

## **Chapter 3: Site Selection, Design Evolution and Consideration of Alternatives**

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### **3 Site Selection, Design Evolution and Consideration of Alternatives**

#### **3.1 Introduction**

3.1.1 This Chapter explains the process which led to the selection of the development site, and provides an overview of the environmental and technical factors considered as part of the design evolution of the 16 turbine development.

#### **3.2 Site Selection**

3.2.1 Gordonbush Extension Wind Farm has been selected as a suitable site for wind energy development due to environmental and technical considerations identified during the site selection and feasibility process, including:

- Excellent wind resource;
- Good access to site following upgrades to the local road network during the construction of Gordonbush Wind Farm;
- Proximity to transmission network and capacity within existing substation (at Gordonbush Wind Farm);
- Absence of nature conservation designations on the site (see Figure 3.1);
- Sparsely populated area reducing the likelihood for unacceptable impacts on local residents;
- Gordonbush Wind Farm became operational in June 2012 and generates enough renewable electricity to power around 60,000 homes each year<sup>1</sup>. It is considered to be one of SSE's best performing sites;
- Opportunity to expand an operational wind farm site, increasing operating efficiency whilst minimising additional environmental effects when compared to a new site for a project of a similar size;
- Located within an Area of Search for wind farm development, as identified by The Highland Council (March 2012);
- Located outwith, but adjacent to a Wild Land Area identified by Scottish Natural Heritage (SNH) (see Figure 3.1); and
- Location in which a development can accord with the principle set out in Scottish Planning Policy in relation to renewable energy.

3.2.2 A core development area was established whereby all technical and environmental studies would be focussed to determine where turbines could be located to maximise energy yield and minimise significant environmental effects.

3.2.3 Environmental assessment work on Gordonbush Estate has been on-going for over a decade as part of the design, development, construction and on-going monitoring of the Gordonbush Wind Farm, which became operational in 2012 following an 18 month construction programme. This information has been drawn upon where relevant to inform the design and throughout the EIA process.

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<sup>1</sup> Based on average household consumption of 3,200 kWh a year

### **3.3 Design Evolution**

- 3.3.1 The design of the Development is determined through two main considerations; technical and environmental constraints, and landscape and visual design principles. Technical and environmental constraints are those such as ecological and ornithological issues, ground conditions, steepness of slope, and so on. This information is compiled into constraints mapping, which identifies the areas of the site that are most and least constrained for development.
- 3.3.2 The layout is determined to some degree by these technical and environmental constraints, as these can provide rigid limitations to development. However, within the parameters laid down by technical and environmental constraints, the landscape and visual design principles are of paramount importance, particularly in relation to the existing wind farm.
- 3.3.3 A Design Statement has been prepared for the Development which sets out the principles and design objectives that were aspired to during the wind farm design process. The Design Statement is included in Appendix 3.1.
- 3.3.4 The aim of the design optimisation process has been to achieve a turbine layout that relates to the landform of the site and adjacent areas, whilst achieving a balanced composition with the surrounding landform and skyline in consideration with the operational Gordonbush Wind Farm, as seen from key receptors.
- 3.3.5 The following sections explain how the various elements of the Development have evolved through the iterative EIA and design process.

#### **Overview of Constraints and Opportunities**

- 3.3.6 The design of the wind farm layout is a vital part of the EIA process as it provides the biggest contribution to mitigating potential effects. Due to the generally high visibility of wind farms, landscape and visual aspects are particularly important and have driven the layout design. A range of other environmental constraints and technical considerations have also informed the iterative design process.
- 3.3.7 A brief overview of the key constraints and opportunities taken into account throughout the iterative EIA and design process is included in this section (see also Figure 3.2). For a detailed description, reference should be made to the appropriate chapter in this ES.

#### Environmental Considerations

##### *Habitats and Protected Species*

- 3.3.8 An extended Phase 1 Habitat survey was undertaken, supplemented by a National Vegetation Classification (NVC) survey of UK Biodiversity Action Plan (BAP) priority habitats. Protected mammal and animal surveys were also undertaken.
- 3.3.9 The presence of valued ecological receptors including Ground Water Dependent Terrestrial Ecosystems (GWDTEs) were also identified and considered during the iterative design process. The intention was to avoid locating turbines within areas classed as highly

groundwater dependent, such as habitat type M6c, and outwith habitat areas classified as moderately groundwater dependent, where possible.

- 3.3.10 Information obtained from the Gordonbush Wind Farm ES, construction and on-going monitoring programme has been referred to.

#### *Hydrological & Hydrogeological*

- 3.3.11 All water courses were identified and a buffer of 50m was applied between a watercourse visible on OS 1:50,000 mapping and the positioning of a turbine.

