Chapter 3

Site Selection and Design

SCOTTISHPOWER RENEWABLES

Table of contents

List of Figures

List of Appendices

None

Chapter 3

3 Site Selection and Design

3.1 Introduction

1. This chapter outlines the process undertaken in selecting the Site as a potential location for a windfarm development, provides a description of the Site and surrounding area, and discusses the design evolution process.

2. One of the principles of the Environmental Impact Assessment (EIA) process is that Site selection and project design should be an iterative constraint-led process, have been followed as part of the evolution of the Proposed Development. This has ensured that potential negative impacts, as a result of the Proposed Development, have been avoided or minimised as far as reasonably possible.

3. This chapter draws on issues considered in more detail in the relevant technical chapters (**Chapters 5 to 13**). This chapter does not pre-empt the conclusions of the later chapters, but rather explains how potential environmental effects have informed the design of the Proposed Development.

4. The final design for the Proposed Development is described in **Chapter 4: Development Description** and is shown on **Figure 4.1 Site Layout**.

3.2 Site Selection and Consideration of Alternatives

5. The Applicant uses a range of criteria to select sites for the development of renewable energy projects. As part of the growth plans for the development of renewable energy projects, the Applicant is continually assessing potential sites. This pipeline of potential sites is commercially sensitive and are not considered to be alternative sites to the Proposed Development. Alternative sites are not considered further in the EIAR. However, in accordance with Schedule 4 (2) of the EIA Regulations, reasonable alternatives in terms of development design, technology, location, size and scale of the Proposed Development have been considered.

6. Forestry and Land Scotland (FLS) facilitate developers once they have selected an area, to generate proposals for consideration and further progression for renewable energy development. In 2011, the Applicant was awarded the south west Scotland forest estate to further explore the potential for renewable energy to be generated on the FLS estate. The Proposed Development Site was one of these sites.

3.2.1 Location

7. The Proposed Development would be located within Carrick Forest in South Ayrshire, centred on British National Grid (BNG) reference BNG (237186, 598381), and as shown within **Figure 1.1 Site Location** (hereafter referred to as the Site**)**. The Proposed Development is located wholly within the South Ayrshire Council administrative area.

8. A number of factors were considered when selecting this location as suitable for a windfarm, including:

- initial desk-based studies and wind monitoring onsite suggest that there is good wind resource available at the Site to support a renewable energy development;
- the Site has been identified by the Applicant as suited for energy storage which would complement the operation of wind turbines;
- there are no international or national statutory designations for landscape and nature conservation in, or within proximity of, the Site Boundary;
- it utilises existing forestry access from the public road network enabling good access from the public road network particularly for longer blades which allows consideration of larger wind turbines to make the best use of the expected wind resource;
- there are available options to connect the Proposed Development onsite substation to the existing transmission line which is located within the Site;
- opportunity to use and upgrade the existing forestry track onsite where possible, especially at existing entrances from the C46W public road; and
- there are no residential properties within 1 kilometre (km) of the wind turbines.

9. In addition, Scottish Planning Policy (SPP) (June 2014) provides support for renewable energy development in principle and encourages local authorities to guide developments towards appropriate locations. Paragraph 154 states that the planning system *"should support the transformational change to a low carbon economy, consistent with national objectives and targets (with further targets being set in due course), including deriving 30% of overall energy demand from renewable sources by 2020 and the equivalent of 100% of electricity demand from renewable sources by 2020.It will also aim to support the development of a diverse range of electricity generation from renewable energy technologies – including the expansion of renewable energy generation capacity"*.

10. SPP Paragraph 155 also states that *"development plans should seek to ensure an area's full potential for electricity and heat from renewable sources is achieved, in line with national climate change targets"*. In response to these policy requirements, South Ayrshire Council has undertaken a Landscape Wind Capacity Study (LWCS) (August 2018) to identify those landscapes which, in principle, have the capacity to accommodate wind turbines. South Ayrshire Council has identified the landscape in which the Site largely sits in as landscape character type (LCT) 17c – foothill with forest and windfarms (see **Figure 5.3 Landscape Character Areas**). This information has helped inform the Site selection process.

11. The iterative design process, informed by this EIAR, helps to ensure that the Site's full potential for electricity generation is achieved.

3.2.2 Technology Size and Scale

12. Onshore wind continues to be one of the cheapest forms of renewable energy; however, the challenge is to meet the Scottish Government targets for net-zero greenhouse gas emissions by 2045, within a context of limited Government support mechanism for onshore wind. The supply of smaller wind turbines across Europe is reducing due to lack of demand as manufacturers are recognising the world market is shifting to larger machines and are focusing their development work on larger wind turbines which secure the highest yield.

13. Larger wind turbines must be considered if onshore wind development is to continue to contribute to both the United Kingdom (UK) and Scottish Government's renewable energy targets. Larger wind turbines provide greater electricity generation than smaller wind turbines. Therefore, for a site to generate the same output, comparatively more smaller wind turbines would be required, which would require a larger site and potentially involve additional environmental effects (i.e. more wind turbines visible, increased footprint). In addition, larger wind turbines in forestry has the potential to reduce the scale of key holing required.

14. The number of wind turbines on the Site has been informed through the design evolution process as detailed further in this chapter and has taken environmental as well as technical considerations into account. The rest of the infrastructure is required to enable construction and operation of these wind turbines. An Energy Storage Facility (i.e. battery)[1] (up to 20 megawatts (MW)) is also being considered as part of this application.

[1] Subject to landowner agreement.

3.3 Site Description

15. The Proposed Development is located within Carrick Forest which is a commercial forest and part of the National Forest Estate. Carrick Forest is owned and managed by FLS in south west Scotland. The Site lies between 243 – 430m Above Ordnance Datum (AOD), the highest point is Garleffin Fell (430m AOD), the summit of which lies within the western part of the Site Boundary. The Site occupies an area of approximately 827.28 hectares (ha). The land use is predominantly commercial forest, there is a comprehensive network of internal forestry roads within the Site which connects to the wider road network. The Site lies within the north of the Galloway Forest Park[2] and partially within the core zone of the Galloway Dark Sky Park[3].

