

14 Aviation and Other Issues

14.1 Introduction

14.1.1 This chapter of the EIAR assesses the potential effects of the Proposed Development in relation to:

- Aviation;
- Carbon Balance;
- Television, Telecommunications and Microwave Fixed Links;
- Shadow Flicker;
- Forestry; and
- Unexploded Ordnance (UXO).

14.1.2 Elements relating to Major Accidents and Disasters have been addressed in the individual technical discipline chapters where relevant.

14.1.3 Impacts on Population and Human Health have been addressed in the individual EIA topic chapters where relevant.

14.2 Aviation

Introduction

14.2.1 This section of the chapter considers the likely significant effects on aviation, radar and defence associated with the construction, operation and decommissioning of the Proposed Development.

14.2.2 The assessment of potential effects on aviation, radar and defence considers technical acceptability, based on air navigation safety, rather than following a strict EIA process of assessing the significance of effects. Such effects often require the implementation of technical mitigation solutions to ensure continued safe operation in the presence of a wind farm. The assessment of effects on these receptors is therefore one of technical analysis and consultation and seeks to identify whether the effect is likely to be 'acceptable' or 'not acceptable' to air navigation services provision.

Statement of Competence

14.2.3 The aviation, radar and defence assessment was conducted by Sam Johnson of RES. Sam is the Senior Aviation Manager at RES, with an MMath in Mathematics. Sam has over 20 years' experience in the radar industry with over 15 years specifically in the

area of wind farms. Sam is a member of the Renewable UK Aviation Working Group and is Chair of Aviation Investment Fund Company Limited (AIFCL).

Guidance

14.2.4 This assessment has been prepared with reference to Civil Aviation Authority (CAA) Publication (CAP) 764, Policy and Guidelines on Wind turbines (CAA, 2016). This is the primary guidance in relation to the assessment of wind turbines on aviation in the UK.

Scope of Assessment

Effects Scoped Out

14.2.5 Interference with surveillance systems and radar can occur when wind turbine blades are moving, therefore potential effects during construction are not assessed.

14.2.6 Upon decommissioning, the Ministry of Defence Geographic Centre (AIS Information Centre) will be informed of the removal of wind turbines. Following this, no decommissioning effects are expected and are not considered further.

Effects Assessed in Full

14.2.7 The assessment identifies and considers the potential effects that the Proposed Development may have on civilian and military aviation, air safeguarding and, if required, the mitigation measures proposed to prevent, reduce or offset any potential adverse effects where possible.

14.2.8 In relation to military and civil aviation assets it considers potential impacts on military Air Defence (AD) Radar, NATS En Route Ltd (NERL) radars, nearby airports and airfields, and the potential mitigation measures identified to address these.

14.2.9 The assessment is based on an evaluation of existing data sources and desk studies, and consultation with key stakeholders.

14.2.10 The effects of turbines on aviation interests are well known but the primary concern is one of safety. The two principal scenarios that can lead to effects on the operations of aviation stakeholders are:

- physical obstruction: turbines can present a physical obstruction at or close to an aerodrome or in the military low flying environment, which itself presents a health and safety risk or otherwise requires changes to flight routes in the area which brings about other operational effects; and
- radar/air traffic services (ATS): turbine clutter appearing on a radar display can affect the safe provision of ATS as it can mask unidentified aircraft from the air traffic controller and/or prevent them from accurately identifying aircraft under

control. In some cases, radar reflections from turbines can affect the performance of the radar system itself.

14.2.11 In this context the scope of the assessment is to consider the impact of the Proposed Development on aviation stakeholders, including military, en route, airports and other airfields, radar systems and air space users. This assessment also considers civil and military stakeholder aviation obstruction lighting requirements.

14.2.12 As standard post consent, the Defence Geographic Centre (AIS Information Centre) will be provided with the following information for incorporation on to aeronautical charts and documentation:

- the date of commencement of the Proposed Development.
- the exact position of the turbine towers in latitude and longitude;
- a description of all structures over 300 feet high;
- the maximum extension height of all construction equipment;
- the height above ground level of the tallest structure; and
- details of a visible and/or infrared aviation lighting scheme.

Baseline Characterisation

Study Area

14.2.13 Consideration is given to aviation infrastructure that is within operational range of the Proposed Development. Operational range varies with the type of infrastructure but broadly includes regional airports operating radar up to 50 km from the Proposed Development, non-radar aerodromes within 17 km, parachute drops zones within 3 km, and military radar and en route radar systems up to 100 km from the Proposed Development (dependent on operational range).

Desk Study

14.2.14 The applicant has a dedicated aviation manager who has provided input to the Proposed Development since its inception. This has included:

- civil and military radar line of sight (LoS) analysis;
- review of relevant aviation charts;
- review of military low flying charts; and
- general aviation advice based on prevailing civil and aviation issues.

Significance Criteria

14.2.15 Significance criteria for aviation impacts are typically difficult to establish; they are not strictly based on the sensitivity of the receptor or magnitude of change but on whether the industry regulations for safe obstacle avoidance or radar separation (from radar clutter) can be maintained in the presence of the turbines.

14.2.16 Any anticipated impact upon aviation stakeholders which results in restricted operations is therefore considered to be of significance.

Assessment Limitations

14.2.17 No limitations have been identified that would affect the findings of the assessment, based on the information available at the time of writing.

Baseline

Civil Aviation

14.2.18 The Proposed Development is within 50 km of Aberdeen Airport and has the potential to impact upon its Instrument Flight Procedures (IFP) and radar.

14.2.19 The Civil Aviation Authority will require the Proposed Development to have visible lighting to assist with air safety.

NERL

14.2.20 The Proposed Development is approximately 25 km from Perwinnes radar and 61.8 km from Allanshill radar. A line-of-sight analysis indicates the potential to affect both assets.

Military Aviation

14.2.21 There are five military radar within 100 km of the Proposed Development; the closest being Air Defence Buchan radar approximately 56 km to the north east.

