2 DESIGN EVOLUTION & ALTERNATIVES

2.1 Introduction

2.1.1 In this chapter a description is given of the site selection process and design strategies that have **been** adopted to arrive at the proposed wind farm described in Chapter 3: Proposed Development. Firstly, the general design principles adopted by RES are outlined and potential key issues which have affected the design are identified. Thereafter, a description is given of how the turbine layout and infrastructure design have evolved in response to constraints identified through the EIA process.

2.1.2 Figures 2.1 – 2.3 are referenced in the text where relevant.

2.2 Current land use and site context

2.2.1 The location of the proposed wind farm is shown in Figure 1.1: Site Location Plan and Figure 1.2: Planning Application Boundary. The site extends to approximately 376.60 ha and predominantly comprises common land on an open, relatively flat ridge. This is mainly characterised by a mixture of acid grassland and heather moorland, the westerly areas of which are grazed (by sheep and cattle) and the north-easterly and easterly parts more lightly grazed. The site lies approximately 472 m above ordnance datum (AOD) at its highest point. Telecommunication masts and a gas governor station are present in the central area of the site. There are no settlements within the site.

2.2.2 A number of Public Rights of Way (PRoW) cross the site, forming wider connections with surrounding residential areas and the local road network. A short section of the corridor of the A472 is located to the north-west of the site. However, the site itself forms a remote upland with access limited to single track roads. The site is drained by a series of watercourses, with those in the south-westerly portion of the site forming tributaries of the River Ebbw. Streams in the northern section of the site fall into Cwm Lickey and the Afon Lwyd to the north.

2.3 Key Issues and Constraints

2.3.1 The design of a wind farm is optimised to produce a layout that maximises the use of the land available for wind power generation balanced against the overall environmental impact of the development. The optimal layout of a wind farm depends on a range of technical, economic and environmental criteria. The following are site specific factors determining the viability of a wind farm:

- Wind Speeds/Energy Yields: Sufficiently high wind speeds to ensure energy production from the wind turbines that would yield an adequate return on investment;
- Planning: A site which complies with planning policy and in particular, avoids unacceptable effects on areas that have been designated by statutory agencies; maintains appropriate distances from dwellings to avoid unduly impacting local amenity; and avoids impeding or interfering with major electromagnetic transmission and airport communication systems;
- Area of Site: A site must have sufficient area to accommodate the number of wind turbines required for economic viability;
- Access: Adequate vehicular access to a site using existing roads wherever possible to minimise the amount of civil works, particularly during the construction phase;
- Local Terrain and Topography: Terrain and topography affect wind flow across a site and need to be considered in relation to turbine performance, specification and life-span;

- Ground Conditions: A site must have suitable ground conditions for the construction of wind turbine foundations, erection of the turbines and the provision of access tracks and cables.

2.3.2 There are additional factors which also influence the scale and viability of a wind farm including:

- Turbines must be separated by specific distances both perpendicular to, and in line with, the prevailing wind direction to minimise turbulent interaction between the wind turbines (i.e. wake effect). This needs to be considered to balance turbine performance with energy extraction, and to protect the life-span of the turbines. Spacing requirements vary between turbine manufacturers and are also subject to wind conditions;
- Wind turbines have to be located at a distance sufficiently far from occupied residential property to ensure adherence to relevant noise criteria and to ensure that shadow flicker impacts are minimised;
- The implications of locating turbines near environmentally sensitive features and areas (ecology, archaeology, hydrology etc.) need to be carefully considered; and
- Landscape and visual design considerations need to be taken into account.

2.3.3 The apportioning of weight to each element is a site-dependent consideration and results in bespoke design approaches and strategies for each site. The following sections identify potential issues and outline how these have been addressed through appropriate design.

2.3.4 The basis of the design process is the evaluation of the various constraints and design recommendations that have been identified through the environmental surveying. The constraints identified through these surveys, along with other technical constraints and appropriate buffers are presented in Figure 2.1: Key Constraints and Infrastructure.

Potentially significant effects

2.3.5 Following consultation and baseline characterisation of the Site, the following key environmental issues have been identified:

- Landscape and visual
- Ecology
- Ornithology
- Cultural heritage
- Hydrology and hydrogeology
- Traffic, transport and access
- Noise
- Shadow flicker
- Aviation and Electromagnetic Interference
- Socioeconomics

2.3.6 The issues listed above have been considered during the iterative design process with the aim of designing out significant effects. Where it is not possible to mitigate these effects through design, the issues are considered further as part of the Environmental Impact Assessment process (EIA) which is described in this Environmental Statement (ES).