16. The following recreational routes cross the Site Boundary:

- there are two core paths which cross the Site, SA 47 and SA 49 (which crosses the very edge of the Site);
- the Old Road through Straiton Heritage Path passes through the north west part of the Site;
- the Scottish Hill Track also passes through the north western and south eastern part of the Site;
- National Catalogue of Rights of Way (CRoW) (SKC.SKC7/1)); and
- forest roads (roads with the Galloway Forest Park).

17. There are several watercourses found within the Site, which drain into the River Stinchar and Water of Girvan. The majority of the Site is within the Palmullan Burn catchment (a sub-catchment of the Water of Girvan), encompassing much of the central and western parts of the Site. Tairlaw Burn catchment, another sub-catchment of the Water of Girvan encompasses the north eastern part of the Site, The southern part of the Site is within the River Stinchar catchment with the south western corner sitting within the Dalquhairn Burn subcatchment. Linfern Loch located directly to the south of the Site is also within this catchment. The loch is owned by a third party.

18. There is a 275 kilovolt (kV) overhead ScottishPower transmission line that passes through the south eastern corner of the Site, and a Scottish Water pipeline connecting to Loch Bradan also runs directly adjacent to the south eastern edge of the Site.

3.3.1 Surrounding Area

19. The surrounding area is rural with land largely being used for commercial forestry and agriculture. There are a number of local 'consultation routes' used for timber extraction as identified by the Timber Transport Forum, in proximity to the Proposed Development.

20. Straiton is the nearest settlement to the Site and is located approximately 6km to the north of the Proposed Development. There are no residential properties within the Site, however there are a number of isolated residential properties in proximity to the Site, these include but are not limited to Glenmartin, Glenalla, Doughty, White Row, Black Row, Tallaminnoch, Tairlaw Toll and the dwelling identified as 'South of Genoch'.

21. The Merrick Wild Land Area (WLA)[4] lies approximately 3km to the south east of the Site. It consists of a range of steep hills, including Merrick which at 843m is the highest mainland hill in the south of Scotland. Together, with several other hills over 600m in height, these steep hills form a ridge with spurs between the tops of Shalloch on Minnoch and Benyellary, collectively known as 'The Range of the Awful Hand'.

22. The Site is within the United Nations Educational, Scientific and Cultural Organization (UNESCO) Galloway and South Ayrshire Biosphere Reserve transition area and buffer zone. The Biosphere Reserve is part of the UNESCO biosphere programme and is a non-statutory designation in recognition of the area's landscape, wildlife, cultural heritage and learning opportunities.

23. There are three ecologically designated sites located within 5km of the Proposed Development which are as follows:

- Auchalton Site of Special Scientific Interest (SSSI) located approximately 4km to the north of the Site;
- Knockgardner SSSI located approximately 4km to the north of the Site; and
- Blair Farm SSSI located approximately 3km to the north west of the Site.

24. Operational windfarms within 10km of the Site are presented in **Table 3.1** and are considered to have the most bearing on the design of the Site.

Development	Status	Number of Wind Turbines	Direction from Site	Approx. Distance to Nearest Wind Turbine
Dersalloch Windfarm	Operational	23	North east	5.12km
Hadyard Hill Windfarm	Operational	52	West	4.435km
Penwhapple Windfarm	Operational	1	North west	9.3km

Table 3.1: Cumulative Developments within 10km of the Proposed Development Wind Turbines

25. Other windfarms, including those in planning, consented or under construction within 30km of the Site and which are considered in the cumulative assessment are illustrated in **Figure 5.9 Cumulative Sites Location Plan 30km Study Area**.

3.4 Design Concept and Approach

26. The identification of constraints continued throughout the design process as more detailed surveys revealed additional design influences on the Proposed Development. As a result, the findings of the technical and environmental studies have been used to inform the design of the Proposed Development, and hence achieve a 'best fit' within the existing conditions of the Site. For example, where potentially significant effects have been identified, efforts have been made to avoid these through refining the design of the Proposed Development. This is referred to within this EIA as mitigation embedded in the Proposed Development layout and design, or simply 'embedded mitigation'.

27. An iterative design approach works in tandem with the EIA process and allows a receptive design process where incremental changes in layout and design result from a continually developing understanding of environmental considerations. This iterative approach allows potential environmental effects, as they are identified, to be minimised through alterations in design. Those effects which have not been mitigated through embedded mitigation are assessed in the technical chapters of this EIAR. Further information on embedded mitigation is explained in each technical chapter of this EIAR as appropriate.

28. 'Embedded mitigation' includes but is not limited to:

- sensitive siting of the proposed infrastructure incorporating appropriate buffer distances from environmental receptors to avoid or reduce effects on the environment;
- considering the size and scale of the Proposed Development appropriate to the location;
- considering the appearance, finish and colour of wind turbines and the control building in accordance with Scottish Natural Heritage[5] (SNH) Guidance 'Siting and Designing Wind Farms in the Landscape', Version 3a ((SNH), 2017);
- re-using existing infrastructure as much as possible to avoid the creation of new infrastructure elements;

[2] Galloway Forest Park is a forest park operated by FLS. Available at: https://forestryandland.gov.scot/visit/forest-parks/galloway-forest-park.

[3] Galloway Dark Sky Park is a place with exceptionally dark night skies and a place where people have committed to keeping these skies dark, by controlling light pollution. Available at: https://forestryandland.gov.scot/visit/forest-parks/galloway-forest-park/dark-skies.

[4] SNH (2017). Merrick Wild Land Area. Available online at: https://www.nature.scot/sites/default/files/2017-11/Consultation-response-Description-of-Wild-Land-Merrick-July-2016-01.pdf.

[5] SNH is now known as NatureScot.

- design of the tracks to minimise cut and fill[6], reducing landscape and visual effects;
- inclusion and design of borrow pit(s)[7] to minimise the amount of the material required to be imported to the Site; and
- potential for up to 50 metres (m) micrositing of infrastructure during construction to ensure the best possible location is chosen based on site investigations.