14.2.22 The Proposed Development is located within an area designated as a 'low priority military low flying area'.

Consultation

Table 14.1: Consultation Responses relating to Aviation, Radar & Defence

Consultee and Date	Scoping / Other Consultation	Issue Raised	Response / Action
Defence Infrastructure Organisation (DIO) (16 Sept 22)	Scoping	<p>The Proposed Development falls within Low Flying Area 14 (LFA 14), an area within which fixed wing aircraft may operate as low as 250 feet or 76.2 metres above ground level to conduct low level flight training. The addition of turbines in this location has the potential to introduce a physical obstruction to low flying aircraft operating in the area.</p> <p>To address the impact up on low flying given the location and scale of the Proposed Development, as a minimum the MOD would require that the development be fitted with MOD accredited aviation safety lighting in accordance with the Air Navigation Order 2016.</p> <p>The MOD must emphasise that the advice provided within this letter is in response to the information detailed in the developer's document titled consultation dated August 2022 sourced from Energy Consents unit. Any variation of the parameters (which include the location, dimensions, form, and finishing materials) detailed may significantly alter how the development relates to MOD safeguarding requirements and cause adverse impacts to safeguarded defence assets or capabilities. In the event that any amendment, whether considered material or not by the determining authority, is submitted for approval, the MOD should be consulted and provided with adequate time to carry out assessments and provide a formal response.</p>	The DIO indicated that the Proposed Development lies within a low flying tactical training area. The MOD Low Flying team will be consulted to agree a suitable aviation lighting scheme if deemed necessary.
Aberdeen International Airport Limited (25 Aug 22)	Scoping	<p>The Proposed Development is located within the wind farm consultation zone for Aberdeen Airport and as such aviation impacts should be considered as part of the EIA. As the scoping report acknowledges it is likely visible to primary surveillance radars used by Aberdeen Airport and mitigation would be required.</p> <p>It is also likely to impact upon Instrument Flight Procedures (IFP). Detailed assessments will be required.</p>	<p>The Applicant will review the layout and update in cognisance of other site constraints and consultee feedback.</p> <p>The revised layout addresses the potential impact upon the radar and reduces the impacts upon IFP. Whilst it removes the impact upon the 3200ft Surveillance Minimum Altitude Area (SMAA), there remains an overlap with the 2800ft SMAA for which consultation is ongoing to find an agreeable approach.</p>
Edinburgh Airport Limited (31 Aug 22)	Scoping	The Proposed Development falls out with our Aerodrome Safeguarding zone for Edinburgh Airport therefore we have no objection/comment.	No further action required.
Glasgow Airport (25 Aug 22)	Scoping	This Proposed Development is located outwith the consultation area for Glasgow Airport. As such we have no comment to make and need not be consulted further.	No further action required.
Glasgow Prestwick Airport Ltd (GPA) (12 Sept 22)	Scoping	The Proposed Development lies outwith the Airport's safeguarding area and as such GPA have no comment to make on the scoping consultation and would have no aviation grounds to object to this proposal should it come to a full Section 36 Planning Application.	No further action required.
Civil Aviation Authority (CAA) (18 Sept 23)	Pre-Submission	<p>The CAA responded to the Applicant to agree a revised lighting scheme for the proposed turbines:</p> <ul style="list-style-type: none"> • Medium intensity steady red (2000 candela) lights on the nacelles of turbines 01, 04, 06, 07, 10, 12 and 16; • A second 2000 candela light on the nacelles of the above turbines to act as alternate in the event of a failure of the main light (note that both lights should not be lit at the same time); • Lights capable of being dimmed to 10% of peak intensity when the lowest visibility (as measured at suitable points around the wind farm by visibility measuring devices) exceeds 5 km; • A scheme of infrared lighting to be agreed with the MOD to account for operators who carry night vision device capability (note that dimming permission is applicable only to visible lights, not infra-red lighting); • Intermediate level 32 candela lights are not required to be fitted on the turbine towers. 	<p>The Applicant will adhere to the agreed lighting scheme.</p> <p>Chapter 6 provides a nighttime assessment based on this scheme.</p>

Mitigation and Residual Effects

Predicted Operational Effects

- 14.2.23 Turbines have the potential to impact the performance of air traffic control radars. These impacts include:
- 14.2.24 The creation of "false" targets, whereby the turbines present on the radar display. Multiple false targets can lead to the radar initiating false aircraft tracks.
- 14.2.25 False returns can also cause track seduction, i.e. real aircraft tracks are 'seduced' away from the true position as the radar updates the aircraft track with the false return. This can lead to actual aircraft not being detected.
- 14.2.26 Shadowing whereby the aircraft is not detected by the radar as it is flying within the physical 'shadow' of the turbine.
- Aviation and Radar*
- 14.2.27 Following the Scoping Opinion of DIO it is concluded by the applicant that there will be no impact upon air defence or air traffic control radar.
- 14.2.28 Through design mitigation, the Proposed Development has evolved to remove potential impacts upon NERL Allanshill radar and upon the Aberdeen Airport's 3200 ft SMAA. Surveillance Minimum Altitude Area
- 14.2.29 Prior to mitigation, it is considered that the Proposed Development would affect the operation of the NERL Perwinnes radar, low flying activities and Aberdeen Airport's Instrument Flight Procedure (IFP) for 2800ft SMAA (the Proposed Development lies within the lateral buffer of the 2800ft SMAA).

Proposed Mitigation

Aviation and Radar

- 14.2.30 There are a number of mitigation options available to alleviate problems caused by turbines to aviation and radar. Mitigation solutions are highly specific to the effect in questions. Consultation with relevant consultees is key to establishing the appropriate method of mitigation.
- 14.2.31 A Resource Management System (RMS) will be agreed with NATS that will remove or reduce to an acceptable level, the impact of the Proposed Development on the NERL Perwinnes Radar. The RMS will be agreed prior to the Proposed Development becoming fully operational.
- 14.2.32 The Applicant has consulted Aberdeen Airport regarding the impact upon the 2800 ft SMAA. An increase to the IFP would mitigate this impact which requires agreement from Aberdeen Airport who would manage the change.