- 3.3.12 A peat depth survey was undertaken to identify peat depths and to inform a layout which minimises peat slide risk where practicable. Results indicate that the majority of the site comprises of peat <1m in depth; however, pockets of deeper peat (>2m) do exist, and these areas were taken into consideration and avoided during the design process. The ground conditions were also a key determining factor in the design of new access tracks and whether these would be a cut design or float design.

#### *Ornithology*

- 3.3.13 Breeding bird and raptor surveys undertaken as part of the Gordonbush Wind Farm ES, construction and on-going monitoring programme, which covered the core development area, in addition to specific bird surveys carried out for the Development, were studied to determine nesting locations and flight lines of species named within Annex 1 of The Birds Directive, or European Directive 2009/147/EC. These were mapped to determine potential constraints in the design of the wind turbine layout.

#### *Cultural Heritage*

- 3.3.14 There are no Scheduled Monuments, Listed Buildings, Conservation Areas, Inventoried Battlefields or Garden and Designed Landscapes within the development boundary.
- 3.3.15 A number of archaeological features were recorded within the core development area during recent field work, as well as from previous reported archaeological investigations undertaken in the area for the original Gordonbush Wind Farm and the Beauly to Dounreay 275kV overhead transmission line. The design iteration process has sought to minimise potential impacts on these features of cultural heritage interest.

#### Landscape and Visual Considerations

- 3.3.16 Potential impacts to landscape character (including wild land) and visual amenity were an important factor in this iterative design process. In particular, the appearance of the Development within the context of Gordonbush Wind Farm.
- 3.3.17 In refining the design, detailed analysis from a number of key viewpoints (see Table 3.1) has been carried out. This has been undertaken in consultation with The Highland Council and SNH and is detailed further within Appendix 3.1: Design Statement.

**Table 3.1: List of Key Viewpoints**

Viewpoint No.	Viewpoint Name	Co-ordinates	Reason for Inclusion	Approximate Distance (to core development area)
ES Viewpoint 2	Loch Brora (south-west side)	284710, 908389	Viewpoint on the west Loch Brora core path, at a location where the operational wind farm is not visible. Within the Loch Fleet, Loch Brora and Glen Loth SLA.	3.6km
ES Viewpoint 3	Brora to Rogart minor road south of Killin	285892, 905961	Viewpoint to represent the first clear visibility of the Development as gained by westbound travellers on this road. No visibility of the operational Gordonbush Wind Farm. Within the Loch Fleet, Loch Brora and Glen Loth SLA.	3.2km
ES Viewpoint 4	Brora to Rogart minor road north of Killin	285565, 907283	Viewpoint approximately 1.5km west of Viewpoint 3, which illustrates how visibility decreases along the road before ceasing several hundred metres to the west of this viewpoint. No visibility of the operational Gordonbush Wind Farm. Within the Loch Fleet, Loch Brora and Glen Loth SLA.	4.4km
ES Viewpoint 5	Strath Brora near Balnacoil	281797, 910867	Viewpoint located to the south of the minor road, included to show visibility that may be gained by people walking beside the river. Visibility from the road itself would be screened by woodland in this area.	750m
ES Viewpoint 6	Brora to Rogart minor road near Sciberscross	278487, 910447	View gained by eastbound travellers on the minor road, with the operational Gordonbush and Kilbraur Wind Farms clearly visible.	4.0km
ES Viewpoint 11	Hope Hill	277861, 918871	Viewpoint within the Ben Klibreck-Armint Forest Wild Land Area. Visibility of the operational Gordonbush Wind Farm.	7.9km

### Consideration and Influence of Gordonbush Wind Farm

- 3.3.18 Gordonbush Wind Farm lies immediately to the north-east of the Development and consists of 35 turbines at a tip height of 110m. The layout is aligned in a fanned grid configuration, which radiate from the ridgeline to the north-east. The aim of the design was to provide a simple layout to relate to the simple topography and land cover. The grid alignment provides a composition that allows the turbines to be evenly spaced and relate to each other, providing visual cohesion and sculptural image. Throughout the design iteration process, the appearance of the Development within the context of Gordonbush Wind Farm was considered (see Appendix 3.1: Design Statement).
- 3.3.19 Early design iterations of Gordonbush Wind Farm extended into the site boundary of the Development; although, were later removed to reduce impacts on blanket bog and to avoid two breeding Merlin. Further peat probing of the development area has since taken place to understand the full extent of peat depth across the site. Results indicate that the majority of the site comprises of peat <1m in depth; however, pockets of deeper peat (>2m) do exist, and these areas would be taken into consideration and avoided during the design process (see Chapter 9: Hydrology, Hydrogeology and Geology). Bird surveys have found no evidence of breeding Merlin within the site boundary (see Chapter 10: Ornithology).
- 3.3.20 Lessons learnt from the construction of Gordonbush Wind Farm have been considered during the design of the Development and would be adopted during construction to ensure all potential impacts on the environment are minimised (see Appendix 4.2: Lessons Learnt). Such mitigation measures are referred to in relevant chapters of the ES, and in Appendix 4.1 (draft CEMP). Where existing infrastructure is in place following the construction of Gordonbush Wind Farm, this has been considered for re-use during the design evolution stages in the construction and operation of the Development (see Chapter 4: Description of Development of this ES).