29. Throughout the design evolution of the Proposed Development layout, a key driver has been the consideration of potential landscape and visual effects on receptors and how the Proposed Development would relate to the existing landscape character as well as existing windfarms in the landscape. Consideration has been given to the scale and number of wind turbines proposed, cumulatively with existing and proposed windfarms in the area, in particular the proposed Craiginmoddie Windfarm and Knockcronal Windfarm. The landscape and visual effects potentially caused by the Proposed Development have been considered extensively from key receptors. The resulting analysis has been an important input into the design evolution process of the Proposed Development and in particular to the layout design of proposed wind turbines.

30. In line with Nature Scot's 'Siting and Designing Windfarms in the Landscape (SNH, 2017), the layout and design of the Proposed Development have been considered as part of an iterative design process aimed at reducing the potential landscape and visual effects of the windfarm whilst taking into account other site constraints and technical requirements.

3.5 Design Objectives

3.5.1 Schedule 9 of the Electricity Act 1989

31. This EIAR has been prepared in respect of a development which will be applied for in the context of Section 36 of the Electricity Act 1989.

32. The Applicant holds a Generation Licence and is required to have regard to the matters set out in Schedule 9 of the Electricity Act in formulating relevant proposals. Paragraph 3(1)(a) of Schedule 9 requires the Applicant to consider the "*desirability of preserving natural beauty, of conserving flora, fauna and geological or physiological features of special interest and of protecting sites, buildings and objects of architectural, historic or archaeological interest.*" In addition, under Schedule 9, paragraph 3(1)(b) the Applicant must "*do what he reasonably can to mitigate any effect which the proposals would have on the natural beauty of the countryside or on any such flora, fauna, features, sites, buildings or objects*". Through the EIA process, the Applicant has sought to develop a scheme that takes account of the duties set out in Schedule 9 of the Electricity Act. The matters that are raised in Schedule 9 have been considered in the EIA process and the findings are presented in this EIAR. Scottish Ministers are then required, under Schedule 9, paragraph 3(2) to have regard to the specified matters and assess whether the Applicant has fulfilled its duties as set out in Schedule 9, paragraph 3(1).

33. Schedule 9 also sets out requirements for the protection of fisheries by generating licence holders whereby paragraph 3(3) states that "*in exercising any relevant functions each of the following, namely, a licence holder, a person authorised by an exemption to generate or supply electricity and the Secretary of State shall avoid, so far as possible, causing injuries to fisheries or to the stock of fish in any waters.*" The assessment of impacts on fish is addressed in **Chapter 6: Hydrology, Hydrogeology, Geology and Soils**; **Chapter 7: Ecology**; and **Appendix 7.3: Aquatic Ecology Baseline Report**.

3.5.2 Design Objectives

34. The landscape and visual design strategy for the Proposed Development has taken into account and sought to balance the following objectives:

- to ensure so far as possible, a layout which achieves a reasonably balanced group of wind turbines when seen from key receptor locations in the surrounding landscape;
- to reduce proximity to and visibility from residential properties as well as the settlements of Barr to the south west, Dailly to the west and Straiton to the north;
- to minimise so far as possible, visibility from the Merrick WLA, Galloway Hills and from key points within Galloway Forest Park and Dark Sky Park;
- take advantage of the natural containment provided by the undulating foothills of the Site and its surroundings to provide screening of the proposed wind turbines to the wider landscape and visual receptors;
- to consider the cumulative landscape and visual impacts from the Proposed Development with operational windfarms such as Dersalloch Windfarm and Hadyard Hill Windfarm, as well as nearby proposed windfarms such as Clauchrie Windfarm, Craiginmoddie Windfarm and Knockcronal Windfarm: and
- to take account of the various environmental and technical constraints identified within the Site.

35. The following list of key design objectives takes into account these landscape considerations and objectives from other environmental disciplines:

- retain wind turbines within the north of the Site Boundary used at time of EIA Scoping to reduce significant visual impacts, so far as possible, on sensitive receptors such as Shalloch on Minnoch and Merrick WLA;
- connecting directly into the existing 275kV overhead line (OHL) which passes through the south eastern corner of the Site eliminating the requirement for a separate OHL and all potential environmental effects of such a development;
- limit proximity to closest residential receptors;
- limit proximity of wind turbines to nearby operational and proposed windfarms;
- avoid the creation of distinct wind turbine outliers by arranging them as a coherent grouping;
- limit the degree of wind turbine stacking from key receptors;
- maintain an appropriate buffer between the Proposed Development and identified breeding bird locations and other known ecological and ornithological constraints;
- limit impacts on priority peatland and carbon assets;
- limit impacts on watercourses;
- limit impacts on known archaeological assets;
- respect other environmental constraints; and
- create a scheme which maximises the potential of the Site to generate and store renewable energy.

3.5.3 Engineering Design Evolution

36. In addition to the landscape and visual considerations in the Site layout design approach, the following technical, engineering and environmental objectives were developed:

- maximise wind energy yield from the wind turbines as far as possible;
- avoid slopes in excess of ten percent for access tracks;
- avoid locating wind turbines in areas of deep peat and known wet/boggy areas;
- reduce requirement for watercourse crossings and maintain a buffer of 50m from watercourses;
- use of the existing infrastructure (forestry tracks and borrow pits on the Site) as far as practicably possible; and
- maintain appropriate buffers from ecological, ornithological and cultural heritage features.

[6] In earthmoving, cut and fill is the process of constructing a new surface such as a road whereby the material from cuts roughly matches the amount of fill needed to make nearby embankments.

[7] Borrow pits refer to the pits dug for using their materials for construction for a roads, hardstanding and foundations and Type 1 surface materials. When the amount of soil obtained from cutting is not enough to complete the road embankment, extra earth is required and this extra earth is collected from borrow pits.

