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3. Alternatives and Scheme Evolution

3.1. Introduction

3.1.1. The Electricity Works (Environmental Impact Assessment) (Scotland) Regulations 2017¹ state in Schedule 4 paragraph 2 that an EIA report must include: 'A description of the reasonable alternatives (for example in terms of project design, technology, location, size and scale) studied by the developer, which are relevant to the proposed development and its specific characteristics, and an indication of the main reasons for selecting the chosen option, including a comparison of the environmental effects.'

3.1.2. This chapter explains why the Site has been selected and summarises the layout options that were considered by the Applicant during the evolution of the proposed scheme.

3.2. Selection of the Wind Farm Site

3.2.1. Feasibility work was undertaken by Infinergy, drawing on specialist consultant input, during 2010 and 2011. The appraisal work undertaken at the feasibility stage covered a range of different issues, including:

- wind speed data;
- distance to private dwellings;
- nearby wind farms;
- distance and connection to grid;
- site access;
- land designations;
- landscape and visual considerations;
- initial noise modelling;
- ecology and ornithology;
- archaeology;
- local development plan policies;
- telecommunication links; and
- aviation.

3.2.2. The option and lease land negotiation for the Site took place primarily during 2011, whilst the feasibility work was being completed. The project passed the feasibility stage in March 2012. The Site was progressed to the EIA and project design stage because it exhibited attributes that include the following:

- The Site does not lie within, nor is it in close proximity to, any areas of national landscape designation.
- The Site does not lie within, nor is it in close proximity, to any ecological designation.
- The distances from the nearest residential properties are such that unacceptable potential noise and residential visual amenity impacts can be avoided.
- The average wind speed at the Site is above 7.0 metres per second (m/s) at a height of 45 m above ground level.

¹ The Scottish Government (2017). Electricity Works (Environmental Impact Assessment) (Scotland) Regulations 2017. http://www.legislation.gov.uk/ssi/2017/101/pdfs/ssi_20170101_en.pdf [Accessed 06/11/2018]

- The topography of the Site is compatible with the construction of a commercial scale wind farm.
- Initial investigations indicated that the peat on the Site was relatively shallow.
- There are existing electricity lines within the locality that can be used to make a grid connection.
- Due to the topography of the Site, it has the capacity to avoid wide-scale landscape and visual impact.
- The Site lies within a landscape character type area (Southern Uplands with Forestry) that is capable of accommodating wind farm development.

3.3. Turbine Layout Iterations

3.3.1. The turbine layout has undergone several iterations as part of the EIA and wind farm design process. The main iterations are described below and **Figures 3.1 - 3.4** illustrate the progression through the Applicant's iterative design process.

Original Scoping Layout

3.3.2. The Shepherds' Rig wind farm Site passed the feasibility stage and became a project in March 2012.

3.3.3. An initial scoping layout was formulated in April 2013, and this consisted of 45 turbines with a tip height of 146.5 metres (m) and a rotor diameter of 82 m (**Figure 3.1**). The layout was based on an 82 m rotor spacing requirement, and the turbines were positioned to avoid immediately apparent constraints (such as 50 m watercourse buffers).

3.3.4. The initial layout showed turbines mainly located within the core of the site between Craigengillan Hill and Marscalloch Hill, but with some turbines to the north of Craigengillan Hill and on the lower lying eastern part of the site, near Lorg Road.

3.3.5. A Scoping Opinion (**Appendix 6.2**) was received from the Energy Consents Unit in July 2013. A range of initial baseline surveys were undertaken during and after the original scoping exercise as part of the EIA. This included:

- ornithological surveys between October 2012 and August 2013;
- ecological surveys involving an extended phase 1 habitat survey and protected species surveys in September 2013;
- cultural heritage desk based assessment and supplementary site visit;
- peat depth surveys across the Site, undertaken in October 2013;
- hydrological site visits and baseline work;
- baseline noise surveys between November 2013 and January 2014;
- strategic access and transport baseline studies in November 2013; and
- aviation baseline analysis and modelling in December 2013.

3.3.6. A series of community open days were held in July 2013 allowing the community to find out more about the EIA work and the emerging layout as well as provide comments on the proposals.

3.3.7. In November 2013, a meteorological mast was installed near the centre of the site, and a wind measurement exercise was undertaken until May 2014.

3.3.8. In early 2015, assessment and design work on the project was put on hold due to the uncertainty associated with the UK Government's proposed changes to the funding arrangements for onshore wind.

3.3.9. In April 2017, following consideration of the economic viability of the emerging development proposals in a post-subsidy environment, a further year of ornithological survey work commenced, and this continued until the end of March 2018.

Updated Scoping Layout

3.3.10. An updated scoping layout was prepared in March 2018 and this consisted of 30 149.5 m to tip turbines, each with a rotor diameter of 100 m, with corresponding turbine spacing (**Figure 3.1**).

3.3.11. Compared to the earlier layout, this configuration showed a substantial reduction in the number of turbines and greater separation between them, and it did not include turbines near the northern edge of the site.