### Habitat Management Plan

- 3.3.21 A Habitat Management Plan (HMP) is currently being implemented on Gordonbush Estate. Consideration of the objectives and successful implementation of this HMP was given during the design development and assessment of the Development. Further details are provided in Chapter 4: Description of Development and Chapter 8: Ecology and Nature Conservation.

### Technical Considerations

#### *Turbine Separation*

- 3.3.22 Appropriate positioning of turbines relative to one another must be taken into consideration to ensure that each wind turbine operates as efficiently as possible. To determine optimum spacing, factors such as average wind speed, flow turbulence and wind direction all need to be taken into account. In addition, appropriate separation from Gordonbush Wind Farm infrastructure (particularly wind turbines) was also considered. As a general rule, a separation ellipse of 5 x 5 rotor diameters was defined.

*Grid Infrastructure*

- 3.3.23 The Beauly to Dounreay 275kV overhead transmission line runs alongside the western extent of the proposed development boundary. As such, a separation equating to topple distance (up to 130m) + 10% would be maintained.

*Topography / Gradient*

- 3.3.24 No wind turbines should be located on steep ground.

**3.4 Design Iterations**

- 3.4.1 The scale and design of the Development has evolved through a number of design iterations before arriving at a 'fixed' design.
- 3.4.2 A core development area was initially established, and included within the scoping report. All technical and environmental studies focussed on this area to determine where turbines could be located to maximise energy yield and minimise significant environmental effects. A primary design focus was to use the existing infrastructure from the operational wind farm wherever possible.
- 3.4.3 A brief description of the key design iterations are detailed below. Further information on these iterations is provided within Appendix 3.1: Design Statement.

**Design 1 (September 2013) and Design 2 (October 2013)**

- 3.4.4 Two initial layouts were put forward as a starting point for the design iteration and EIA process. Design 1 included a total of 20 turbines, whilst Design 2 included a total of 18 turbines. In both layouts, turbines were located to maximise energy yield from the available space within the core development area. Turbines were proposed to have a maximum tip height of 132m.
- 3.4.5 These layouts were technically driven with no consideration of ground conditions or other environmental factors. Potential issues arising from these layouts formed the basis for the formulation of the design principles and informed the ongoing design process.



Plate 3.1: Design 1 (September 2013)