2.4 Consultation

2.4.1 As part of the EIA process, RES and the consultant project team consulted with various stakeholders, the outcome of which has been considered in the design process where relevant and incorporated into the appropriate chapters of this ES, to ensure that the scope of the ES fully, but concisely, addresses all potentially significant issues.

2.4.2 A table detailing where the ES addresses issues raised in the Scoping Direction received from Planning and Environment Decisions Wales (PEDW) can be found in Technical Appendix 1.3: Scoping Consultation Summary Table. Any further consultation undertaken by the consultant project team is detailed in the specific chapter.

Public Consultation

2.4.3 RES is committed to finding effective and appropriate ways of consulting with all its stakeholders, including local residents and community organisations, and believes that the views of local people are an integral part of the development process. RES began the engagement process in November 2021, more than 2 years prior to the submission of the planning application, to facilitate a constructive consultation process which helped RES to understand and address any concerns as the project developed. Public exhibitions were held in March 2022 to introduce RES and the proposed wind farm to the communities.

2.4.4 Further public exhibitions were held on 20th and 21st June 2023 which included more detailed maps and information about the proposals.

2.4.5 Information presented at the public exhibitions included the following:

- Background information about RES as a company;
- Map of the proposed layout;
- Photomontages representing how the proposed layout would appear from a range of viewpoints;
- Zone of Theoretical Visibility (ZTV) diagrams. (A ZTV is a map-based diagram illustrating where and how many wind turbines, or wind farms, would theoretically be visible from all parts of a given area). The methods for preparing ZTVs and their uses within the EIA process are described in Chapter 5: Landscape and Visual;
- Other information about the project and the development process, including the secondary applications for common land consent under Section 16 and Section 38 of the Commons Act 2006;

2.4.6 RES staff were available to answer questions and feedback was encouraged. A Pre-Application Community Consultation (PACC) Report will accompany the planning application and Environmental Statement. The PACC Report provides an account of the consultation completed to date with the public and with statutory consultees, as well as any deadlines set, and activities required under section 61Z of the 1990 Act. The report also provides a comprehensive record of the pre-application public consultation undertaken.

2.5 Alternatives

2.5.1 RES considers a range of potential options when selecting and designing wind farm sites. The following sections outline the broad design alternatives that have been considered in terms of the EIA Regulations.

Do-Nothing Alternative

2.5.2 The "do-nothing" scenario is a hypothetical alternative considered as a basis for comparing the potential significant effects of a development proposal. In the case of the Development the "do-nothing" scenario would be for the Site to continue to be managed for agricultural rough grazing by the landowners and Commoners. It is likely that current land management activities would continue.

Alternative Sites

2.5.3 RES has a robust site selection methodology, using a Geographical Information System (GIS) to aid identification of potential wind farm sites and this site was selected based on that methodology.

2.5.4 The proposed wind farm site meets the criteria listed in section 2.3.1 of this chapter. The GIS model was used to identify potential constraints which could restrict development or would need to be addressed in the design process.

Alternative Layout Designs

2.5.5 There have been several iterations of the turbine and infrastructure layouts. From the outset the following design principles have been employed when making design decisions:

- Mitigation by design should be the principal method of reducing potential environmental impacts;
- Utilisation of existing infrastructure should be implemented whenever possible to avoid unnecessary development;
- All site infrastructure should be designed as efficiently as possible to reduce the overall extent of development whilst maximising the renewable energy generation potential.

2.5.6 A key tool in the design process is the key constraints drawing which integrates all potential constraints that need to be considered in the design process. The finalised key constraints drawing is shown as Figure 2.1: Key Constraints and Infrastructure.

2.5.7 The key constraints drawing is iteratively updated where required through the EIA process as new information from surveys, site visits and consultation is received. The following surveys and assessments informed the key constraints drawing:

- National Vegetation Classification (NVC) Phase 2 survey
- Terrestrial fauna surveys
- Peat probing
- Hydrology assessment
- Landscape field survey
- Aviation
- Transport and traffic
- Geology and mining
- Noise
- Technical and engineering site walkovers.

2.5.8 The final site layout for the proposed wind farm (Figure 3.1: Infrastructure Layout) balances the need to optimise the energy yield whilst paying due regard to environmental and technical sensitivities. Wind farm design is an iterative process and is influenced by potential environmental effects identified throughout the EIA process, policy recommendations,

environmental, technical, engineering and landscape design considerations, and as a result of feedback from consultees.