3.6 Constraints Identification and Mapping

3.6.1 Introduction

37. The design of any windfarm is driven by the key objective of positioning wind turbines so that they capture the maximum energy possible within a suitable area, further informed by environmental and technical factors.

38. The designations within the Site (refer to **Figure 3.1 Environmental Designations**) and surrounding area (refer to **Figure 3.2 Wider Environmental Designations**) were identified as part of the early stage constraints mapping.

39. Other known environmental and technical constraints within the Site were also identified as part of the early stage constraints mapping. It is important to note that the identification of a constraint does not necessarily result in the exclusion of that area from the potential development envelope; rather it means that careful thought and attention was paid to the constraint and where necessary and feasible, the design altered appropriately. The key constraints which were considered during the design process included:

- topography;
- identified landscapes and visual constraints;
- sensitive ornithology, protected habitats and species;
- ground conditions (including peat);
- watercourses, private water supplies and related infrastructure;
- cultural heritage assets;
- location of residential properties – potential impacts on residential visual amenity, proximity to noise sensitive receptors; and potential for shadow flicker effects;
- aviation;
- key recreational and tourist routes;
- forestry; and
- telecommunications links, power lines and pipelines.

40. The identification of constraints continued throughout the design evolution process as more detailed surveys refined the Site Boundary.

41. A description of how the various environmental and technical disciplines have contributed to the design through detailed assessment is described below. Information in respect of the survey work undertaken is provided in the technical chapters of this EIAR.

3.6.2 Wind Analysis

42. Wind analysis and efficiency modelling has been carried out by the Applicant at key stages throughout the design evolution process to identify the areas of the Site likely to produce the most yield and ensure the commercial viability of the Proposed Development. Wind yield calculations provided were used to establish the initial search area for the potential wind turbine positions. As further constraints information was obtained and the design processed, wind analysis was again considered at each subsequent potential wind turbine layout.

43. For wind turbines to work as effectively as possible, they must be suitably spaced relative to the predominant wind direction. If they are too close together in this direction, the wake effects from the wind turbines located on the upwind edge of the array would create turbulent air for the next row and so on through the array. A high wake effect (expressed as a percentage) is disadvantageous to the overall productivity of the Site. Conversely, if wind turbines are located too far apart, the opportunity to maximise the capacity and thereby electricity generation from the Site is reduced.

44. There is no industry standard for spacing, only manufacturer recommendations and operational experience. Referring to onsite wind measurement data, it was confirmed by the Applicant that there are high percentages of wind direction from northwest, through southwest and southeast at the Site. As a result, a spacing of five times rotor diameter in all wind directions was applied for the Proposed Development.

45. In accordance with National Grid guidance[8], a 450m[9] OHL buffer was included to ensure that no wind turbines were placed in proximity to the OHL.

3.6.3 Topography

46. The steepest areas of the Site have been avoided for the development of infrastructure. The topography within the Site Boundary consists of undulating forested foothills, ranging between 242m to 430m above ordnance datum (AOD). Lower lying areas are in the east, with rising ground to the west including Garleffin Fell as the highest point within the Site. Linfern Loch lies just to the south of the centre of the Site at approximately 290m AOD. Beyond the Site boundary to the south, the land is characterised by the steep valleys of the River Stinchar. To the north and north east, beyond the foothills at the edge of the Site, the land falls steeply to the Water of Girvan valley. Beyond the southern boundary of the Site, the forestry opens out to the rugged moorland uplands of Eldrick Hill and Balloch forest plantation.

47. Areas with slope exceeding 25% gradients were identified as part of the initial constraints mapping and excluded for any and all development. Further assessment was undertaken throughout the design process with wind turbines located away from potentially restrictive topography, including the areas south-west of wind turbine 1 and south of wind turbine 4.

48. Slope and the topography of the Site have been considered as a further constraint for the location and placement of infrastructure. Access tracks have been designed with a maximum slope of ten percent to ensure all locations can be accessed safely and without limitation for the abnormal load vehicles delivering the wind turbine components. The positioning of the hardstanding and crane pads aim to minimise required earthworks to establish a level and suitably constructed platform, avoiding steep or undulating topography where possible.

3.6.4 Landscape Character and Visual Amenity

49. Potential effects on the landscape and visual resource have been an important factor in this iterative process, with both the appearance of the Proposed Development considered on its own, and its appearance within the context of the operational Dersalloch and Hadyard Hill Windfarms, the not yet consented Clauchrie and Craiginmoddie Windfarms and the proposed Knockcronal Windfarm being considered. This was carried out through the repeated testing of layout iterations as seen from agreed design viewpoint locations representing key local landscape and visual receptors around the Site.

50. Due to the generally high visibility of windfarms, landscape and visual aspects are particularly important and have therefore driven the layout design from an early stage. The final wind turbine layout has been optimised for landscape and visual reasons as far as possible using the agreed viewpoints.

51. Where possible, the proposed excavation and location of the access tracks, hardstandings, Substation Compound, borrow pits and other infrastructure has been reviewed to minimise physical landscape, landscape character and visual amenity effects.

3.6.5 Ecology and Ornithology

52. Ecological surveys were carried out across the Site throughout 2020 and 2021 including a National Vegetation Classification (NVC) survey, protected species surveys (including for badger, otter, water vole, pine marten, red squirrel, great crested newts (GCN), bats, fish and fresh water pearl mussel surveys (FWPM)), in order to identify broad areas of constraint to windfarm development.

53. Surveys for potential Groundwater Dependent Terrestrial Ecosystems (GWDTE) found evidence that these habitats are mainly confined to areas within forestry rides and adjacent to watercourses traversing the Site. These areas

[8] EnergyNetworks Association (2012). Separation between Wind Turbines and Overhead Lines. Available at: https://www.spenergynetworks.co.uk/userfiles/file/Energy_Networks_Association_Separation_Wind_Turbines_Overhead.pdf

[9] 450m is in relation to being three times the rotor diameter measured horizontally from the centre line of each wind turbine body to the nearest point on the centre line of the overhead line (the “separation distance”).

have been avoided as far as possible in the wind turbine layout design. As the design evolved, these areas were further investigated to establish their groundwater dependency. The potential GWDTEs identified, are considered to have 'Low' groundwater dependency and are not considered sensitive to groundwater alterations as a result of the Proposed Development. If considered to be groundwater fed, mitigation measures have been proposed to reduce potential alterations to sub-surface flows and groundwater levels by the works.

