Any requirements for environmental (e.g., PPC permitting) or health and safety consents (e.g., COMAH) will be discussed, confirmed and agreed with the relevant authority prior to construction.

2.8.49 Within the space provided by the substation construction compound (75 m x 45 m), based on the assumed parameters (and as illustrated indicatively on **Figures 2.10** and **2.11**), it is considered possible to achieve an arrangement comprising 2.6 m x 16.1 m ISO containers with top-mounted HVACs, each with a single accompanying PCS, along with a single 2.6 m by 11.4 m switchgear container, assuming that other electrical elements (including metering and grid-connection transformer) could be either included within or shared with the wind farm substation compound. Based on a current industry Grid Battery Storage solution, where a 16.1 m-long container can host between 1.2 MW (power): 5.3 MWh (energy) at configuration for "maximum energy" (roughly 4.1 hours duration), and 7.2 MW:3.8 MWh at "maximum power" (roughly 0.5 hours duration), this could relate to an indicative system of anywhere between 21.6 MW:95.4 MWh to 129.6 MW:68.4

MWh. Sufficient space within the substation construction compound remains to accommodate the battery energy storage facility alongside any bunding or drainage required.

2.8.50 The final choice of battery model will ensure compliance with the above parameters. The number, dimensions, housing type, finish, arrangement, security fencing and landscaping of energy storage elements will be subject to THC consultation and approval prior to construction.

Permanent Anemometer Mast

2.8.51 The permanent anemometer mast would comprise of a freestanding steel lattice tower to the same height as the turbine hubs (up to a maximum of 125 m in height reflecting the potential candidate turbines). An indicative design is shown in **Figure 2.12**. The concrete mast foundation will measure approximately 9 m x 9 m and 2 m in depth. The lattice mast frame reduces the visual impact of the structure and will facilitate climbing for maintenance purposes. The access to the anemometer mast would be via the onsite network of access tracks. The mast would require a hardstanding area of approximately 30 m x 20 m for erection and ongoing maintenance.

Permanent LiDAR

2.8.52 Two locations for permanent LiDAR ("light detection and ranging") facilities are identified on **Figure 2.2**. The dimensions and elevations for these two facilities are shown in **Figure 2.12**. Access to the LiDAR facilities will be via the onsite network of access tracks. Each unit will be connected to the wind farm SCADA system. Power supply and data transfer will be via wind farm cabling (buried in the electrical cable trenches). A backup power system, data logger and a small storage facility will be sited at each LiDAR location. Security fencing with gated access similar to the substation compound will enclose the LiDAR unit compounds. Each Lidar installation would require a hardstanding area of approximately 30 m x 20 m for erection and ongoing maintenance.

Construction Phase

2.8.53 Construction of the Proposed Development is anticipated to take approximately 21 months from mobilisation to completion.

2.8.54 An indicative construction programme is set out in **Table 2.3** below. Many of these construction activities would be carried out concurrently, although predominantly in the order set out below. A more detailed construction plan will be prepared prior to construction.

Table 2.2: Indicative construction programme

Activity	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
Site establishment																					
Construction of new access tracks and crane hardstandings																					
Turbine foundation construction																					
Substation, energy storage and electrical works																					
Cable trenching and installation																					
Crane delivery																					
Turbine delivery, erection and commissioning																					
Site reinstatement																					

Construction Traffic

2.8.55 It is anticipated that the largest volume of traffic will be associated with the construction phase of the project, when vehicles are likely to be travelling from major centres and ports to deliver materials to the site. The origins of materials and goods are expected to be the port of Invergordon.

2.8.56 The main construction traffic access routes will likely comprise the following:

- A9
- A836
- A839

2.8.57 Further detail is provided in **Chapter 12: Traffic and Transport** of the EIA Report. The AIL route is shown in **Figure 12.1**.

Construction Workforce

2.8.58 A detailed construction workforce schedule, i.e., employee numbers throughout the construction programme, and likely shift patterns would not be known until the contract for building the Proposed Development has been awarded, however the maximum number of staff likely to be on site at any one time would be 50.

Mobilisation Compounds

2.8.59 During the construction period, a number of temporary mobilisation compounds will be required. These will facilitate the construction activities prior to the main construction compounds becoming operational. The locations of the mobilisation compounds are shown on **Figure 2.2**.

2.8.60 To create the mobilisation compounds, turf and topsoil will be stripped and bunded at the edge of the mobilisation compounds. A layer of geotextile membrane will be placed on the subsoil, and Type 1 aggregate stone will be imported and compacted to create temporary surfaces. Appropriate temporary drainage mitigation will be installed around each mobilisation compound. and the two mobilisation compounds will be decommissioned on completion of construction activities.

2.8.61 The compounds will be located respectively at the west and east of the access track and their dimensions will be:

- 123 m x 30 m, at the west of the access road; and
- 165 m x 30 m at the east of the road.

Construction Compounds

2.8.62 During the construction period, a number of construction compounds will be required that will include a laydown area for wind turbine components. The locations of the construction compounds are shown on **Figure 2.2**.

2.8.63 The main construction site office and compound will comprise temporary cabins to be used for the site offices, the monitoring of incoming vehicles and welfare facilities for site staff including toilets; parking for construction staff visitors and construction vehicles; secure storage for tools and small parts; a receiving area for incoming vehicles; and temporary security fencing around the compound.

2.8.64 The compounds will be used as storage areas for the various components, fuels and materials required for construction. Typically, the major structural components of the turbines would be delivered directly to the turbine hardstandings. Temporary lay-down areas will be provided for parking and unloading vehicles, including AIL.