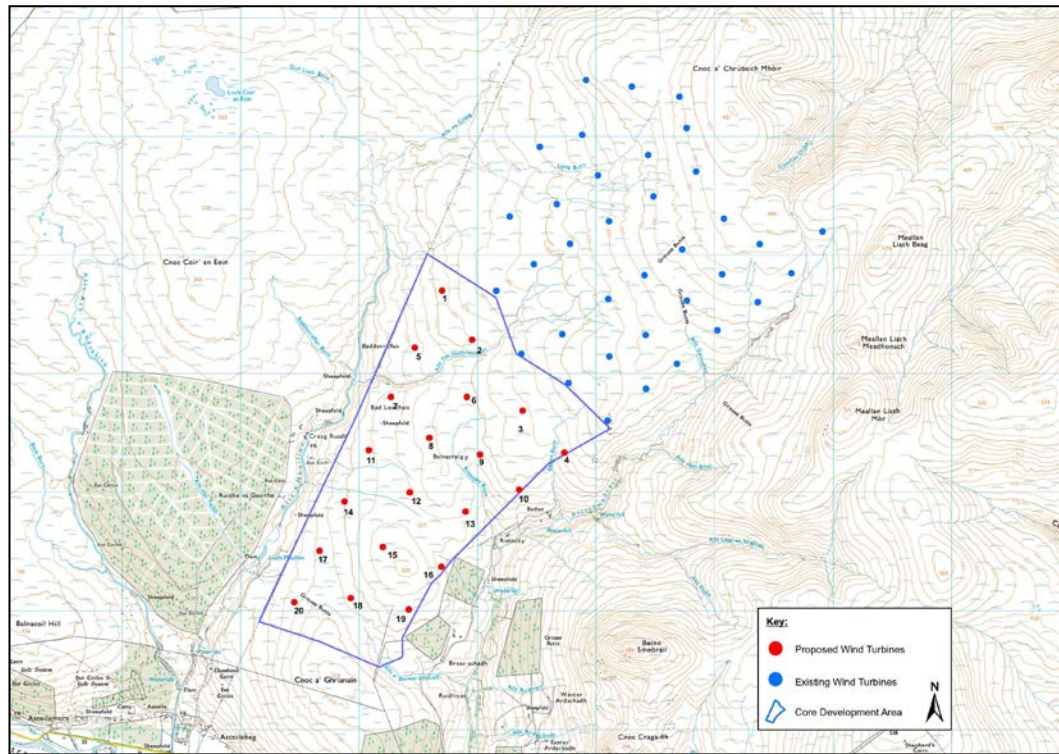
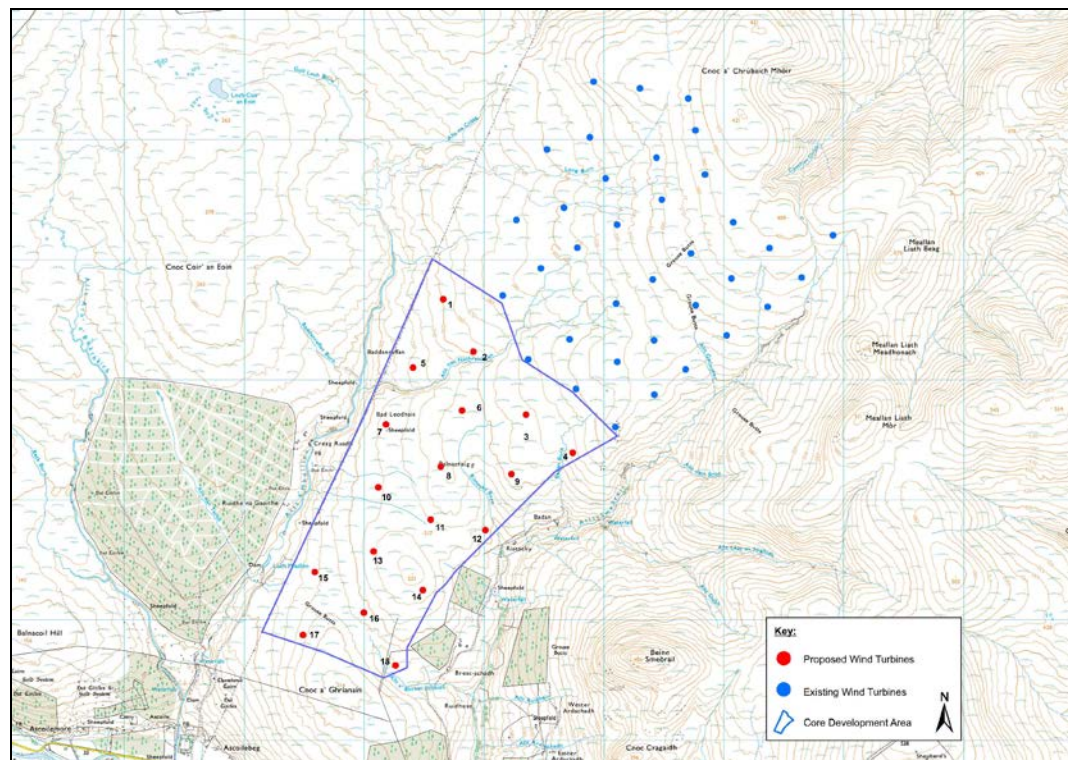


Plate 3.2: Design 2 (October 2013)