54. The recommended habitat standoff distances from blade swept path to key habitat features have been incorporated into the design to reduce collision risk to bats.

55. Ornithology surveys have been carried out across the Site from 2018 to 2020, including flight activity surveys; breeding raptor and breeding bird surveys; and winter walkovers for non-breeding birds. Black grouse and nightjar surveys have also been completed. Appropriate buffer areas were placed around sensitive features, where identified, and these buffers were adhered to in the design of the Site.

3.6.6 Peat Habitat and Depth

56. As indicated on the SNH Carbon and Peatland Map (2016), the Site is predominantly covered by Class 5 (peat soil; no peatland vegetation). Class 4 (predominantly mineral soil with some peat soil; heath with some peatland) is present within the central and western areas of the Site. NatureScot Carbon and Peatland Class 1 (Nationally important carbon-rich soils, deep peat and priority peatland habitat) is located to the west of Linfern Loch, with no Class 2 ((Nationally important carbon-rich soils, deep peat and priority peatland habitat) or Class 3 (predominantly peaty soil with some peat soil; peatland with some heath) within the Site. Whist there are Class 1 soils within the Site the design has avoided siting any part of the development within this habitat. Site visits have confirmed the presence of peat of variable condition and depth across the Site, with deeper peat occurring in the central area north of Linfern Loch and to the south east of the Site. Area of deeper peat were avoided where reasonably practicable when considering the wind turbine locations and infrastructure design.

57. Peat probing was undertaken in March 2020 and August 2021. A review of this data, in conjunction with slope gradients allowed areas of deep peat (typically greater than 2.5m) to be avoided for development, where possible at an early stage. Wind turbine locations avoided areas of deep peat greater than 2.5m where possible. However, the hardstanding for wind turbine 10, tracks for wind turbine 7 and hardstanding for wind turbines 3 and 1 are located within depths greater than 2.5m. This was due to a number of other constraints (landscape, visual etc.) which meant the hardstanding was not able to be located outwith the area of deeper peat.

58. The peat data is discussed in **Chapter 6: Hydrology, Hydrogeology, Geology and Soils**. As part of the Proposed Development, where possible all proposed infrastructure and borrow pit search areas have been designed to avoid areas which may be subject to peat slide risk. Peat depth was fully considered as part of optimising the design and in recognition of peat as a carbon sink. A carbon balance assessment has been undertaken to determine the payback period for the Proposed Development (refer to **Chapter 13: Other Issues**).

59. The ground condition constraints that were taken into account in the design of the Proposed Development have been:

- identification of peat depths in excess of 2.5m – to minimise incursion, protect from physical damage, minimise excavation and transportation of peat, reduce potential for peat instability and minimise potential soil carbon loss; and
- avoidance of areas where initial peat stability concern was identified, where possible to avoid areas with possible instability issues and associated indirect effects on surface water.

3.6.7 Hydrology and Hydrogeology

60. A 50m buffer zone has been applied around all watercourses which traverse the Site. These buffers were used to ensure that wind turbines and infrastructure, other than tracks which have to cross watercourses were not located, where possible, in proximity to hydrological features in accordance with windfarm construction best practice (SNH, 2019). This reduces the risk of run off and water pollution into existing watercourses.

61. In some cases, the use of existing tracks, which are already less than 50m to a watercourse, have been identified as the best option for design, minimising the need for new access tracks.

62. Watercourse crossings have been minimised as far as possible; using existing crossings where possible. Six watercourse crossings where controlled activities regulations (CAR) apply have been identified from the final track layout, with reference to 1: 50,000 ordnance survey (OS) mapping within the Site. Further detail is provided in **Chapter 4: Development Description.**

63. Consideration was also given to the potential impacts upon private water supplies (PWS). Data on PWS was obtained from South Ayrshire Council and Scottish Environmental Protection Agency (SEPA), and are identified as a constraint to the Proposed Development. A 5km radius around the Site Boundary was applied and any PWS within 5km were identified. Seven PWS were located within the 5km radius, with six of them assessed during a site visit. During that survey, one further property was identified as of interest and included in the assessment. A 500m buffer was applied around these PWS and wind turbines were located outside of this buffer.

64. Development on peatland has been largely avoided based on the peat probing data collected in 2020-21. No infrastructure is located on class 1, nationally important carbon-rich soils, deep peat and priority peatland habitat. Development on peatland was fully considered as part of the design, both in recognition of the role of peatland in establishing possible habitat connectivity and as a carbon sink. A carbon balance assessment has been undertaken to determine the payback period for the Proposed Development (refer to **Chapter 13: Other Issues**).

3.6.8 Cultural Heritage Features

65. A walkover survey of the wind turbine locations and access tracks provided early identification of heritage assets within the Site. There are two undesignated heritage assets within the Site Boundary. The potential for impacts on these heritage assets was mitigated through the design process, with preservation in situ being the preferred option for mitigation of heritage assets. The early identification of these heritage assets allowed for the avoidance of a high concentration of heritage assets within the northern portion of the Site Boundary, that included the Scheduled Monument of Knockinculloch Enclosures (SM3357), with changes in the design ensuring this area was not directly impacted upon.

3.6.9 Noise Sensitive Receptors

66. During 2020, background noise monitoring was undertaken at six noise sensitive receptors. These receptors were agreed with South Ayrshire Council as being representative of those closest to the Proposed Development. The selected receptors provide a good geographic spread across the local area, including properties in a sample of different directions from the Proposed Development. The noise assessment requires consideration to the Proposed Development operating in isolation and under a cumulative scenario. The local cumulative developments are Dersalloch Windfarm (operational), Hadyard Hill Windfarm (operational), Craiginmoddie Windfarm (in Planning and Knockcronal Windfarm (in Scoping at time of assessment). The assessment therefore considers those receptors where there is the greatest potential for impact both close to the Proposed Development and close to the identified cumulative developments.