2.5.9 The following sections describe the evolution of the turbine and infrastructure layouts.

2.6 Design Evolution

Turbine Layout

2.6.2 The final proposed turbine layout is shown in Figure 2.2: Turbine Layout. There were fiveprinciple iterations of the turbine layout, shown in Figure 2.3: Turbine Layout Evolution, which were developed at the following stages in the project process:

- Initial feasibility stage, when turbines were located based on initial LVIA guidance and constraint setbacks, and the Pre-Assessed Area for onshore wind development as set out in the National Development Framework, Future Wales: The National Plan 2040;
- Revised turbine layout, following detailed LVIA siting and EMI links;
- Second revised turbine layout, following information received from the site utility survey;
- Pre-Application Consultation stage, following the completion of Phase 2 peat surveys and accounting for civil design requirements, as well as the geotechnical investigation.
- Final constraints and refinement stage, following further moves to avoid areas of peat enabled by an updated understanding of the wind distribution on site and the dominant wind direction.

Layout 1 - Initial Feasibility Stage

2.6.3 At the beginning of the development process an initial layout was produced to show the maximum potential extent of the development within the developable area. The developable area was defined as the land with slopes of less than 15% on which it would technically be feasible to install large wind turbines. The initial layout was prepared in accordance with design principles, prior to baseline surveys being completed, informed by the following:

- Provisional buffer separation from housing prior to environmental studies
- Provisional buffer around the existing transmitter as a precautionary measure prior to consultation
- Tip height plus 10% buffer to public roads
- Slope

2.6.4 In addition, the preliminary landscape and visual impact assessment guidance was taken into account to reduce the associated impacts of the proposed wind farm, as well as the initial constraint setbacks as a result of the overhead transmission line. Furthermore, this initial turbine layout ensures that all turbines are located within the Pre-Assessed Area for onshore wind development as set out in the National Development Framework, Future Wales: The National Plan 2040. This identified that the Site could potentially accommodate 21 turbines with a 149.9 m tip height. This is shown in Layout 1 of Figure 2.3: Turbine Layout Evolution.

Layout 2 - Revised Turbine Layout

2.6.5 The key risks addressed through the second layout iteration were landscape and visual impact and telecommunications and electro-magnetic interference (EMI) links. The developable area for turbine siting was reduced to take into account more detailed feedback from the landscape and visual impact consultant to minimise the visual impact of the proposed wind farm. In addition,

turbines were repositioned in order to reduce the proposed wind farm's effects on the EMI links between transmitter masts.

2.6.6 This resulted in a layout of 15 turbines, as shown in Layout 2 of Figure 2.3: Turbine Layout Evolution.

Layout 3 –Turbine Layout Revision

2.6.7 The second major iteration of the turbine layout was revised primarily to take into account the information gathered as part of the utility surveys carried out on the site. As a result of these surveys, an appropriate buffer was applied to High-Pressure Gas Pipelines (HPG) and overhead lines (OHL) to ensure that turbines were sited at a sufficient distance. In addition, a more detailed consideration of the terrain resulted in turbine movements.

2.6.8 As a result of these changes, the turbine layout was reduced to 13 turbines, as shown in Layout 3 of Figure 2.3: Turbine Layout Evolution.

Layout 4 – Pre-Application Consultation

2.6.9 The fourth major iteration of the turbine layout took place following the completion of environmental surveys and was included in the Pre-Application Consultation application documents. Detailed environmental and technical surveys were carried out to characterise the baseline environmental conditions on the site and associated study areas, as described in more detail in chapters five to 14 of this ES. Any constraints to development resulting from the baseline surveys were added to the key constraints drawing and design recommendations were taken into account as the layout evolved.

Landscape and Visual

2.6.10 As described in Chapter 5: Landscape and Visual, zones of theoretical visibility (ZTV) drawings were prepared to indicate areas from where all, or parts of, the proposed wind farm were likely to be visible. These were used primarily to identify the location of Preliminary Viewpoints as part of the baseline Landscape and Visual Impact Assessment (LVIA). They were also used to assist in the detailed analysis of the potential visibility of the proposed wind farm throughout the Study Area that had been identified for the LVIA.

Ecology and biodiversity

2.6.11 Following the baseline surveys and characterisation of the site no additional layout constraints were proposed by the ecological consultant.