14.2.33 A reduced visible aviation lighting scheme has been agreed with the CAA. A reduced lighting scheme seeks not every perimeter turbine to be lit and no tower lights provided an infrared scheme is agreed with the DIO. The proposed lighting scheme is presented in **Figure 14.1**. The results of the assessment for night-time lighting are contained in **Chapter 6: Landscape & Visual Impact Assessment**.

14.2.34 An infrared lighting scheme will be agreed with the DIO prior to the Proposed Development becoming fully operational.

Summary

- 14.2.35 The Proposed Development will potentially impact the NERL radar at Perwinnes. It has been agreed with NATS that the impact can be mitigated with a suitable mitigation scheme and this could be secured through an appropriately worded suspensive planning condition.
- 14.2.36 Infrared lighting will be agreed with the DIO for the MOD low flying requirements and a visible lighting scheme has been agreed with the CAA.
- 14.2.37 Whilst a working solution to the Aberdeen Airport's 2800ft SMAA is outstanding, consultation is ongoing and subject to agreement, a mitigation scheme could be secured through an appropriately worded suspensive planning condition.

14.3 Carbon Balance

Introduction

- 14.3.1 The ‘carbon calculator’ is the Scottish Government’s tool provided to support the process of determining wind farm developments in Scotland. The purpose of the tool is to assess, in a comprehensive and consistent way, the carbon impact of wind farm developments. This is done by comparing the carbon costs of wind farm developments with the carbon savings attributable to the wind farm.
- 14.3.2 The carbon balance assessment presented has been produced to calculate the carbon emissions generated in the construction, operation and decommissioning of Hill of Fare Wind Farm (the Proposed Development).
- 14.3.3 The carbon calculator spreadsheet and online tool calculates payback time for wind farm sites on peatland, using methods given in Nayak et al, 2008 and revised equations for Greenhouse Gas (GHG) emissions (Nayak et al, 2010 and Smith et al, 2011, and the Wind Farm and Carbon Savings Technical Note v2.2.10.0.
- 14.3.4 This section of the Chapter has been produced by Alicia McDowall of ITP Energised utilising the carbon calculator (online version 1.7.0) with project description and forestry data provided by the Applicant, hydrology and peat data provided by Envirocentre and ecological data provided by ITP Energised.

Methodology

Input Parameters

- 14.3.5 The carbon calculator (online version 1.7.0) allows a range of data to be input to utilise expected, minimum and maximum values, where relevant and applicable. If several parameters are varied together, however, this can have the effect of ‘cancelling out’ a single parameter change. For this reason, the approach for this assessment has been to include ‘maximum values’ as those values which would result in longest (maximum) payback period; and ‘minimum values’ as those values which would result in the shortest (minimum) payback period. The ‘expected’ value is based on the most realistic option for the site.
- 14.3.6 The Proposed Development will comprise 16 turbines each with a power rating of approximately 6.6 MW. For this reason, the factors which have been used in this assessment include the following:
- The recommended capacity factor within the calculation spreadsheet has been amended to a site-specific value of 38.6%;

- The choice of methodology for calculating the emission factors used the ‘site specific methodology’ defined within the calculation spreadsheet;
- A combination of site-specific and default values for carbon content and bulk density of peat have been used for the assessment. The carbon content ranges from 19.57% to 64.28% with an expected value of 42.3% used. The bulk density of peat ranges from 0.15 g cm⁻³ to 0.072 g cm⁻³ with an expected average of 0.293 g cm⁻³. The average of site-specific values for both carbon content and peat bulk density were obtained via laboratory analysis (**Technical Appendix 10.1**). Minimum and Maximum values are derived from Soil Survey of Scotland of all Scottish peatlands in "Windfarm Carbon Calculator Web Tool, User Guidance";
- Generic hydrological parameters have been used for average groundwater. A value of 0.3 m has been used as the expected value. A ‘minimum’ value of 0.1 m has been used to represent areas of intact peat (the higher the water table, the longer the payback period), and a ‘maximum’ value of 0.5 m has been used to represent areas of eroded peat.
- A review of the available literature (Nayak et al., 2008) found that the extent of drainage effects is reported as being anything from 2 m to 50 m horizontally around a site of disturbance. Research into the effects of moor gripping and water table data from other sites yielded a horizontal draw down distance typically of about 2 m. It is thought that in extreme cases, this may extend between 15 m and 30 m, though 15 m is considered an appropriate distance. Smith et al. (2011), identified the average extent of drainage impact at three sites (Cross Lochs, Farr Windfarm and Exe Head) as ranging from 3 m to 9 m. However, the actual extent of drainage at any given location will be dependent on local site conditions, including underlying substrata and topography. As site-specific values are not available, the standard values from ‘Windfarm Carbon Calculator Web Tool, User Guidance’ have been used. Therefore, the expected value is 10 m (minimum 5 m, maximum 50 m).
- The most recent values for the three required counterfactual factors provided in the online carbon calculator have been included are: grid mix: 0.19338 Tonnes of carbon dioxide per megawatt hour (t CO₂ MWh⁻¹), fuel mix: 0.432 t CO₂ MWh⁻¹ and coal: 1.002 t CO₂ MWh⁻¹;
- Infrastructure dimensions, including estimated excavation size for turbine foundations, hardstands and track lengths are outlined in **Chapter 2: Project Description**. The final dimensions of each borrow pit have yet to be defined. Average dimensions from the search areas identified have been used, however it is unlikely that actual borrow pits would be as large;

- The assessment is based on a series of average soil depths taken from peat surveys undertaken at the site. Probe locations sited on mineral / organic soils (<0.5 m) are conservatively included within the averages.; and
- An estimate of the total volume of concrete has been included, based on an anticipated 9,600 m³ concrete being required for each turbine foundation.

14.3.7 A full summary of input parameters is presented in **Appendix 14.1** and can be viewed online using the reference GYPU-K6X2-14MT.