2.8.65 Any lighting would be directional in accordance with Institute of Lighting Professionals (ILP) guidance and mounted on the individual portacabins.

2.8.66 The construction compounds and lay down areas would be constructed by first stripping the topsoil/peat, which would be stored in a mound for subsequent reinstatement at the end of the construction period, in line with industry best practice[5]. Care will be taken to maintain separate stockpiles for turf and the different soil/peat types to prevent mixing during storage. A geotextile would then be placed on the sub-stratum, which would be overlain by a working surface of stone to approximately 750 mm thickness.

2.8.67 Reinstatement would involve removing the stone and underlying geotextile before carefully ripping the exposed substrate and replacing the excavated soil/peat.

Construction Hours

2.8.68 It is anticipated that the main construction hours for the Proposed Development will be between 07.00 and 19.00 from Monday to Friday, and 08.00 and 13.00 on Saturdays unless otherwise agreed with THC. Certain activities, such as electrical works in the substation or turbine erection in the event of delays due to high winds, may require to be undertaken outwith these hours. Construction hours generally also apply to the delivery of materials to the Proposed Development; however abnormal loads may be delivered out of these hours when the road network is at its quietest to reduce traffic disturbance. Delivery of the nacelles, towers and blades to the Proposed Development area would require the use of abnormal sized and slow-moving trucks. These trucks would require a police escort and the timing of these deliveries may be dictated by the police. More details can be found in **Chapter 12 Traffic and Transportation**.

Operational Phase

Turbine Monitoring and Control

2.8.69 Wind turbines have a proven track record for operating safety. All turbines are controlled by a Supervisory Control and Data Acquisition (SCADA) system, which would gather data from all the turbines and provide the facility to control them from a remote location. The SCADA system would gather data from all the turbines via communications cables connecting to each turbine (the cables being buried in the electrical cable trenches).

2.8.70 In the case of any fault, including over-speed of the blades, overpower production, or loss of grid connection, the turbines shut down automatically through integrated braking mechanisms. They are also fitted with vibration sensors so that, if, in the unlikely event a blade was damaged, the turbines would again be automatically shut down.

[5] Current best practice includes *Good Practice during Wind Farm Construction* (2019), A joint publication by Scottish Renewables; Scottish Natural Heritage; Scottish Environment Protection Agency; Forestry Commission Scotland; Historic Environment Scotland; Marine Scotland Science; AEECoW. 4th Edition. https://www.scottishrenewables.com/assets/000/000/453/guidance_-_good_practice_during_wind_farm_construction_original.pdf?1579640559 [accessed December 2021]

Meteorological Effects

2.8.71 Turbines, as with any tall structure, can be susceptible to lightning strike and appropriate measures are included in the turbine design to conduct lightning strike down to earth and minimise the risk of damage to the structure. In the case of a lightning strike on a turbine or blade the turbine would be automatically shut down.

2.8.72 In cold weather, ice can build up on blade surfaces when operating. The turbines can continue to operate with a thin accumulation of snow or ice but would be shut down automatically when there is a sufficient build up to cause aerodynamic or physical imbalance of the rotor assembly. Many models now include de-icing technology.

2.8.73 In the circumstances of a lightning strike hitting a turbine or an ice throw incident taking place, the Proposed Development turbines are sufficiently far away from recreational routes that no users of such routes would be impacted.

2.8.74 Local meteorological conditions would be monitored by a permanent anemometer mast and up to two LiDAR installations, which would be located as shown on **Figure 2.2**.

Turbine Servicing and Repair

2.8.75 Each manufacturer has specific maintenance requirements; however, it is anticipated that routine servicing of the turbines would typically be undertaken twice a year, with a full annual service and a minor service every intervening six months. In the first year, there is also likely to be an initial three-month service post-commissioning. Individual turbines would be switched off when servicing is ongoing. Maintenance and servicing would include activities such as changing of gearbox oils and individual turbine components.

2.8.76 Blade inspections would be likely to be required between every two and five years. These would traditionally be undertaken using a cherry picker or similar but may also be performed with a 50-tonne crane and a man-basket or using drones. Repairs to blades would use the same equipment. Light winds and warmer, dry conditions are required for any blade repairs hence summer (June to August) would be the most appropriate period for this work.

2.8.77 Operational waste would generally be restricted to small volumes of waste generated from machinery repair and maintenance. The maintenance contractors would dispose of any such waste off-site, in line with Scottish waste management regulations and duty of care.

Track Maintenance

2.8.78 Once the Proposed Development is operational, the volume of traffic using the access tracks would be low. Correspondingly, the need for any track maintenance works is anticipated to be low and infrequent. Any such works required would generally be undertaken during the drier conditions in the summer months.

Operational Workforce

2.8.79 A team of several staff including engineer fitters would supervise the operation of the wind turbine installation and would visit the Proposed Development to conduct routine maintenance. The frequency of these visits would depend on the turbine manufacturer.

Decommissioning Phase

2.8.80 The Proposed Development is anticipated to have an operational life of 35 years, after which it would be decommissioned, and the turbines dismantled and removed. This is the proposed course of operations which is being applied for and any alternative to this action would require separate consent from the ECU, and so is not considered within this EIA Report.

2.8.81 During decommissioning the turbines would be dismantled and removed, along with any associated above ground electrical equipment. This decommissioning work would be the responsibility of the applicant, or any subsequent owners of the Proposed Development. Underground cables would be left in place and foundations would be removed to a depth of 0.5 m below ground level to avoid environmental impacts from deeper removal. Prior to decommissioning of the site, a method statement would be prepared and agreed with THC.

2.9 References

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