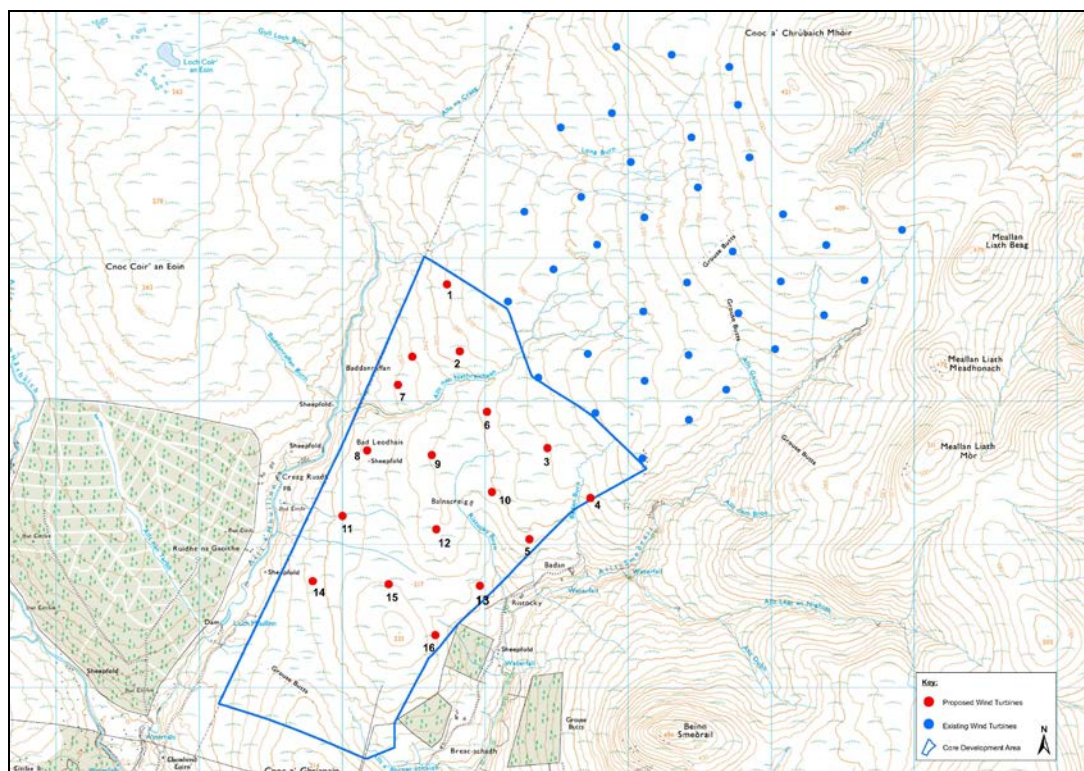
### Design 3 (July 2014)

3.4.6 Following collation and preliminary analysis of the environmental survey data, as well as review of the scoping opinion responses and feedback from the local community following a public exhibition, a first iteration constraints meeting was held in July 2014 with the EIA team to outline and discuss preliminary findings. Potential issues raised by the EIA team included:

- **Landscape & Visual** – the concept of the turbine design is to develop visual coherence with the existing Gordonbush Wind Farm, where turbines are arranged in a series of arched rows. In addition, the Development should aim to reduce coalescence with Kilbraur Wind Farm which is located on the opposite side of Strath Brora glen, to avoid the perception of encroachment. Potential views of the Development from the minor road that runs through the glen were also raised.
- **Noise** – Noise modelling carried out on Design 1 indicated that there was a potential for noise impacts on nearby receptors as a result of the Development.

3.4.7 Following consideration of the above, it was determined that the four most southerly turbines had the potential to result in adverse landscape, visual and noise impacts. As a result, it was decided that these four turbines should be removed from the Development, reducing the total number of turbines to 16. In addition, to reduce visibility from the glen, the height of the turbines was reduced to a maximum tip height of 130m.

Plate 3.3: Design 3 (July 2014)



### Design 4 (August 2014)

3.4.8 Further analysis of the 16 turbine layout resulted in the design being further refined to relocate turbines away from environmental sensitivities found on the site, including:

- **Peat** – Turbine positions were relocated to avoid pockets of deep peat across the site identified during a peat probing exercise (see Plate 3.4a).
- **Groundwater Dependent Terrestrial Ecosystems (GWDTE)** – Initial surveys displayed areas of the site exhibiting high and moderate GWDTEs. Further survey work was carried out to demonstrate that habitat type M15b, classed as moderate GWDTE in Scottish Environment Protection Agency (SEPA) guidance, are not groundwater fed in this hydrogeological setting. The findings were shared with SEPA who agreed that habitat M15b was not groundwater fed at this site (see paragraph 3.4.14). The positions of turbines were adjusted to avoid being directly located within areas of high GWDTE, and outwith moderate areas, where possible (see Plate 3.4b).