Carbon Assessment Outputs

14.3.8 A summary of the anticipated carbon emissions and carbon payback of the Proposed Development is show in **Table 14.2** below.

14.3.9 As recommended in current guidance, estimated savings presented above are for replacement of fossil fuel electricity generation but, while this could be the case in the short term, it is not the most probable scenario in the longer-term. The grid-mix of electricity generation represents the overall carbon emissions from the grid per unit of electricity and includes nuclear and renewables as well as fossil fuels. Based on the grid-mix results, the Proposed Development is expected to result in a saving of approximately 69,033 tonnes of carbon dioxide (tCO₂) per year with an expected carbon payback time of 2.8 years, while for the fossil fuel mix result this would be a saving of approximately 154215 tCO₂ over 1.2 years.

Table 14.2 Estimated carbon payback time in years with generation of electricity source

Generation Source	Carbon Payback Period (years)		
	Minimum Value	Expected Value	Maximum Value
Coal-fired plant	0.3	0.5	0.6
Fossil fuel-mix	0.8	1.2	1.4
Grid-mix	1.8	2.8	3.2

Summary

14.3.10 The calculations of total carbon dioxide emission savings and payback time for the Proposed Development indicates the overall payback period for 16 turbines with installed capacity of around 6.6 MW would be around 0.8 to 1.4 years, when compared to the fossil fuel mix of electricity generation.

14.3.11 This means that the Proposed Development is anticipated to take around 1.2 years to repay the carbon exchange to the atmosphere (the CO₂ debt) following its construction. At most it would take 3.2 years of operation set against the grid-mix scenario but expected to be 2.8 years to payback its carbon emissions. With an operational period sought of 50 years, it would contribute to Scottish Government's

national objectives on reducing carbon emissions for approximately 47 years. This is considered to be a significant beneficial effect on climate change mitigation.

References

Birnie R.V., Clayton P., Griffiths P., Hulme P.D., Robertson, R.A., Sloane B.D., and S.A. Ward. (1991). *Scottish peat resources and their energy potential*. Department of Energy.

Lindsay, R. (2010). *Peatbogs and Carbon: a critical synthesis*. RSPB.

Nayak D.R., Miller D., Nolan A., Smith P., Smith J.U. (2008). *Calculating Carbon Savings from Windfarms on Scottish Peatlands - Revision of Guidelines*. October 2007 to January 2008. Final Report.

Nayak D.R., Miller D., Nolan A., Smith P., Smith J.U. (2010) *Mires and Peat.*, Article 09 4, 1-23 <http://www.mires-and-peat.net/>, ISSN 1819-754X.

Scottish Government (2016). *Calculating Potential carbon losses and savings from wind farms on Scottish peatlands*. Technical Note - Version 2.10.0.

SEPA. *Windfarm Carbon Calculator Web Tool, User Guidance*. Available at: www.informatics.sepa.org.uk/CarbonCalculator/assets/Carbon_calculator_User_Guidance.pdf Accessed 28.10.2023.

Smith J.U., Graves P., Nayak D.R., Smith P., Perks M., Gardiner B., Miller D., Nolan A., Morrice J., Xenakis S., Waldron S., Drew S. (2011) *Carbon implications of windfarms located on peatlands - update of the Scottish Government Carbon Calculator tool*. Final Report, RERAD Report CR/2010/05.

14.4 Television, Telecommunications and Microwave Fixed Links

Introduction

- 14.4.1 This section of the chapter summarises the potential television and telecommunications effects associated with the Proposed Development.
- 14.4.2 This section of the Chapter, addressing Television, Telecommunications and Shadow Flicker has been produced by Stefanos Kolydas of RES. Stefanos is a Senior Project Technical Analyst with an MSc in Renewable Energy Engineering. Stefanos has over eight years' experience in the renewable energy industry.

Guidance

- 14.4.3 Tall structures such as turbines may cause interference of nearby television and telecommunications links. As such, any links in the vicinity of the Proposed Development must be identified and operators must be consulted.
- 14.4.4 The Ofcom Spectrum Information Portal was used in the first instance to identify fixed microwave links crossing or adjacent to the site.
- 14.4.5 A number of other telecommunications services in addition to fixed microwave links may be present, however most of these services are generally only affected if turbines are located in immediate vicinity. Furthermore, where other services are present, there is usually a supporting fixed microwave link to allow onward signal transmission, which would be identified in this assessment. It is therefore considered that the search for fixed microwave links, and discussion with identified operators, also covers all other services.

Scope of Assessment

Effects Scoped Out

- 14.4.6 Effects on television and telecommunications have been scoped out of detailed assessment because digital television is less likely to be affected by the atmospheric conditions that rendered analogue television unwatchable and does not suffer from reflection effects or ghosted image generation.

Microwave Fixed Links

- 14.4.7 Fixed microwave links are direct line-of-sight communication links between transmitting and receiving dishes placed on masts generally located on hilltops that vary in length from a few kilometres to over 70 km.

- 14.4.8 Telecommunications and broadcasting network operators have been consulted during the design evolution. **Table 14.3** summarises the responses from link operators contacted.

Table 14.3 Link Operators responses

Link Operator	Response/Issue Raised	Actions
Arqiva	No part of any turbine should be within 100 m of the link	A buffer of 100 m + blade length has been applied to the link
BT	No concerns raised	No actions required
JRC	No concerns raised	No actions required
Atkins	No concerns raised	No actions required

- 14.4.9 A microwave link belonging to Arqiva was identified crossing the Proposed Development area. Arqiva was contacted 14 April 2022 to understand more of the link and an appropriate buffer. Arqiva confirmed on 26 April 2022 that no part of any turbine should be within 100 m of the link, and that if this separation were maintained they would have no objection to the Proposed Development. The link is identified in the Site Key Constraints **Figure 3.1**. All proposed turbines are clear of the requested separation. Arqiva confirmed with the Applicant on 12 September 2023 that it had no concerns with the Proposed Development.
- 14.4.10 BT responded to Scoping with its Opinion on 22 August 2022, to confirm that the Proposed Development should not cause interference to BT's current and presently planned radio network and maintained this position on 12 September 2023 with sight of the final layout.
- 14.4.11 The Joint Radio Company (JRC) Limited, which provides Scanning Telemetry Services, responded to Scoping on 21 August 2022, indicating a potential impact by the Proposed Development upon a microwave link. Following consultation by the applicant with JRC, a more detailed examination by JRC confirmed no significant degradation anticipated and therefore no objection.
- 14.4.12 Atkins confirmed with the Applicant on 14 September 2023 that it would have no objection to the Proposed Development.
- 14.4.13 With the information available to the Applicant, the Proposed Development does not affect microwave fixed links.