Hydrology and Hydrogeology

2.6.12 As recommended in Chapter 9: Hydrology and Hydrogeology, turbine centres are located a minimum of 50 m from significant watercourses. A significant watercourse is defined as a watercourse that appears on 1:50,000 Ordnance Survey mapping.

Geology & Mining

2.6.13 A series of ground investigations have quantified the geological and mining hazards relating to the site. As described earlier in this chapter the layout of the proposed wind farm has been iteratively developed to take account of the results, to avoid geological and mining hazards as well as areas of deep peat. A coal mining risk assessment has been undertaken by RSK Geosciences and is included in Technical Appendix 9.2. The assessment concludes there is low or negligible risk from coal mining related hazards and will have no effect on the proposed development .

2.6.14 The potential impact on sensitive habitats associated with peat is considered as part of the ecology and biodiversity assessment, and an assessment of peat hydrology is considered as part of the hydrology and hydrogeology assessment.

Acoustic

2.6.15 One of the key turbine layout design constraint considerations was the minimisation of impacts at the nearest residential receptors and as such the turbine layout was designed to ensure that there is an adequate separation distance between any of the proposed turbines and the nearest residential property.

2.6.16 As described in detail in Chapter 11: Acoustic, background noise surveys were carried out to establish baseline conditions and the wind turbine layout was assessed for acoustic impact. A noise curtailment regime has been imposed to mitigate acoustic impacts on residential properties such that operational noise levels would comply with the relevant criteria at all residential properties.

Shadow Flicker

2.6.17 Whilst there is no specific standard for the assessment of shadow flicker in the UK, planning requirements of shadow flicker are contained within Parsons Brinckerhoff (2011) which states: "the 10 rotor diameter rule has been widely accepted across different European countries, and is deemed to be an appropriate assessment area".

2.6.18 A separation distance from housing has been applied for visual impact and noise to the key constraints drawing. However, the effects of shadow flicker have been assessed within 10 x the rotor diameter (1170m) plus the requested micrositing allowance (50m) to cover an area 1220m from the turbine locations. Chapter 12: Shadow Flicker & Reflected Light provides more information.

Electromagnetic Interference, TV and Radio

2.6.19 Wind turbines can potentially interfere with microwave links and communication systems that use electromagnetic waves as the transmission medium, primarily television, radio or point to point electromagnetic (PtP EM) links.

2.6.20 RES has consulted with all organisations operating microwave links which could be affected by the proposed wind farm. This is detailed in Chapter 13: EMI & Aviation.

2.6.21 Should interference to TV reception occur as a result of the proposed wind farm, a range of viable mitigation measures can be considered. Any necessary work would be undertaken in a timely manner following receipt of a valid complaint and would be funded by the wind farm operator.

Aviation

2.6.22 Wind turbines can potentially interfere with aviation operators by either physically affecting the safeguarding of an aerodrome by the close proximity of the turbines or through interference with the Air Traffic Control (ATC) radars that direct aircraft in flight. RES consulted with all relevant organisations which could be affected by the proposed wind farm including the Defence Infrastructure Organisation (DIO) and Cardiff Airport and Bristol Airport.

2.6.23 A planning condition has been agreed with Cardiff Airport, for which the primary radar is located approximately 35 km south-west of the proposed wind farm, as below:

2.6.24 *No turbines shall be erected until a scheme for the mitigation of impact of the wind turbines on the operation of Cardiff Airport primary surveillance radar (the "radar mitigation scheme") has been submitted to and approved in writing by the Local Planning Authority. The development shall thereafter be operated fully in accordance with the approved radar mitigation scheme throughout the operational life of the development.*

2.6.25 The proposed wind farm is located approximately 40 km north-west of the Bristol Airport primary radar. A planning condition has been agreed with Bristol Airport, as below:

2.6.26 *No turbines shall be erected until a scheme for the mitigation of impact of the wind turbines on the operation of Bristol Airport primary surveillance radar (the "radar mitigation scheme") has been submitted to and approved in writing by the Local Planning Authority. The development shall thereafter be operated fully in accordance with the approved radar mitigation scheme throughout the operational life of the development.*

2.6.27 No response has yet been received from the DIO via scoping but previous liaison with the DIO indicates that there would be a requirement for the proposed wind farm to agree a suitable scheme of visible and/or infrared lighting to assist military aircraft in avoiding the proposed wind turbines.

2.6.28 The proposed wind farm is approximately 86 km south-west of the NERL Clee Hill radar. NERL has indicated that the proposed wind farm would have an unacceptable impact upon the Clee Hill en-route radar that may impact operations from the London Area Control Centre. NATS has issued a draft Statement of Common Understanding (SOCU) to RES, which is currenrtly being negotiated.

