12 Aviation and Other Issues

12.1 Introduction

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

- Aviation;
- Television, Telecommunications and Microwave Fixed Links;
- Shadow Flicker;
- Climate and Carbon Balance;
- Major Accidents and Disasters;
- Population and Human Health; and
- Air Quality.

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

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

12.1.4 This assessment has been undertaken by the Applicant and SLR Consulting.

12.2 Aviation

Introduction

12.2.1 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.

12.2.2 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. This chapter therefore differs slightly from the proceeding structure and uses different assessment terminology from the other technical chapters in this EIA Report.

Guidance

12.2.3 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.

12.2.4 The primary aviation lighting guidance for turbines at 150 metres tip height, or more, is the Air Navigation Order (ANO) 2016, Chapter 2, Lights and Lighting.

Scope of Assessment

Effects Scoped Out

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

12.2.6 Upon decommissioning, the Ministry of Defence Geographic 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

12.2.7 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.

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

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

12.2.10 The effects of wind 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: wind 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): wind 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 wind turbines can affect the performance of the radar system itself.

12.2.11 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.

12.2.12 As standard post consent, the Defence Geographic 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 wind 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.

Consultation

Table 12.1: Consultation Responses relating to Aviation, Radar & Defence

Consultee and Date of response	Scoping / Other Consultation	Issue Raised	Response / Action
Defence Infrastructure Organisation (DIO) (5 March 24)	Scoping	**Radar** The turbines will be 64.4 km from, detectable by, and will cause unacceptable interference to the ATC radar used by RAF Lossiemouth. Wind turbines have been shown to have detrimental effects on the performance of Primary Surveillance Radars. These effects include the desensitisation of radar in the vicinity of the turbines, shadowing and the creation of "unwanted" aircraft returns which air traffic controllers must treat as aircraft returns. The desensitisation of radar could result in aircraft not being detected by the radar and therefore not presented to air traffic controllers. Controllers use the radar to separate and sequence both military and civilian aircraft, and in busy uncontrolled airspace radar is the only sure way to do this safely. Maintaining situational awareness of all aircraft movements within the airspace is crucial to achieving a safe and efficient air traffic service, and the integrity of radar data is central to this process. The creation of "unwanted" returns displayed on the radar leads to increased workload for both controllers and aircrews. Furthermore, real aircraft returns can be obscured by a turbine's radar return, making the tracking of both conflicting unknown aircraft and the controllers' own traffic much more difficult. In this case the 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. If the developer is able to overcome the issues stated above, to address the impact up on low flying given the location and scale of the development, the MOD would require that conditions are added to any consent issued requiring that the development is fitted with aviation safety lighting and that sufficient data is submitted to ensure that structures can be accurately charted to allow deconfliction. 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. It is likely that the CAA specified lighting will exceed that required by the MOD but to ensure the safeguarding of any low flying/rotary military aircraft, the MOD would request the wind farm is lit with no less than 25cd visible or infra-red (IR) lighting on perimeter turbines.	The DIO indicated that the proposed site lies within line of sight of the RAF Lossiemouth primary radar and within a low flying tactical training area. Consultation will continue with the MOD to ascertain the extent of any impact on the radar and the MOD Low Flying team will be consulted to agree a suitable aviation lighting scheme if deemed necessary.
Aberdeen International Airport Limited (21 February 24)	Scoping	This proposal is located outwith the consultation area for Aberdeen Airport. As such we have no comment to make and need not be consulted further.	No further action required.
Highlands and Islands Airport Limited (11 March 24)	Scoping	HIAL request that an Aviation Impact Feasibility Study (AIFS), of the proposed development, is undertaken to understand any impact on the infrastructure and operation of Inverness Airport. The following are required to be assessed by the applicant: • Air Traffic Control Surveillance Minimum Altitude Chart (ATCSMAC) • Instrument Flight Procedures (IFPs) • New Airspace and Instrument Flight Procedures (Inverness Airport only) • Lighting Requirement	An IFP assessment, including ATCSMAC, IFPS, New Airspace and IFPS (Inverness Airspace only), will be commissioned to ascertain if there is any impact on the airport's IFPs. If there is an impact, discussions will take place with HIAL to ascertain whether any airspace changes or IFP redesigns are required. A viable lighting scheme has been agreed with the CAA (see below).
Civil Aviation Authority (CAA) (25 July 24)	Pre-Submission	The CAA responded to the Applicant to agree a reduced lighting scheme for the proposed turbines: • Medium intensity steady red (2000 candela) lights on the nacelles of turbines T02, T05, T08, T10, T12, T15, T18, T19, T24 and T26; • a second 2000 candela light on the nacelles of the above turbines to act as an alternative in case of failure of the main light (note that both lights should not be lit at the same time); • the visible lights on these turbines to be capable of being dimmed to 10% of peak intensity when the visibility as measured at the wind farm exceeds 5km. • a scheme of infrared lighting to be agreed with the MoD (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.	The Applicant will adhere to the agreed lighting scheme. **Chapter 5: Landscape and Visual** provides a nighttime assessment based on this scheme.