Plate 3.4a: Design 4 (Peat Constraint) (August 2014)

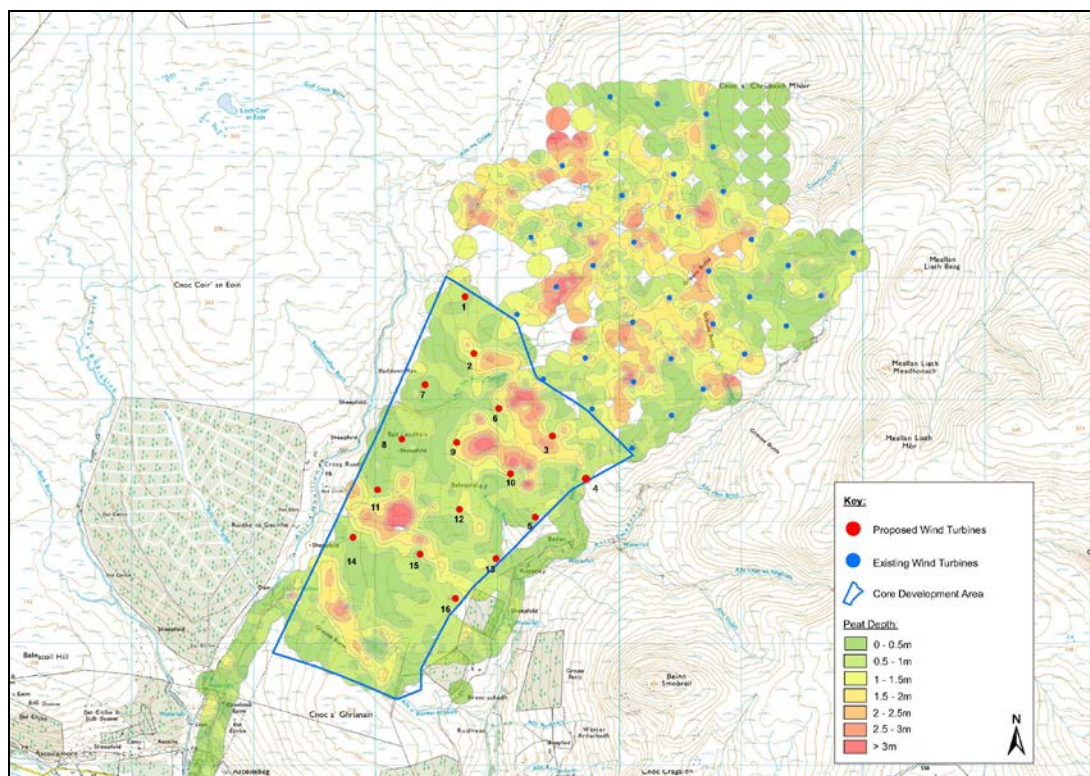
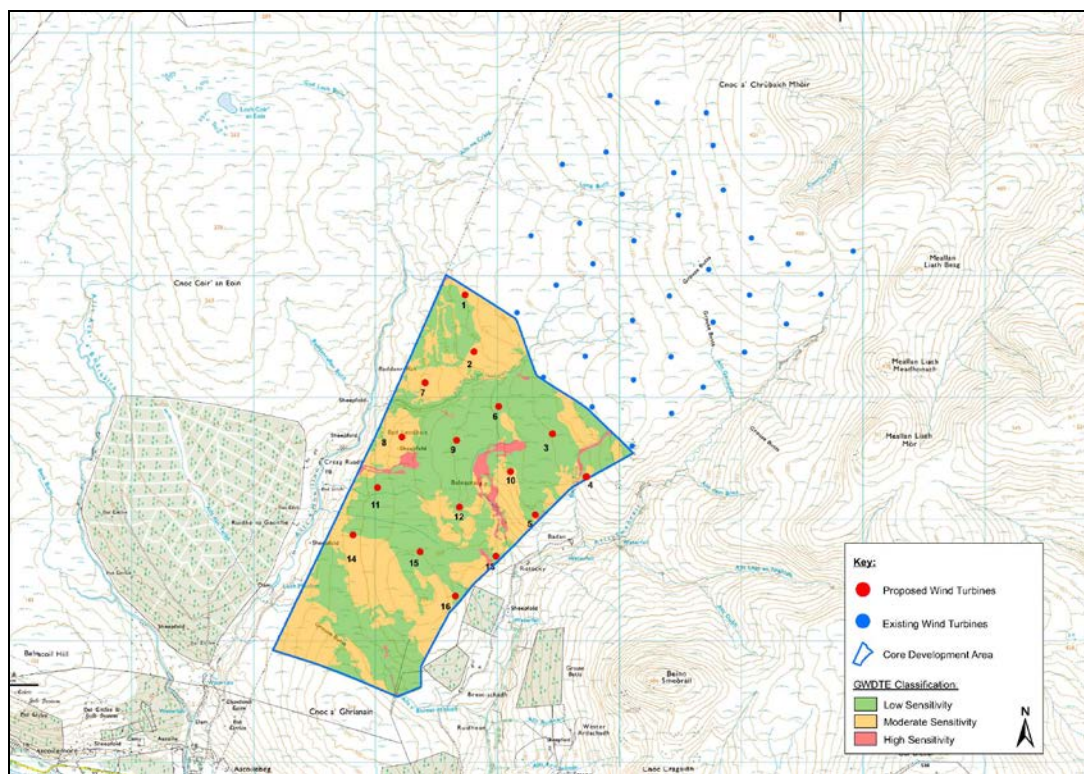