67. The receptors with the greatest potential to be subject to cumulative noise impacts are 'Doughty Farm', 'Glenalla', and 'Knockskae'. Doughty Farm, a dwelling, is to the west of the Proposed Development in the direction of the Hadyard Hill Windfarm, and also in close proximity to the proposed Craiginmoddie Windfarm. Glenalla, a dwelling, is to the north of the Proposed Development, but also sufficiently close to be subject to noise from the proposed Craiginmoddie and Knockcronal Windfarms, which are to the north and west of the Site espectively. Knockskae is one of the closest dwellings to the proposed Knockcronal Windfarm, but it is also sufficiently close that it could also be subject to noise from the Proposed Development. Potential cumulative noise impacts have therefore been a key consideration throughout the design process, including at all receptors where there is the potential for a cumulative noise impact to arise.

3.6.10 Shadow Flicker

68. Shadow flicker has the potential to be an issue for properties which are closer to a wind turbine than a distance of ten times the diameter of the wind turbine's blade length. South Ayrshire Council request that the Study Area around each wind turbine for shadow flicker is 2.5km which is the approach taken in this EIAR. This was considered as part of the constraints mapping process. This is detailed further in **Section 13.6 Shadow Flicker** in **Chapter 13: Other Issues**.

3.6.11 Recreational Receptors

69. During the constraints identification process, a number of recreational receptors were identified. As a result, a core path buffer was applied during the design process to avoid operational impacts on these recreational receptors, specifically core paths SA47 and SA49. These are detailed further in **Chapter 12: Socio-Economics**, **Table 12.9** and **Figure 12.1 Socio-economics, tourism and recreational receptors**.

3.6.12 Forestry

70. As the Site is located within a working commercial forest, forestry forms an integral part of the Proposed Development as trees would require to be felled around infrastructure positions to allow for construction of the development. A Windfarm Forest Plan (see **Appendix 13.1 Forestry**) has been developed for implementation if the Proposed Development is consented. This plan details felling and replanting proposals illustrating the forestry and felling requirements associated with the construction and operation of the Proposed Development. Felling, and subsequent requirements for compensatory planting, have been minimised as far as possible. Wind turbines have been 'keyholed' (3 ha, 100m radius[10]) around each wind turbine base into the existing forestry where crop growth rates and current crop height allow, so that only the trees required for the infrastructure and its associated buffer zones would be cleared. Where this is not possible, the crops will be felled back to the nearest windfarm edge or management boundary and the restocking will be planted so that there is a keyhole around the Proposed Development post restocking.

71. Reference to the local topography, existing forestry, the forest plan and maximising the use of existing forestry infrastructure was considered in the design process.

3.6.13 Telecommunications

72. Consultation with telecommunication providers and stakeholders identified no links which could potentially be affected by the Proposed Development.

3.6.14 Infrastructure

73. There is a 275 kilovolt (kV) OHL that passes through the south eastern corner of the Site (shown on **Figure 3.1 Environmental Designations**). As per National Grid guidance[8], a suitable buffer of 450m was included to ensure that no wind turbines were placed in proximity to the OHL.

74. There is also a Scottish Water pipeline which runs directly adjacent to the south eastern edge of the Site (shown on **Figure 3.1 Environmental Designations**). A 220m buffer was applied.

3.7 Design Evolution

75. The design process, as informed by the EIA, comprised six iterations to the infrastructure layout of the Proposed Development.

76. Changes to the Proposed Development layout were made as a result of the findings of the baseline surveys to avoid, reduce or offset the potential environmental effects, to reflect engineering constraints or as a result of comments made during the consultation.

77. Six formal design workshops were held in July, August and September 2020 attended by members of the EIA team, design engineers and members from the Applicant's project team. The workshops provided a forum whereby all the known constraints (including environmental) could be presented and discussed. This allowed infrastructure to be appropriately designed to maximise the viability of the Proposed Development with minimal impacts on the local environment, drawing on the technical and practical experience of the project team.

78. A summary of the four key layout iterations for the Proposed Development is provided in **Table 3.2** below, these are displayed as iterations A-D. **Figure 3.3 Design Iteration of Wind Turbine and Infrastructure Layouts** details the design changes as described in **Table 3..** The final design is shown in **Figure 4.1 Site Layout**.

Design Iteration	Description
A	Scoping layout (17 wind turbines)
B	Refined wind turbine layout post design workshop (13 wind turbines)
C	Infrastructure design
D	2020 design layout

Table 3.2 Design Iterations for the Proposed Development

3.7.1 Layout A – Scoping

79. Layout A (shown on **Figure 3.3 Layout A**) was the layout developed following an initial design workshop on 18 March 2020 to inform the EIA Scoping Report issued in May 2020. Layout A comprised 17 wind turbines at a blade tip height of up to 200m.

80. This scoping layout focused on the following aspects:

- avoid siting wind turbines near breeding bird constraints;
- group the wind turbines into a continuous development maintaining a connection between the eastern and western sections of the Site;
- avoid siting the wind turbines on the steepest slopes to prevent instability and peat slide risk;
- site the wind turbines appropriately, in order to reduce the effects of the Proposed Development on the perceived wild land characteristics of the Merrick WLA and minimise the visual presence of the Proposed Development from the Girvan and Stinchar Valleys;
- minimise the effects on visual amenity to nearby settlements, including Barr, Dailly, Crosshill and Straiton;
- maximise wind energy yield from the wind turbines as far as possible;
- avoid slopes in excess of ten percent for access tracks;
- avoid areas of peat and known wet/boggy areas;
- reduce the requirement for watercourse crossings and maintain a buffer of 50m from watercourses;
- maintain appropriate buffers from ecological, ornithological, and cultural heritage features;
- maintain a buffer of 315m for roads and 220m for core paths;
- maintain a buffer of 1km from residential properties;
- maintain a 450m OHL buffer based on National Grid guidance;
- maintain a 75m buffer for blade oversail from the Site Boundary.