Summary

14.4.14 The Proposed Development is expected to have no impact on any telecommunication systems.

References

*Ofcom (2023). Spectrum Information Portal. Available at:
<https://ofcom.org.uk/spectrum/information/spectrum-information-system-sis/spectrum-information-portal>
Accessed: 29.08.2023.*

14.5 Shadow Flicker

Introduction

- 14.5.1 This section of the chapter summarises the potential effect of shadow flicker associated with the Proposed Development.
- 14.5.2 This section of the Chapter has been produced by Stefanos Kolydas of RES. Stefanos is a Senior Project Technical Analyst with an MSc in Renewable Energy Engineering. Stefanos has over eight years' experience in the renewable energy industry.
- 14.5.3 In sunny conditions, any shadow cast by a turbine will mirror the movement of the rotor. When the sun is high, any shadows will be confined to the wind farm area but when the sun sinks to a lower azimuth moving shadows can be cast further afield and potentially over adjacent properties. Shadow flicker is generally not a disturbance in the open as light outdoors is reflected from all directions. The possibility of disturbance is greater for occupants of buildings when the moving shadow is cast over an open door or window, since the light source is more directional.
- 14.5.4 Whether shadow flicker is a disturbance depends upon the observer's distance from the turbine, the direction of the dwelling and the orientation of its windows and doors from the wind farm, the frequency of the flicker and the duration of the effect, either on any one occasion or averaged over a year.
- 14.5.5 In any event and irrespective of distance from the turbines, the flickering frequency will depend upon the rate of rotation and the number of blades. It has been recommended (Clarke, 1991) that the critical frequency should not be above 2.5 Hz, which for a three-bladed turbine is equivalent to a rotational speed of 50 rpm. The turbines at the Proposed Development would rotate at a maximum of approximately 13 rpm, well below this threshold.
- 14.5.6 The common rate or frequency at which photosensitive epilepsy might be triggered is between 3 and 30 hertz (Hz, flashes per second). Large commercial turbines, such as those proposed, rotate at low speeds resulting in less than 3 flashes per second and are therefore unlikely to cause epileptic seizures (Harding et al., 2008; Smedley et al., 2010). Therefore, there are not considered to be any health effects associated with the project and the assessment will address the effects of shadow flicker related only to local amenity.
- 14.5.7 A related visual effect to shadow flicker is that of reflected light. Theoretically, should light be reflected off a rotating turbine blade onto an observer then a stroboscopic effect would be experienced. In practice a number of factors limit the severity of the phenomenon and there are no known reports of reflected light being a significant problem at wind farms.
- 14.5.8 A limiting factor is that wind turbines have a semi-matt surface finish which means that they do not reflect light as strongly as materials such as glass or polished vehicle bodies.
- 14.5.9 Secondly, due to the convex surfaces found on a turbine, light will generally be reflected in a divergent manner.
- 14.5.10 Thirdly, as with shadow flicker, certain weather conditions and solar positions are required before an observer would experience this phenomenon.
- 14.5.11 It is therefore concluded that the Proposed Development will not cause a material reduction to amenity owing to reflected light.

Policy and Guidance

- 14.5.12 The following guidance documents have been referred to in undertaking the assessments:
- Scottish Government - Onshore wind turbines: planning advice
 - Department of Energy & Climate Change (DECC) guidelines
- 14.5.13 The update to Shadow Flicker Evidence Base (2011), published by the then Department for Energy and Climate Change (DECC), states that assessing shadow flicker effects within ten times the rotor diameter of wind turbines has been widely accepted across different European countries, and is deemed to be an appropriate area.
- 14.5.14 Scottish Government guidance advocates that beyond this distance, shadow flicker should not be a problem.

Methodology

- 14.5.15 Properties have been assessed within a radius of ten rotor diameters distance of any turbine as per DECC guidelines.
- 14.5.16 This shadow flicker assessment is based on turbines with a 155 m rotor diameter and the planning application includes a 100 m micro-siting distance for infrastructure. As such, this 100 m distance is added to the ten-rotor diameter (155 m = 155 * 10) distance to give a total distance of 1650 m (= 1550 m + 100 m) from any turbine.

14.5.17 Analysis was undertaken for shadow flicker at all properties within 1650 m from any turbine.

14.5.18 This analysis takes into account the motion of the Earth around the Sun, the local topography and the turbine locations and dimensions. The analysis was performed using the proposed layout.

Assessment Results

14.5.19 **Figure 14.2** details the locations of affected properties relative to the Proposed Development.

14.5.20 With due reference to the DECC report, and allowance for 100 m micro-siting, the potential shadow flicker is given in **Table 14.4**.