Plate 3.4b: Design 4 (GWDTE Constraint) (August 2014)



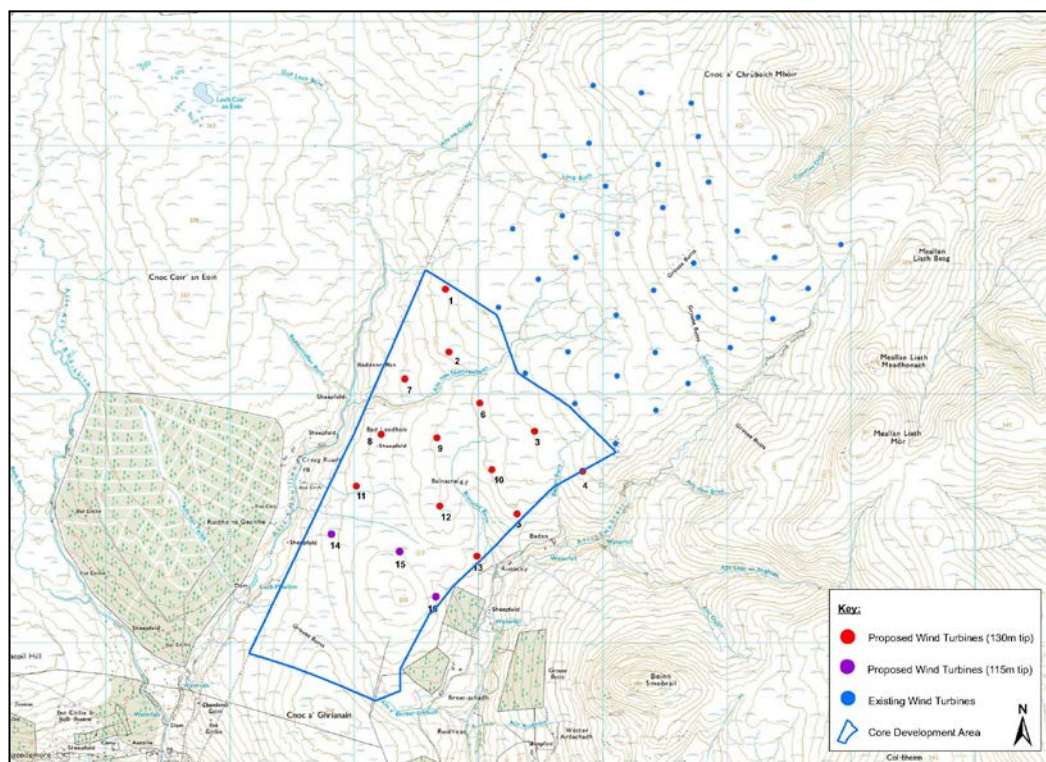
### Design 5 (September 2014)

3.4.9 Further refinement of the layout from a landscape and visual perspective was undertaken, culminating in a number of minor changes, as follows:

- **Landscape & Visual** – Further analysis was undertaken from key viewpoints (including Loch Brora (south-west side); Brora to Rogart Minor road south of Killin; Brora to Rogart minor road north of Killin and Brora to Rogart minor road near Sciberscross; Craggie Beg and Ben Horn) to determine how a reduction in height of some turbines may affect the visual envelope and composition from key views. The most southerly three turbines (Turbines 14, 15 and 16 as shown in Plate 3.5) were positioned on slightly raised ground and often appeared prominent in views. It was decided that a reduction in height of these three turbines would benefit the Development. This will be explained further in Appendix 3.1: Design Statement.
- **Topography** – Further site investigation was undertaken to assess the technical feasibility of constructing and operating each turbine. These investigations identified that Turbine 4 was positioned on land of relatively steep gradient resulting in potential difficulties in constructing and accessing the turbine. As such, Turbine 4 was repositioned to a location 115m north-east, on land of more suitable gradient.

3.4.10 Following consideration of the above, the three most southerly turbines were reduced in height to 115m to tip (the remaining 13 turbines maintaining a tip height of 130m to tip). In addition, Turbine 4 was micro-sited to a position approximately 115m to the north-east.