Methodology

Scope of Assessment

Study Area

12.2.13 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 50km from the Proposed Development, non-radar aerodromes within 17km, parachute drops zones within 3km, and military radar and en route radar systems up to 120km from the Proposed Development (dependent on operational range).

Desk Study

12.2.14 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

12.2.15 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 aircraft separation (from radar clutter) can be maintained in the presence of the wind turbines.

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

Assessment Limitations

12.2.17 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

12.2.18 The Proposed Development is 30km from Inverness Airport and has the potential to impact upon its Instrument Flight Procedures (IFP).

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

NERL

12.2.20 There are no NERL radars within 100km of the Proposed Development. Analysis indicates no radar LoS exists from the nearest NERL radars at Allanshill.

Military Aviation

12.2.21 The Proposed Development is 63km from RAF Lossiemouth and has the potential to impact upon its primary radar. Initial in-house analysis indicates no or minimal radar LoS.

12.2.22 The Proposed Development is located within an area designated as a ‘low priority military low flying area’.

Potential Effects

12.2.23 Wind turbines have the potential to impact the performance of ATC radars. These impacts include:

- the creation of "false" targets, whereby the wind turbines present on the radar display. Multiple false targets can lead to the radar initiating false aircraft tracks.
- 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.
- shadowing whereby the aircraft is not detected by the radar as it is flying within the physical ‘shadow’ of the wind turbine.

12.2.24 Further consultation is required with the MOD regarding the potential impact on RAF Lossiemouth radar to ascertain the extent of any impact on operations as early indications show no, or minimal, turbine visibility to the radar.

12.2.25 An assessment will be carried out on the Inverness Airport IFPs followed by liaison with the airport, should any mitigation be deemed necessary.

Proposed Mitigation

12.2.26 There are a number of mitigation options available to alleviate problems caused by wind turbines to aviation and radar. Mitigation solutions are highly specific to the effect in question. Consultation with relevant consultees is key to establishing the appropriate method of mitigation.

12.2.27 The Applicant is in consultation with Inverness Airport regarding the potential IFP impact and will commission the requested Aviation Impact Feasibility Study. If an impact is identified, the Applicant will agree a suitable mitigation with the Airport.

12.2.28 A reduced visible aviation lighting scheme has been agreed with the CAA. A reduced lighting scheme seeks not every perimeter wind 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 12.1** and **Technical Appendix 12.1**. The results of the assessment for night-time lighting are contained in **Chapter 5: Landscape & Visual Impact Assessment**.

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

Residual Effects

12.2.30 Should impacts on the RAF Lossiemouth radar be significant, and the Proposed Development is shown to breach the Inverness Airport safeguarding criteria, the Applicant will implement appropriate mitigation measures to ensure no significant adverse effects remain.

Summary

12.2.31 The Proposed Development will potentially impact the RAF Lossiemouth radar and IFPs at Inverness Airport. Further assessments and consultation are required to determine if any mitigation is needed. Should mitigation be required, a suitable mitigation scheme will be agreed. 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.

12.3 Television, Telecommunications and Microwave Fixed Links

Introduction

12.3.1 This section of the chapter summarises the potential television and telecommunications effects associated with the Proposed Development.

Guidance

12.3.2 Tall structures such as wind turbines may cause interference with nearby television and telecommunications links. As such, any links in the vicinity of the Proposed Development must be identified and operators must be consulted.

12.3.3 The Ofcom Spectrum Information Portal[1] was used in the first instance to identify fixed microwave links crossing or adjacent to the site.

12.3.4 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 wind turbines are located in the 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

12.3.5 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.

Telecommunication and Microwave Fixed Links

12.3.6 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 70km.

12.3.7 Telecommunications and broadcasting network operators have been consulted during the design evolution. **Table 12.2** summarises the responses from link operators contacted.

Table 12.2: Link Operators responses

Link Operator	Response/Issue Raised	Actions
BT	No concerns raised	No actions required
JRC	No concerns raised	No actions required
Atkins	No concerns raised	No actions required

12.3.8 BT confirmed with the applicant on 3 May 2024 that the Proposed Development should not cause interference to BT's current and presently planned radio network.