3.3.12. In March 2018, an updated Scoping Opinion was requested from the Energy Consents Unit (**Appendix 6.3**). Further survey work was commenced at that time, including the following:

- updated ecological habitat and protected species surveys;
- further peat surveys;
- landscape and visual viewpoint analysis;
- forestry surveys;
- hydrological surveys;
- fisheries surveys;
- cultural heritage field surveys;
- traffic surveys; and
- bat surveys.

3.3.13. The majority of this further survey work was undertaken between March and May 2018, although the protected species and bat survey work continued throughout the summer of 2018 in accordance with best practice and associated survey timescales.

3.3.14. An updated scoping opinion was issued by the Energy Consents Unit at the end of May 2018 (**Appendix 6.4**). The updated scoping opinion confirmed that no substantive additional survey work was required beyond the further surveys outlined in 3.3.12.

3.3.15. In early May 2018, constraint information established by the original and further survey work was collated and mapped to establish the developable area within the Site, and this is shown in **Figure 3.2**. The constraints included the following:

- site boundary over-sail: 58.5 m (one blade length) to prevent turbines extending outwith the site boundary;
- roads: 150 m buffer;
- residential properties: 750 m buffer;
- watercourses: 50 m buffer;

- areas of peat of greater than 1.5 m depth based on the initial peat depth surveys using 100 m probe spacing'
- steepness of slope over 11°.

Turbine Option Analysis

- 3.3.16. A number of layout options were then generated within the developable area using different turbine candidate types and dimensions, and the wind farm wind yield outputs were modelled using the met-mast data.
- 3.3.17. Each layout option was then subject to a financial modelling exercise to establish whether they were economically viable.
- 3.3.18. The layout options analysed at this stage included:
- the updated scoping layout consisting of 30, 149.5 m to tip turbines with a 100 m rotor diameter;
 - 27, 149.5 m to tip turbines with a 100 m rotor diameter;
 - 18, 149.5 m to tip turbines with a rotor of 112 m; and
 - 18, 149.5 m to tip turbines with a rotor of 117 m.
- 3.3.19. This modelling exercise established that a layout with 18 turbines, each with a height of 149.5 m to tip with 117 m rotor diameter would be the most viable option.

Pre-Design Workshop Layout

- 3.3.20. In early May 2018, the 18 turbine, 149.5 m to tip, 117 m rotor layout option was subject to an initial landscape design review and was refined to improve its appearance from a range of viewpoints within the locality.
- 3.3.21. This resulted in the pre-design workshop layout (Iteration 1) which is shown in **Figure 3.3**.
- 3.3.22. In comparison to the previously updated scoping layout, this iteration resulted in eleven turbines being deleted. This change has reduced the overall scale of the Proposed Development. The iteration also resulted in fewer turbines in total in the higher parts and vicinity of both Marscalloch and Craigengillan Hill, and it does not have turbines within the lower lying eastern part of the Site near Lorg Road.
- 3.3.23. Compared to the updated scoping layout, turbines have been deleted and set back from the south-eastern edge of the Site so that they are further away from Stroanfreggan Craig Fort and Smittons Bridge cultural heritage features. This was recommended by Historic Environment Scotland in their updated scoping response.

Design Workshop Layout

- 3.3.24. A design workshop was held during May 2018, after most of the additional baseline survey work had been completed and the Site related environmental constraints digitised and analysed by the technical assessors.

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- 3.3.25. The starting point at the workshop was Iteration 1. This layout was carefully reviewed by the landscape architect using wirelines to avoid turbine stacking and gaps in the layout from key viewpoints, and detailed adjustments to turbine positions were made.
- 3.3.26. A review of the visibility of the turbines from the nearest residential properties was undertaken (without tree screening). This resulted in the reduction in the tip height and rotor diameter of two of the most northern turbines to reduce the visual impact on the properties at Moorbrock.
- 3.3.27. The layout was also reviewed by the cultural heritage consultant and amendments were made to ensure that turbines were adequately separated and appropriately aligned to ensure that the effects on the setting of cultural heritage features was minimised.
- 3.3.28. Turbine location amendments were also made by the hydrogeological and ecological consultants to ensure that turbines avoided deeper peat areas based on the initial peat survey results and were appropriately separated from hydrological and ecological features.
- 3.3.29. The modified layout was modelled by the noise consultant to ensure that there would be no noise limit exceedances at nearby properties.
- 3.3.30. The amended layout that was generated at the design workshop (Iteration 2) consisted of 18 turbines: 16, 149.5 m to tip 117 rotor turbines and two, 125 m to tip, 90 m rotor turbines (**Figure 3.3**).

Post Design Workshop Iterations

- 3.3.31. Following the workshop, the layout was re-analysed in terms of wind yield and financial viability.
- 3.3.32. An examination of the turbine spacing and site constraints established that there was space to include an additional turbine and re-site some of the turbines onto relatively higher land to increase the output of the project, without undermining the design established at the workshop. The rotor diameters of two of the northernmost turbines were also increased to 105 m.
- 3.3.33. This stage, which was undertaken with the input of the wider EIA team, involved the layout going through a number of detailed iterations (3, 4, 5) and resulted in Iteration 6 which consisted of 19 turbines: 17, 149.5 m to tip 117 rotors and two, 125 m to tip 105 rotor, as shown in **Figure 3.4**.