Public Rights of Way and Common Land

2.6.29 A number of public footpaths cross the site. Following consultation with Caerphilly County Borough Council and Torfaen County Borough Council, it may be necessary to divert some of these rights of way either permanently or temporarily during construction of the wind farm. Applications for rights of way diversions cannot be submitted with a DNS application and, where necessary, these applications would be submitted following determination of the DNS application.

2.6.30 The proposed wind farm also includes the provision of 14.50 ha of new common land to replace the common land that would be occupied by the proposed wind farm infrastructure. The application to de-register land occupied by the proposed wind farm and to register the replacement land is the subject of a secondary application under Section 16 of the Commons Act.

2.6.31 A further secondary application under Section 38 of the Commons Act, to enable temporary works to take place during construction of the wind farm, will also accompany the DNS application.

2.6.32 As a result of the surveys and assessments outlined above and from feedback received during consultation, the turbine layout was adjusted to account for the Phase 2 peat survey results to ensure that turbine positions and the associated infrastructure avoided areas of deeper peat. This resulted in Layout 4 shown in Figure 2.3: Turbine Layout Evolution.

2.6.33 Prior to the layout being finalised RES engineers undertook site visits to check that there were no remaining physical characteristics on-site that may impact upon the turbine performance such as topography and the proximity and height of forestry in relation to the turbines and to agree principles for the design of the on-site infrastructure based on the constraints identified.

Final Turbine Layout

2.6.34 The final turbine layout iteration took place following the Pre-Application Consultation. Further wind measurements were obtained, updating understanding of wind distribution on site, especially the dominant wind direction. This enabled the site to be re-optimised to minimise turbine loads and further avoid peat in response to feedback from statutory consultees during the Pre-Application Consultation and the further peat survey in May 2024. This layout is shown with the turbine coordinates in Figure 2.2: Turbine Layout.

2.7 Infrastructure Design Evolution

Engineering considerations

2.7.2 Key infrastructure considerations and design alternatives in response to constraints are summarised in the following sections.

Site Entrance Location

2.7.3 No alternative locations for the site entrance were considered through the design evolution as the terrain of the site means that the existing entrance to the Common is the most viable entrance.

Track

2.7.4 The proposed wind farm tracks were designed in accordance with the following principles:

- Avoidance of environmental and technical constraints (as shown in Figure 2.1: Key Constraints and Infrastructure);
- Follow natural contours as far as possible, in order to avoid unnecessary excavation;
- Minimisation of the overall length of access track;
- Minimisation of the number of watercourse crossings;
- Minimisation of the number of gas main crossings;
- Avoidance of steep slopes to minimise earthworks.

2.7.5 A key constraint in relation to the track was the avoidance of areas of deeper peat identified through peat probing surveys completed in April 2023. Peat depths greater than 50cm were avoided wherever possible.

Control Building and Substation

2.7.6 The buildings would be centrally located on the site which would allow ease of access from both the public road network and turbine locations. The substation is located away from the identified environmental constraints, on shallower gradient to minimise excavation. The substation is located as close as possible to the point of connection to the overhead electricity distribution network, minimising the length of overhead electricity lines required for the connection.

Temporary Construction Compound

2.7.7 The temporary construction compound is required to be located close to the site entrance and turbine locations for logistical reasons. The location is away from any identified environmental constraints, on shallower gradient to minimise excavation, and respects existing field boundaries.

Borrow Pits

2.7.8 The proposed wind farm incorporates temporary on-site borrow pits to make use of site-won stone and reduce the requirement for the transportation of materials to the Site. The borrow pits are located close to the site entrance, in order that maximum benefit can be gained for the construction of the site tracks. The location of the borrow pits avoids deep peat and all other identified constraints. The location of the borrow pits was also confirmed as acceptable by the noise assessment. Further details are included in Chapter 11: Acoustic.

Final Infrastructure Layout

2.7.9 The final infrastructure layout in relation to the combined constraints is shown in Figure 2.1: Key Constraints & Infrastructure.

2.8 Summary

2.8.1 The final layout of the proposed wind farm reflects the need to optimise the energy yield whilst minimising potential effects on environmental sensitivities. Wind farm design is an iterative process, and the design has been influenced by potential environmental effects identified through the EIA process. The proposed layout has evolved in response to policy recommendations, environmental, technical, engineering and landscape and visual design considerations and as a result of feedback from key consultees.