12.3.9 The Joint Radio Company (JRC) Limited, which provides Scanning Telemetry Services, responded to Scoping on 19 February 2024, confirming no impact on any radio link infrastructure and thus no objection.

12.3.10 Atkins confirmed with the Applicant on 3 May 2024 that it would have no objection to the Proposed Development.

12.3.11 With the information available to the Applicant, the Proposed Development does not affect microwave fixed links.

Summary

12.3.12 The Proposed Development does not directly affect fixed links.

12.3.13 The potential effect of the Proposed Development is considered to be not significant with respect to other television or radio communication networks.

[1] https://www.ofcom.org.uk/spectrum/information/spectrum-information-system-sis/spectrum-information-portal (last accessed 18/09/2024)

12.4 Shadow Flicker

Introduction

12.4.1 This section of the chapter summarises the potential effect of shadow flicker associated with the Proposed Development.

12.4.2 In sunny conditions, any shadow cast by a wind 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.

12.4.3 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.

12.4.4 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 2.5Hz, which for a three-bladed turbine is equivalent to a rotational speed of 50 revolutions per minute (rpm). The proposed turbines at Clune Wind Farm would rotate at a maximum of approximately 12.1rpm, well below this threshold.

Policy and Guidance

12.4.5 The following policy documents have been referred to in undertaking the assessments:

- National Planning Framework 4; and
- Highland Council's Highland-wide Local Development Plan in its Supplementary Guidance: Onshore Wind Energy[2]

12.4.6 The following guidance documents have been referred to in undertaking the assessments:

- Scottish Government - Onshore wind turbines: planning advice[3]
- Department of Energy & Climate Change (DECC) guidelines[4]

12.4.7 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 assessment area, although there is potentially a need to differentiate between appropriate assessment areas at different latitudes.

12.4.8 The Highland Council's Onshore Wind Energy Supplementary Guidance states that an increase in distance from the widely accepted 10 times rotor diameter to 11 is to account for the northern latitudes, in line with the conclusions of the DECC Update of UK Shadow Flicker Evidence Base (2011).

Methodology

12.4.9 Properties have been assessed within a radius of 11 rotor diameters distance of any turbine as per The Highland Council supplementary guidance and scoping response.

12.4.10 This shadow flicker assessment is based on turbines with a 162m rotor diameter and the planning application includes a 100m micro-siting distance for infrastructure. As such, this 100m distance is added to the 11-rotor diameter (1,782m = 162 * 11) distance to give a total distance of 1,882m (= 1782m + 100m) from any turbine.

12.4.11 Analysis was therefore undertaken for shadow flicker at all properties within 1,882m from any wind turbine using the WindPro Software, Version 3.5. A single property has been identified within the study area, as per **Figure 12.2**.

12.4.12 The shadow flicker 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 a layout of 26 turbines, each with a tip height 200m.

Assessment of Significance

12.4.13 Whilst the time and duration of shadow flicker events can be predicted accurately, the level of the effect is difficult to quantify as this would depend on the location of windows within a property, the use of the rooms affected, the level of shading surrounding the property and how susceptible the receptor is to light flicker.

[2] https://www.highland.gov.uk/download/downloads/id/16949/onshore_wind_energy_supplementary_guidance-_currently_adopted_suite.pdf, (last accessed 23/08/2024)
[3] Available online: https://www.gov.scot/publications/onshore-wind-turbines-planning-advice/, (last accessed 04/07/2024)
[4] Available online: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/48052/1416-update-uk-shadow-flicker-evidence-base.pdf, p12, (last accessed 04/07/2024)

12.4.14 As confirmed by the DECC study (2011), there is no standard Scottish or UK guidance relating to a limit for shadow flicker, and this remains the case. The only guidance providing additional recommendations is the Northern Irish PPS 18 (2009) guidance which recommends that for properties within 500m of the turbines, shadow flicker should not exceed 30 hours per year or 30 minutes per day.

12.4.15 The assessment has therefore adopted a criterion of 30 hours of shadow flicker in one year as a significance threshold. Where less than 30 hours of shadow flicker is predicted to occur in one year at a particular property, this is considered to be a minor effect (not significant), with significance increasing in relation to the number of hours (over 30) of shadow flicker per year, in accordance with best practice guidance.

Assessment Results

12.4.16 **Figure 12.2** details the locations of affected properties relative to the proposed development.

12.4.17 With due reference to The Highland Council Onshore Wind Energy Supplementary Guidance, and allowance for 100m micro-siting, the potential shadow flicker on the identified receptors is given in **Table 12.3**.