Table 14.4: Shadow Flicker Assessment Summary of Results

RES Property ID	Property Address	Total Hours per Year
H136	Dove Cottage, Midmar, Inverurie, AB51 7LX, UK	71.7
H137	Craigshannoch Lodge, Midmar, Inverurie, AB51 7LX, UK	68.7
H139	Craigshannoch Cottage Midmar, Inverurie, AB51 7LX, UK	65.6
H253	Braeside, unoccupied derelict building not within the UK Address Base	32.3
H89	Cormoir, Torphins, Banchory, AB31 4NP, UK	19.4
H87	Blairhead, Torphins, Banchory, AB31 4NP, UK	13.1

The above impacts represent a worst-case scenario for the following reasons:

- The analysis assumes that the turbines rotors are always turning (in reality this only occurs when there is sufficient wind to turn the rotor blades and the wind turbines are not undergoing maintenance);
- The analysis assumes that the orientation of the turbines is always aligned so as to cast a sufficient shadow towards the property (in reality the turbines automatically turn to face the prevailing wind which may, or may not, create this condition)
- The analysis assumes that sunshine is always of sufficient intensity to cause shadow flicker (in cloudy skies it is unlikely to do so);
- The analysis assumes that all receptors have relevantly orientated windows (in reality this may not be true); and
- The analysis assumes that no trees or walls obscure the view of the turbines and hence block any potential shadow flicker (in reality many properties have trees or bushes near to the property that may obscure the view to the Proposed development).

14.5.21 Property H136 is predicted to experience the largest amount of shadow flicker, albeit only 71.7 hours spread across the year. Given the likelihood of this worst case scenario occurring to a much lesser extent in reality this is assessed to be minor and not significant.

Mitigation

14.5.22 Mitigation measures can be incorporated into the operation of the Proposed Development to reduce the instance of shadow flicker. Mitigation measures include planting tree belts between the affected dwelling and the responsible turbine(s) and shutting down individual turbines during periods when shadow flicker could theoretically occur. Should there be incidences of shadow flicker reported, it will be investigated and the relevant mitigation applied.

References

- Clarke A.D (1991), *A case of shadow flicker/ flashing: assessment and solution*, Open University, Milton Keynes.
- Brinckeroff, Parsons (2011) 'Update of UK Shadow Flicker Evidence Base', Department of Energy and Climate Change, UK Government.

14.6 Forestry

Introduction

- 14.6.1 This section of the chapter summarises the potential effects of the Proposed Development on forestry.
- 14.6.2 This section has been completed by ITP Energised and Gavin Shirley of RES. Gavin is a Development Project Manager with RES with an MSc in Urban and Regional Planning and has over twelve years' experience in the renewable energy industry.

Consultation

- 14.6.3 Scottish Forestry did not respond to the Applicant's Scoping Report.

Policy and Guidance

- 14.6.4 Relevant overarching planning policies for the Proposed Development are detailed within the Planning & Sustainable Place Statement that accompanies the application. A desktop study was undertaken drawing upon published National, Regional and local level publications, assessments and guidance to establish the broad planning and forestry context within which the Proposed Development is located.
- 14.6.5 Forestry related policies and documents listed below have been considered within the forestry assessment. The following section provides an outline of those planning policies which are relevant to the Proposed Development, and in particular to forestry.
- 14.6.6 With the introduction of the Forestry and Land Management (Scotland) Act 2018 and its associated Regulations on 01 April 2019, the old regulatory regime of felling control under the Forestry Act 1972 was repealed in Scotland. From 01 April 2019, anyone wishing to fell trees in Scotland requires a Felling Permission issued by Scottish Forestry, unless an exemption applies or another form of felling approval such as a felling licence (including a forest plan) has previously been issued.
- 14.6.7 Under the new Regulations felling which is authorised by planning permission consent continues to be exempt from the Regulations and does not require a Felling Permission issued by Scottish Forestry.

Scotland's Forestry Strategy 2019 - 2029

- 14.6.8 Scotland's Forestry Strategy 2019 - 2029 (SFS)³, was published in 2019 after a consultation period. The strategy provides an overview of contemporary Scottish

forestry; presents the Scottish Government's 50-year vision for Scotland's forests and woodlands; and sets out a 10-year framework for action.

- 14.6.9 The vision is that "...in 2070, Scotland will have more forests and woodlands, sustainably managed and better integrated with other land uses. These will provide a more resilient, adaptable resource, with greater natural capital value, that supports a strong economy, a thriving environment, and healthy and flourishing communities."
- 14.6.10 It lists a number of objectives summarised below:
1. Increase the contribution of forests and woodlands to Scotland's sustainable and inclusive economic growth;
 2. Improve the resilience of Scotland's forests and woodlands and increase their contribution to a healthy and high quality environment; and
 3. Increase the use of Scotland's forest and woodland resources to enable more people to improve their health, well-being and life chances.

It further describes the priorities as:

- Ensuring forests and woodlands are sustainably managed;
- Expanding the area of forests and woodlands, recognising wider land-use objectives;
- Improving efficiency and productivity, and developing markets;
- Increasing the adaptability and resilience of forests and woodlands;
- Enhancing the environmental benefits provided by forests and woodlands; and
- Engaging more people, communities and businesses in the creation, management and use of forests and woodlands.

- 14.6.11 There are ambitious targets included within the strategy for new woodland creation:
- 10,000 ha per year in 2018;
 - 12,000 ha per year from 2020/21;
 - 14,000 ha per year from 2022/23; and
 - 15,000 ha per year from 2024/25.

- 14.6.12 The stated objective is to increase Scotland's woodland cover from the current 18.5% to 21% by 2032.

Control of Woodland Removal Policy

- 14.6.13 In parallel with the SFS and other national policies on woodland expansion, there is a strong presumption against permanent deforestation unless it addresses other environmental concerns. In Scotland, such deforestation is dealt with under the

Scottish Government's 'Control of Woodland Removal Policy 9'. The guidance relating to the implementation of the policy was revised and updated in 2009.

14.6.14 The purpose of the policy is to provide direction for decisions on woodland removal in Scotland. The policy document lays out the background to the policy, places it into the current policy and regulatory context, and discusses the principles, criteria and process for managing the policy implementation. The following paragraphs summarise the policy relevant to the Proposed Development.

14.6.15 The principal aims of the policy include:

- To provide a strategic framework for appropriate woodland removal; and
- To support climate change mitigation and adaptation in Scotland.

14.6.16 The guiding principles behind the policy include:

- There is a strong presumption in favour of protecting Scotland's woodland resources; and

14.6.17 Woodland removal should be allowed only where it would achieve significant and clearly defined additional public benefits. In appropriate cases, a proposal for compensatory planting may form part of this balance.