Final Turbine Layout

- 3.3.34. The Iteration 6 layout was re-examined by the specialist consultants and some further refinements were made, including re-positioning the northernmost turbines slightly further south, and the southernmost turbines on slightly lower land on the northern slopes of Marscalloch Hill.
- 3.3.35. As a consequence of the initial civil infrastructure layout design work, three turbines were slightly re-sited further from the watercourses in the central part

of the Site to enable hard-standings and other infrastructure to be located outside of 50 m watercourse buffers.

- 3.3.36. This refined turbine layout was then fixed as the final layout (Iteration 7). The final layout comprises **19** turbines: 17, 149.9 m to tip, 117 rotor turbines and 2, 125 m to tip 105 m rotor turbines. The final turbine layout is shown in **Figure 3.4**.

3.4. Selection and Evolution of the Associated Infrastructure

Internal Track Layout

- 3.4.1. The internal track layout for the final turbine arrangement was developed so that it meets the following criteria:

- upgrade of existing forestry tracks where possible;
- minimisation of the variation in the vertical alignment of the tracks;
- minimisation of the number of dead ends within the layout;
- minimising the overall length of tracks;
- ensuring a safe and efficient layout to facilitate wind farm construction;
- minimisation of incursion into environmental constraint areas;
- minimisation of the number of watercourse crossings and alignment of tracks so that crossings are approximately at right angles; and
- minimisation of tracks through areas of peat greater than 0.5 m in depth.

- 3.4.2. An early iteration of the track layout incorporated the upgrading of the existing forestry track between Marscalloch Hill and Craigenkillan Burn. However, this resulted in a numerous track spurs in the layout to connect with turbines in the western part of the site.

- 3.4.3. The track layout was therefore amended so that a continuous loop was created connecting the western turbines, instead of re-using the existing forestry track in this part of the site.

Construction Compound Location

- 3.4.4. The location of the main construction compound, adjoining the main the access track into the wind farm, was selected for the following reasons:

- It is beneficial to have the compound near the wind farm access route so that delivery vehicle trip length can be reduced and deliveries can be managed effectively.
- The land is flatter than the other land available near the access track.
- The land lies close to an existing forestry track and disused quarry.

Selection of the Access Junction

- 3.4.5. Two main access junction options were considered at an early point in the site infrastructure design work.

- 3.4.6. Option one lies near the southern most corner of the site and consists of a pre-existing established access route into the Smittons forestry plantation from the B729, to the south east of Marscalloch Hill.

- 3.4.7. Option two lies near the centre of the site and also consists of an existing access point into the Smittons plantation, from Lorg Road, to the south of Black Burn Bridge.
- 3.4.8. Option one (shown in Figure 4.17) was selected as the preferred main access junction for the wind farm for reasons that included the following:
- An access point at the southern end of the site would enable construction traffic to leave the public highway at an earlier point.
 - The southern access point would avoid the need for upgrades to the B729 on the approach to Smittons Farm and the southern part of Lorg Road.
 - The southern option is more concealed within plantation either side of the B729, whereas option two would be more visible from the open moorland to the east.
 - There is an existing quarry on the forestry track near the access point, which can be used as a borrow working at an early stage of the construction programme.

Selection of the Substation Compound Location

- 3.4.9. The final position of the substation compound was selected for the following reasons:
- A location within the centre of the turbine area reduces the overall length of site cabling required and is therefore better in terms of electrical efficiency.
 - The location lies in a location that is well set back from the eastern edge of the site thereby reducing its visibility, particularly from Lorg Road.
 - The location lies within an area which is not ecologically sensitive.
 - The peat at the location is less than 0.5m in depth.
- 3.4.10. With the rapid advancement of battery storage technology, the Applicant chose to incorporate a battery storage facility within the substation and control building compound to further maximise the potential of the Site.

Selection of the Borrow Working Areas

- 3.4.11. The locations of the borrow working search areas have been selected for the following main reasons:
- The borrow working search areas are located at pre-existing quarry sites used to create and maintain forestry tracks.
 - The location of the southern borrow working area is relatively close to the main access junction, facilitating the upgrading and formation of the main access track into the site at an early stage of the construction programme.
 - Borrow workings would be located in each part of the site to ensure that on site haulage movements are reduced.
 - Workings are located outside of any environmental constraint areas such as areas of deeper peat or ecologically sensitive habitat.
 - The locations on the northern side of Marscalloch Hill and western side of Craigenhill Hill reduce the visibility of the borrow workings.

3.5. Conclusion

- 3.5.1. The final wind farm layout for which s36 consent is sought is as shown in **Figure 4.1** which accompanies Chapter 4: Description of the Proposed Development.