Plate 3.5: Design 5 (September 2014)



### Design 6 (Final Layout) (January 2015)

- 3.4.11 Further consultation with SEPA was undertaken to discuss the potential impacts on areas of habitats classified as moderate GWDTE's. This was supported by further investigation carried out by the project hydrologist to determine the potential impact of the Development on groundwater flow and groundwater quality feeding the identified sensitive receptors. Results demonstrated that no further changes to the design were considered necessary. This data was shared with SEPA who agreed that the layout design was acceptable in terms of potential impacts on GWDTE<sup>2</sup> (see Chapter 9: Hydrology, Hydrogeology and Geology).
- 3.4.12 Subsequent discussions with SEPA<sup>3</sup> also resulted in a minor reconfiguration of the access track leading to Turbine 14 and 16 to minimise potential impacts on peat.

### Summary

- 3.4.13 A summary of the key stages in the design iteration process is provided in Table 3.2.
- 3.4.14 The final layout consists of 16 turbines; Turbines 1 – 13 with a maximum tip height of 130m and Turbines 14 – 16 with a maximum tip height of 115m (see Figure 4.2).

<sup>2</sup> Email sent by Gordon Robb (SLR Consulting) to Susan Haslam (SEPA) on 22<sup>nd</sup> January 2015 'RE: SEPA Response to Consultation Reference 113001/4.4/L130925'

<sup>3</sup> Letter sent by Susan Haslam (SEPA) to Gordon Robb (SLR Consulting) on 27<sup>th</sup> January 2015, Ref: PCS/138096

**Table 3.2: Summary of key stages in the design iteration process**

Design Iteration	No. of Turbines	Turbine Height	Effect of Modification
1	20	132m	Maximised energy yield by using all available space.
2	18	132m	Alternative design to maximise energy yield.
3	16	130m	Removed 4 southerly turbines to reduce potential noise impacts and visual impacts from Strath Brora Glen.
4	16	130m	Refinement of turbine locations to avoid deeper areas of peat and GWDTEs.
5	16	Turbine 1 – 13 = 130m Turbine 14 – 16 = 115m	Reduction in tip height of the three southerly turbines to reduce prominence from key views.
6	16	Turbine 1 – 13 = 130m Turbine 14 – 16 = 115m	Final Layout

### 3.5 Associated Infrastructure

3.5.1 As previously noted, the Development lies adjacent to Gordonbush Wind Farm, which presents an opportunity to utilise some of the existing infrastructure.

#### Internal Track Layout

3.5.2 A focus of the internal track layout was to utilise the existing Gordonbush Wind Farm access tracks as far as practicable. The aim was to have spurs of new track from the main spine to each individual turbine.

3.5.3 Once the wind turbine layout had been fixed, the environmental constraints gathered during this process were analysed to inform the internal spur track design. Minimising potential impacts to environmentally sensitive receptors was paramount. This was completed as an iterative process between the Applicant and the EIA Team. As a result approximately 11km of existing track are to be reused and 7.96km of new track would be required. A combination of cut tracks and floating tracks are proposed, depending on local ground conditions.

#### Borrow Pits

3.5.4 Existing on site borrow pits used during the construction of Gordonbush Wind Farm were preferred to the establishment of new borrow pits, where practicable. A ground investigation exercise was carried out to establish whether the reinstated on site borrow pits had the potential to be reopened.

3.5.5 Not all of the borrow pits included in the Gordonbush Wind Farm planning application were developed due to aspects such as material availability requirements. Therefore, during the ground investigation works, preference was given to those on site borrow pits that had previously been utilised, but other factors depending on material availability and

proximity to where it is required were also considered. Any further borrow pits required were also identified following the detailed surveys within the core development area.

- 3.5.6 This detailed survey demonstrated that 2 borrow pits had potential to be reopened (see Figure 4.2 and Appendix 9.4: Borrow Pit Assessment). Stone required for construction of the Development would be limited, as the internal access tracks developed for the Gordonbush Wind Farm would be utilised, with material required for development of the spur tracks and other requirements.

#### **On-site Substation & Control Building**

- 3.5.7 The Development would connect to the electricity transmission network using the existing substation constructed for Gordonbush Wind Farm (see Figure 4.2: Site Layout). The substation would connect the Development to the adjacent existing 275kV transmission line.

### **3.6 References**

Planning Advice Note 68: Design Statements (2003), Scottish Government

Siting and Designing Wind Farms in the Landscape (Version 2) (2014), Scottish Natural Heritage

Strategic Locational Guidance for Onshore Wind Farms in Respect of the Natural Heritage, Policy Statement No. 02/02 (2002, latest update March 2009), Scottish Natural Heritage

The Highland Council (2011). Interim Supplementary Guidance: Onshore Wind Energy (Approved March 2012)