14.6.18 Woodland removal, without a requirement for compensatory planting, is most likely to be appropriate where it would contribute significantly to:

- Enhancing priority habitats and their connectivity;
- Enhancing populations of priority species;
- Enhancing nationally important landscapes, designated historic environments and geological sites of special scientific interest (SSSI);
- Improving conservation of water or soil resources; or
- Public safety.

14.6.19 Woodland removal, with compensatory planting, is most likely to be appropriate where it would contribute significantly to:

- Helping Scotland mitigate and adapt to climate change;
- Enhancing sustainable economic growth or rural/community development;
- Supporting Scotland as a tourist destination;
- Encouraging recreational activities and public enjoyment of the outdoor environment;
- Reducing natural threats to forests or other land; or
- Increasing the social, economic or environmental quality of Scotland's woodland cover.

14.6.20 The consequences of the policy are stated as:

- Minimising the inappropriate loss of woodland cover in Scotland;
- Enabling appropriate woodland removal to proceed with no net loss of woodland -related public benefits other than in those circumstances detailed in the policy; and
- Facilitating achievement of the Scottish Government's woodland expansion ambition in a way that integrates with other policy drivers (such as increasing sustainable economic growth, tackling climate change, rural/community development, renewable energy and biodiversity objectives).

14.6.21 Addressing the policy requirements can be met through changes to forest design, increasing designed open space, changing the woodland type, changing the management intensity, or completing off site compensation planting.

National Planning Framework 4

14.6.22 National Planning Framework (NPF) 4 was published in February 2023. Policy 6: Forestry, woodland and trees aims to protect and expand forests, woodland and trees and ensure that woodland and trees on development sites are sustainably managed. The Policy notes that Development proposals that “enhance, expand and improve woodland and tree cover will be supported” and continues by noting that policy support will not be forthcoming for proposals which “would result in:

- Any loss of ancient woodlands, ancient and veteran trees, or adverse impact on their ecological condition;*
- Adverse impacts on native woodlands, hedgerows and individual trees of high biodiversity value, or identified for protection in the Forestry and Woodland Strategy;*
- Fragmenting or severing woodland habitats, unless appropriate mitigation measures are identified and implemented in line with the mitigation hierarchy;*
- Conflict with Restocking Direction, Remedial Notice or Registered Notice to Comply issued by Scottish Forestry.”*
- 14.8.17 Part C. advises that “Development proposals involving woodland removal will only be supported where they will achieve significant and clearly defined additional public benefits in accordance with relevant Scottish Government policy on woodland removal. Where woodland is removed, compensatory planting will most likely be expected to be delivered.”*

Baseline

14.6.23 The proposed turbines are sited on the Hill of Fare, an open heather moorland with sporadic self-seeded trees. The outline Biodiversity Enhancement and Management Plan (BEMP) (Technical Appendix 8.5) includes proposals to control the spread of

self-seeding trees to maintain the open heather moorland as well as introduce approximately an area of 15.79 ha with riparian tree planting.

- 14.6.24 Surrounding the Hill of Fare are areas of commercial forestry, as can be seen on the OS basemap of **Figure 1.2**. It can also be seen from this figure that most of the site is unforested. The eastern section of the Site, by the site entrance and central southern section at the Howe of Corrichie, are the only forestry areas within the site boundary. These are both owned and managed by Dunecht Estates.
- 14.6.25 The Desktop study, using NatureScot datasets, indicate the eastern section forms part of Midmar Forest and carries with it a designation of Ancient Woodland though has been managed for commercial forestry (refer to **Figure 8.1**). However, since Storm Arwen tracked through the UK in November 2021, significant portions of forestry were blown down in Aberdeenshire including this eastern area within the Site designated as Ancient Woodland.
- 14.6.26 Were the Proposed Development not to proceed, these areas would be replanted with commercial forestry tree species. The open heather moorland on the Hill of Fare would be gradually reduced with increased creep of self-seed conifers.
- 14.6.27 There are existing access tracks through the forestry areas of the site which will be upgraded to facilitate access for the traffic associated with the Proposed Development and there are some elements of infrastructure within such areas. These include:
- Temporary enabling works compound during construction/public car parking during operation;
 - Temporary batching plant;
 - Two borrow pit search areas;
 - Control building and substation compound with hardstanding area; and
 - Battery storage.
- 14.6.28 The total area for the above infrastructure is calculated to be 270,170 m² (27.02 ha). This figure excludes the existing access tracks which will be upgraded since they are tracks, bereft of trees but does include the working construction area required around the proposed infrastructure including access track widening.
- 14.6.29 However, the Temporary Enabling Works Compound During Construction, which will be a Public Car Parking During Operation, Temporary Batching Plant and one Borrow Pit Search Area are proposed within forestry areas which have been cleared owing to Storm Arwen. In doing so, the extent of physical felling required has been reduced. The following photographs taken in March 2023 showcase the extent of land cleared of forestry and the proposed locations of some infrastructure.



Photograph 1: Temporary Batching Plant Location looking west towards Hill of Fare.



Photograph 2: Borrow Pit Search Area looking east.



Photograph 3: View south towards Control Building & Substation and BESS.

Proposed Felling

- 14.6.30 Accounting for the pre-felled and wind-blown areas totalling 144,576 m² (14.46 ha), the actual area of felling required is calculated to be 125,594 m² (12.56 ha) (270,170 m² - 144,576 m²). The majority of felling is within the central southern section where the Battery Energy Storage System (BESS) is proposed.
- 14.6.31 As discussed in **Chapter 3**, the BESS and Control Building & Substation were located off the open heather moorland of the Hill of Fare primarily to reduce the potential landscape and visual impact and still be distant enough from potential receptors to account for any potential acoustic impact. From an operational perspective, it is not as distant from the site entrance as it might be further west on the Hill of Fare. In addition, being located adjacent to an existing track which also loops to the public road network to the south, there is that secondary option of access for service crews in the event of an emergency.