Table 12.3: Shadow Flicker Assessment Summary of Results

RES Property ID	Property Address	Distance from nearest turbine (m)	Total hours per year
H21	Easter Strathnoon, Tomatin, IV13 7XY	1,745	0.0

12.4.18 No properties are expected to experience shadow flicker from the Proposed Development, and as such the Proposed Development is expected to have no impact on amenity due to shadow flicker.

Summary

12.4.19 The Proposed Development is expected to have no impact on amenity due to shadow flicker.

12.4.20 No mitigation is therefore proposed for the Proposed Development in relation to shadow flicker.

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
- Development and Infrastructure Service (2017) 'Onshore Wind Energy Supplementary Guidance', The Highland Council
- Department of the Environment (2009), Planning Policy 18 'Renewable Energy', Northern Ireland Executive.

12.5 Climate and Carbon Balance

Introduction

12.5.1 This section of the chapter details the calculations to work out CO_2 emissions from the Proposed Development. In addition to generating electricity, the Scottish Government sees wind farms as an important mechanism for reducing the UK's carbon dioxide (CO_2) emissions. This section estimates the CO_2 emissions associated with the manufacture and construction of the Proposed Development as well as estimating the contribution the Proposed Development would make to reducing CO_2 emissions, to give an estimate of the whole life carbon balance of the Proposed Development. The assessment is based on a detailed baseline description of the Proposed Development and its location. All calculations are based on Site specific data, where available. Where Site specific data is not available approved national/regional information has been used.

12.5.2 An assessment on the vulnerability of the Proposed Development to climate change has not been included, as it is considered that none of the identified climate change trends would affect the Proposed Development, with the exception of increased windstorms. Mitigation with regards to extreme weather events, including windstorms, is detailed in Section 12.6. The effects of climate change on environmental receptors has been considered in each of the relevant environmental topic chapters of this EIA Report where appropriate (Chapters 5 to 12).

12.5.3 Each unit of wind generated electricity would displace a unit of conventionally generated electricity, therefore, saving power station emissions. **Table 12.4** provides a breakdown of the estimated emissions displaced per annum and over the assumed lifespan of 40 years for the Proposed Development.

Carbon and Peatland

12.5.4 Renewable energy developments in upland areas may often be sited on peatlands which hold stocks of poorly protected carbon, and so have the potential to release carbon to the atmosphere in the form of CO_2 if disturbed. Scotland has the majority of peat soils in the UK and, therefore, has a responsibility to ensure stability of this carbon and to ensure that developments do not cause a significant loss of this carbon reservoir.

12.5.5 The Proposed Development is located in area where peaty soils and peat have been impacted by commercial land use management by the management of the hydrology, grazing and burning that has taken place across the Site, which will have reduced the underlying 'peat resource' as a source of carbon. This peatland cannot be considered as pristine due to the disturbance from the land use and drainage activity resulting in release of CO_2 to the atmosphere and long-term degradation as a 'carbon sink'. The deeper peat, (below the water table) will still be a carbon sink as long as the water table is maintained and the peat is not artificially drained.

12.5.6 The carbon balance assessment considers the implications of any parts of the Proposed Development which could lead to the additional release of CO_2 resulting from the disturbance of peat.

12.5.7 In order to minimise the requirement for the extraction of peat, the layout design process has avoided areas of deeper peat where possible. The layout design process is described in **Chapter 2: Site Description and Design Evolution**. Specific details on the peat depth and probing surveys undertaken are included in **Technical Appendix 9.1: Peat Landslide and Hazard Risk Assessment** and **Technical Appendix 9.2: Outline Peat Management Plan**.

Characteristics of Peatland

12.5.8 The loss of carbon from the carbon fixing potential from plants and vegetation on peat land is small but is calculated for the area from which peat is removed and the area affected by drainage. The carbon stored in the peat itself represents a much larger potential source of carbon loss.

12.5.9 When flooded, peat soils emit less carbon dioxide but more methane than when they are drained. In flooded soils, carbon emissions are usually exceeded by plant fixation, so the net exchange of carbon with the atmosphere is negative and soil stocks increase. When soils are aerated, carbon emissions usually exceed plant fixation, so the net exchange of carbon with the atmosphere is positive.

12.5.10 To calculate the carbon emissions attributable to the removal or drainage of the peat, emissions occurring if the soil had remained in situ and undrained are subtracted from the emissions occurring after removal or drainage.

12.5.11 The indirect loss of CO_2 uptake (fixation) by plants originally on the surface of the Site but eliminated by construction activity including the destruction of active bog plants on wet sites and felling, is calculated on Site specific data collected as part of the EIA process and based on blanket bog.