3.7.2 Layout B – Refined Wind Turbine Layout Post Design Workshop

81. Layout B (shown on **Figure 3.3 Layout B**) comprised 13 wind turbines with a blade tip height of up to 200m and was developed following a design workshop held on 8 July 2020 with the aim of reducing environmental impacts including landscape and visual, disturbance to peat and improving energy yield.

82. Wind turbines 1 and 2 were removed from the western section of the Site as these wind turbines were identified as being visually most prominent and having a particular impact on the Galloway Dark Sky Park and Merrick WLA to the south of the Site. The Proposed Development was then refined by repositioning the wind turbines into the centre of the Site, thereby reducing the impact to the Galloway Dark Sky Park and Merrick Wild Land Area and reduce visibility from properties, settlements and valleys.

83. Wind turbine 12 was removed due to its proximity to Linfern Loch.

[10] This radius was calculated based upon a 115m hub height and a 170m rotor diameter and was largely driven by the need for a 50m distance from blade tip to the forest edge to further mitigate any potential impacts on bat populations. Depending on the turbine model selected, the keyhole requirement could be less.

84. Wind turbine 17 was also removed due to visibility from residential areas to the north east. Visibility to wind turbine 16 was also reduced by relocating it closer to the centre of the Site.

85. Findings from the phase one peat probing surveys resulted in wind turbines 3, 5, 10 and 13 being moved outside of the deeper peat areas. Wind turbine 10 was moved south west, wind turbines 3 and 13 were moved south and wind turbine 5 was moved north.

3.7.3 Layout C – Infrastructure Design

86. An initial infrastructure design layout was proposed (shown on **Figure 3.3 - Layout C**) based on the wind turbine layout from Layout B and discussed at several design workshops as the design evolved. During the various workshops, the key improvements to the infrastructure design included:

- reducing the amount of cut and fill for crane hardstandings associated with the wind turbines. Cut and fill not only has implications for use of natural materials and transport but also for visual effects and forestry loss.
- to aid the safe delivery of wind turbine components and associated parts, track slope gradients were assessed to ensure they did not exceed ten percent;
- access tracks utilised existing forest tracks as much as possible to minimise the impact on forest and environment;
- two construction access points were designed to accommodate abnormal loads and to maintain FLS operational access to the Site;
- the infrastructure at wind turbine 7 and wind turbine 10 were realigned further away from the watercourse buffer;
- a small bypass road was included to the south of wind turbine 13 to allow access for FLS vehicles and wagons out with wind turbine hardstanding;
- the main temporary construction compound was refined to move closer to wind turbine 15 (instead of wind turbine 16) and because it is desirable to have the construction compound near the entrance of the Site;
- the Substation Compound was shifted away from the OHL to avoid any potential health and safety risk during construction. The substation was sited in consultation with SP Energy Networks (hereafter referred to as 'SPEN' who advised the footprint and requested to keep it as close to the OHL as possible); and
- in addition to the infrastructure amendments, the location for wind turbine 4 was realigned further up the slope of the hill and away from the watercourse buffer and steeper contours.

87. This infrastructure layout was used as the basis for phase 2 peat probing data collection to feed into the subsequent design iterations.

3.7.4 Layout D – 2020 Design Layout

88. A final design workshop was held on 22 September 2020, the changes to reach the final design layout included:

- confirmation of the final borrow pit search area locations;
- cut and fill was reviewed and altered;
- the addition of three 150m spurs as part of the access tracks;
- changes to the access from wind turbine 8 to wind turbine 6. This was initiated following an additional engineering site visit on 2 September 2020, which identified that the approach from the north or east of the Site was preferable to avoid a track across the open land. This access route was beneficial because it takes advantage of a natural depression from behind the hill which hides the track from views to the south, including from the core path SA 47 and the WLA and also minimised cut and fill requirements. The location of wind turbine 6 was shifted to accommodate the proposed access track from wind turbine 8, the hardstanding and crane pad at wind turbine 5 had to be aligned and orientated along the access to create a better road alignment. The resulting shift of wind turbine 6 benefitted from being located in an area of shallower peat;

89. Following design iterations in Layout A-D, for the purposes of this EIAR the wind turbines were renumbered from those in **Figure 3.3 Design Iteration of Wind Turbine and Infrastructure Layouts (A-D),** specifically Layout D. The updated numbering, which is used from this point forward, is shown on the final design in **Figure 4.1 Site Layout**.

3.7.5 Final Design Layout

90. Following further consultation with SPEN in late 2020, the Substation Compound location was re-located to improve the connection to the OHL. The footprint was also increased to fully accommodate the area required for the SPEN substation.

91. A second temporary construction compound was added in the north of the Site which is proposed to convert all, or part of, to a permanent cark park for recreational users and visitors to Carrick Forest upon completion of construction works and for the duration of the operational life of the windfarm. The exact details of the car park will be agreed with FLS.

92. The final design layout as shown on **Figure 4.1 EIA Site Layout** includes the updated Substation Compound layout, SPEN temporary construction compound and the second temporary construction compound which will become a new FLS car park.

3.8 Other Site Infrastructure

3.8.1 Substation Compound

93. The Substation Compound would be located in the south east of the Site within an area of 189m by 126m. This land avoids sensitive habitats, areas of deep peat and steep slopes, as being located greater than topple distance from the proposed wind turbines. The Substation Compound would comprise of:

- the Proposed Development's substation;
- the Energy Storage Facility (i.e. battery) which would have a storage capacity of around 20MW;
- the Transmission Operators's (TO) Substation;
- the Applicant's control building; and
- point of connection to the National Grid.

94. The Proposed Development's substation, would be located directly beside the TO's Substation, which is designed, built and operated by the electricity grid network operator (SPEN).