14.6.32 The Proposed Development has sought to minimise potential impact upon existing forestry on site. In order to comply with the criteria of the Scottish Government's Control of Woodland Removal Policy, compensation planting will be required (**Table 14.5**).

Table 14.5: Compensatory Planting

Total area of construction within forestry	Area of forestry already wind blown / pre-felled	Remaining area of felling required	Area of riparian planting proposed	Area of additional compensatory planting proposed
27.02 ha	14.46 ha	12.56 ha	15.79 ha	27.02 ha
			Total potential replanting = 42.81 ha	

14.6.33 The Applicant is committed to providing appropriate compensatory replanting. A construction footprint of 27.02 ha is identified within area assigned for forestry on Site. The outline BEMP (**Technical Appendix 8.5**) proposes 15.79 hectares of riparian planting within the Site and an area up to 27.02 ha has been identified on Brown Hill for planting within the Site, refer to **Figure 13.1**. This can be used to plant the remaining deficit of 11.23 ha or, if required, planted further up to 27.02 ha. The total replanting of forestry is proposed up to 42.81 ha.

14.6.34 The extent, location and composition of such planting will be agreed with Dunecht Estates and Scottish Forestry and enforced through a planning condition prior to the commencement of operation of the Proposed Development.

References

- NatureScot (2002). *Ancient Woodland Inventory*. Available at: www.opendata.nature.scot/datasets/snh::ancient-woodland-inventory/explore?location=57.122127%2C-2.469496%2C13.00 (Accessed on: 21.09.2023).
- Scottish Forestry. (2023) *Storm Arwen Windblow Mapping*. Available at: <https://experience.arcgis.com/experience/2df27ce217fd4bada220e81485f1c616%20Date> accessed: 30.08.2023.
- Scottish Forestry. (2023). *Woodland Removal*. Available at <https://forestry.gov.scot/support-regulations/control-of-woodland-removal> Date accessed: 30.08.2023.
- Scottish Government. (2018). *Forestry and Land Management (Scotland) Act 2018*. Available at: <https://www.legislation.gov.uk/asp/2018/8/contents/enacted> Accessed on 30.08.2023.

14.7 UXO

- 14.7.1 A risk assessment was commissioned by the Applicant in March 2022 to understand the potential risk of Unexploded Ordnance (UXO) on Site. The desk-based assessment was undertaken by 1st Line Defence Ltd. It is relevant to the health and safety of personnel on site and gives context to the historical land use at the Site. The full report is available in **Technical Appendix 14.2**.
- 14.7.2 The likelihood of German unexploded bombs falling within the Site during World War II (WWII) is considered to be minimal given the very low bomb density across the region, with no positive evidence found to suggest that the Site or its surrounding area sustained any incidents of bombing. As such, the site has been assessed as of Low Risk from German aerial delivered UXO.
- 14.7.3 However, the entire Site was designated a WWII armaments training area. Owing to the historical discovery of ordnance in the area, the risk of contamination within the Site is considered to be elevated. With the limited historical information available, at a desktop study stage, it has not proven possible to identify areas of higher and lower risk within the Site even though the overall area is large. The Site has therefore been assessed at a precautionary Medium Risk from Allied UXO contamination, and it is considered prudent to recommend that intrusive works within the bounds of the historic range have UXO support. There has been no significant post-war redevelopment within the Site.
- 14.7.4 As a result of the desk study, the Applicant has ensured that ground investigation work has included UXO support on the ground and will continue through construction.
- 14.7.5 The desk study also demonstrates the additional human influences upon this Site which have also included moorland management, commercial forestry, underground and overground cabling and telecoms.

14.8 Summary

- 14.8.1 **Table 14.2** provides a summary of the effects detailed within this chapter.
- 14.8.2 The carbon balance assessment demonstrated that the payback period for the Proposed Development's total carbon dioxide emission savings is estimated to be between 0.8 and 1.4 years. This means that it would take around 1.2 years to offset the carbon emissions associated with the construction of the Proposed Development. Based on the grid-mix results, the Proposed Development is expected to result in a saving of approximately 69,033 tCO₂ per year with an expected carbon payback time of 2.8 years, while for the fossil fuel mix result this would be a saving of approximately 154215 tCO₂ over 1.2 years.
- 14.8.3 Over its 50-year operational lifespan, the Proposed Development is expected to significantly contribute to the Scottish Government's carbon emissions reduction objectives for approximately 47 years, making it a substantial positive impact on climate change mitigation.

Table 14.2: Summary of Residual Effects

Topic	Potential Effect	Mitigation	Means of Implementation	Residual Effect
Aviation	Visible Aviation Warning Lighting	Reduced Lighting Scheme with only 7 turbines lit at the nacelle and no tower lights on any.	Lighting scheme agreed with CAA	Not significant
Aviation	Military low flying	Infrared lighting fitted to relevant turbine(s)	Lighting scheme will be agreed with DIO	Not significant
Aviation	Civil RADAR	An RMS will be agreed with NATS that will remove or reduce to an acceptable level, the impact of the Proposed Development on the NERL Perwinnes Radar	An RMS will be agreed with NATS	No impact, not significant
Aviation	Impact upon the 2800 ft SMAA.	Sectoring and/or increasing the height of the 2800 ft SMAA.	A change to the IFP would mitigate this impact which requires agreement from Aberdeen Airport who will manage the change.	No impact, not significant
Telecomms	Impact upon an Arquiva link	Through embedded mitigation, no part of any turbine is within 100 m of the link.	Layout design avoids impacting the link.	No impact, not significant
Shadow Flicker	Potential shadow flicker at identified receptors.	Layout design, physical screening, turbine curtailment.	Layout design limits potential number of receptors and potential exposure. Additional mitigation will be implemented if appropriate following investigation of incidences being reported.	Not significant
Forestry	Loss of woodland	Compensatory replanting	Planting scheme will be agreed with Scottish Forestry	Not significant
UXO	Exposure to UXO	UXO support	Re-assess risk pre-construction and apply relevant UXO support such as ground scanning in advance of earth works	Not significant