95. The location of the Substation Compound was selected in consultation with SPEN based on technical requirements for the grid connection and proximity to the existing 275 kV OHL. The location was chosen based on relatively flat topography and peat probing data to ensure that areas of deeper peat were avoided. The topography in this area has gradual elevation changes but considering the required size of the Substation Compound the location was shifted to minimise earthworks to form the level area needed for the buildings and electrical equipment. The internal site grid connection cables would be undergrounded within the Site from each wind turbine to the Substation Compound, therefore having no visual impact.

96. Further information regarding the Substation Compound is presented in **Chapter 4: Development Description.**

3.8.1 Temporary Construction Compounds

97. Both temporary construction compounds have been located with the aim of limiting the effects on sensitive habitats, deep peat, existing forestry and within a safe distance from the OHL while being close to the access tracks. Steep areas have been avoided to reduce the requirement for cut and fill.

98. The main temporary construction compound (100m x 100m) has been located along the southern access track to control traffic entering the Site through the main Site entrance, to be located close to the wind turbines and to facilitate construction of the Substation Compound and Energy Storage Facility (i.e. battery).

99. The second (30m x 30m) temporary construction compound has been located along the northern access track to provide a second compound to facilitate the upgrade of the junctions in to Site and any offsite access works. This location is also considered suitable by FLS to be retained (in part or in whole) as a car park during the operational life of the windfarm for recreational users to provide a safe space to park when visiting the Carrick Forest.

100. The temporary construction compounds are shown on **Figure 4.1 EIA Site Layout.**

3.8.2 SPEN Temporary Construction Compound

101. SPEN require a temporary construction compound (approximately 60m x 60m) to construct the TO Substation. This will be located in the south east of the Site to the north of the new access track, adjacent to the Substation Compound, as shown on **Figure 4.1 EIA Site Layout.**

3.8.3 Site Access

102. Two construction access points were designed to accommodate abnormal loads and to maintain FLS access to the Site, as shown in **Figure 4.2a Indicative Site Access (South)** and **Figure 4.2b Indicative Site Access (North)**.

103. It is proposed that the Site access would utilise two existing entrances to the Carrick Forest from the C46W public road thereby minimising the amount of new track required as part of the Proposed Development. Some upgrading of the existing Site accesses would be required to facilitate the vehicles required to deliver the wind turbine components.

3.8.4 Site Access Tracks

104. As part of the site selection factor and utilising existing infrastructure, using the existing tracks associated with FLS's commercial forestry was considered. This minimises impacts such as cut and fill requirements, habitat loss and the amount of felling required. The onsite access tracks for the Proposed Development have been designed to use existing access tracks as far as possible. All access tracks have been designed to follow routes which do not include excessive gradients. This is to aid the safe delivery of wind turbine components and associated parts.

105. However, some new, or upgrade, of existing access tracks would be required as it is not possible to fully meet the access requirements of the Proposed Development with the Site tracks in their current arrangement. As a result, at each design iteration, as described in **Table 3.2**, the areas whereby new or upgrading of existing access tracks has been updated accordingly. All access tracks have been designed to follow routes which do not include excessive gradients. This is to aid the safe delivery of wind turbine components and associated parts.

3.8.5 Borrow Pit Search Areas

106. Borrow pits are required as a source of rock to be used in the construction of the tracks, hardstandings and foundations. Potential locations for the borrow pits were identified based upon a review of geological mapping and Site reconnaissance. The location of each was considered and refined with respect to the Site infrastructure and environmental constraints.

107. During design optimisation, the locations of infrastructure and track design were refined in order to minimise the number of earthworks and cut and fill required to construct the Proposed Development. The total number and size of borrow pits was selected to meet the estimated volume of rock required to construct the tracks, hardstandings and foundations. This included evaluation of the use of existing and historic borrow pits on the Site. This required consultation and agreement with FLS.

108. If the Proposed Development were consented, further intrusive geotechnical investigation would be carried out to identify which of the four borrow pit locations would yield the required quality of rock for each aspect of the infrastructure. It is unlikely that all four borrow pits would be needed, but this gives flexibility in case there is low yield identified at any location. Borrow pits locations are illustrated on **Figure 4.1 Site Layout**.

3.8.6 Site Boundary

109. The Site Boundary has evolved with the layout since Scoping to ensure that all infrastructure and works required for the construction and operation of the windfarm are captured within it, as shown in **Figure 1.2 Site Boundary**. Once the design was finalised, the Site Boundary was reduced to reflect the area required for development. The Site Boundary represents the area for which the Applicant is seeking consent.

3.9 Micrositing

110. In order to be able to address any localised environmental sensitivities, unexpected ground conditions or technical issues that are found during detailed intrusive site investigations and construction, it is proposed that agreement is sought for a 50m micrositing allowance around windfarm infrastructure. The technical assessments (presented in **Chapters 5 to 13**) have considered the potential for micrositing and it is considered that the proposed infrastructure could be microsited within 50m without resulting in potential new effects. During construction, the need for any micrositing would be assessed and agreed with the onsite Environmental Clerk of Works (ECoW) to ensure avoidance of local known sensitive receptors.

3.10 Conclusion

111. The final layout has been informed by a robust EIA and design iteration process, taking into account potential environmental effects, physical constraints, and health and safety considerations. The information used to inform the design iteration process has included consultation responses, extensive baseline data and the EIA undertaken. The final layout of the Proposed Development is described in detail in **Chapter 4: Development Description** and shown on **Figure 4.1 Site Layout.** Note that for the EIA, the wind turbines have been re-numbered from as illustrated in **Figure 3.3 Design Iteration of Wind Turbine and Infrastructure Layouts (A-D).**

112. The principles of the EIA process, the Site selection and project design should be an iterative constraint-led process and have been followed in the design of the Proposed Development. This has ensured that potential adverse effects as a result of the Proposed Development have been avoided or minimised as far as reasonably possible.

3.11 References

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Carrick Windfarm Project Team

ScottishPower Renewables
9th Floor
320 St Vincent Street
Glasgow
G2 5AD

carrickwindfarm@scottishpower.com

SCOTTISHPOWER
RENEWABLES