12.5.12 Emissions due to the indirect, long-term liberation of CO_2 from carbon stored in peat due to drying and oxidation processes caused by construction of the Proposed Development, can also be calculated from site specific data for the Proposed Development. This figure is a worst-case scenario, as the peat would be reused onsite to minimise carbon losses.

Carbon Payback Methodology

12.5.13 The assessment of the carbon payback is based on a detailed baseline description of the Proposed Development and its location. All calculations are based on site specific data, where available. Where site specific data is not available approved national/regional information has been used.

12.5.14 The methodology to calculate carbon emissions is based on 'Calculating carbon savings from windfarms on Scottish peat lands - A New Approach' (Nayak et al, 2008[5]), prepared for the Scottish Government Science, Policy and Co-ordination Division. This was superseded in 2011 by the document 'Calculating Carbon Savings from Wind Farms on Scottish Peatlands - A New Approach', (Nayak et al, 2008 and 2010[6]) and (Smith et al, 2007[7]). In terms of carbon footprint, the 'carbon calculator' is the Scottish Government's tool provided to support the process of determining the carbon impact of wind farm developments in Scotland. It is noted that this methodology is specifically designed for wind farms and not renewable energy developments like the Proposed Development. Therefore, the assessment only considers the wind turbine element of the Proposed Development.

Effects of Carbon Emissions from Construction

12.5.15 Emissions arising from the fabrication of the wind turbines and the associated components are based on a full life analysis of a typical wind turbine and include CO_2 emissions resulting from transportation, erection, operation, dismantling and removal of wind turbines and foundations and transmission grid connection equipment from the existing electricity grid system.

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

[6] Nayak D.R., Miller D., Nolan A., Smith P., Smith (2010) Mires and Peat (Article 09), 4, 1-23, http://www.mires-andpeat.net/, ISSN 1819-754X

[7] Smith, P., Smith, J.U., Flynn, H., Killham, K., Rangel-Castro, I., Foereid, B., Aitkenhead, M., Chapman, S., Towers, W., Bell, J., Lumsdon, D., Milne, R., Thomson, A., Simmons, I., Skiba, U., Reynolds, B., Evans, C.,

12.5.16 With respect to wind turbines, emissions from material production are the dominant source of CO_2. Emissions arising from construction (including transportation of components, quarrying, building foundations, access tracks and hardstands) and commissioning are also included in the calculations. The assessment has used Nayak et al (2008) default values for 'turbine life' emissions, calculated with respect to installed capacity.

12.5.17 The Proposed Development is seeking consent for a 40 year period. This figure has therefore been used in the calculator.

Input Parameters

12.5.18 To undertake this assessment, the following parameters were considered, which encompass a full life cycle analysis of the Proposed Development. These parameters include:

- emissions arising from the fabrication of the wind turbines and all the associated components;
- emissions arising from construction, (including transportation of components; quarrying; building foundations, access tracks and hardstands; and commissioning);
- the indirect loss of CO_2 uptake (fixation) by plants originally on surface of the Site but eliminated by construction activity (including the destruction of active bog plants on wet sites);
- emissions due to the indirect, long-term liberation of CO_2 from carbon stored in peat due to drying and oxidation processes caused by construction; and
- loss of carbon due to drainage.

12.5.19 As part of their methodology, Nayak et al have provided a spreadsheet called 'Scottish Government Windfarm Carbon Assessment Tool' to calculate whole life carbon balance assessments for windfarms on peat lands. The calculation spreadsheet (calculator version 2.14.1, provided by the ECU and used for the Proposed Development as the online carbon calculator is currently offline, see **Technical Appendix 12.2**) allows a range of data to be input in order to address expected, minimum and maximum values. However, if several parameters are varied together, 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 the longest (maximum) payback period; and 'minimum values' as those values which would result in the shortest (minimum) payback period.

12.5.20 This spreadsheet tool provides generic values for CO_2 emissions associated with some components (such as wind turbine manufacture) and requires Site specific information for other components (such as habitat type, extent of peat disturbance and ground water levels).

12.5.21 This assessment draws on information detailed in the EIA Report, **Chapter 7: Ecology** and **Chapter 9: Geology, Hydrology and Hydrogeology**. For the purpose of this assessment, it is assumed that all the embedded good practice measures outlined in **Chapter 7: Ecology** and **Chapter 9: Geology, Hydrology and Hydrogeology** would be employed.

12.5.22 The final wind turbine choice is not yet known but would likely be around 7.2MW and the greenhouse gas savings and carbon payback are based on the input parameters of the proposed 26 wind turbines. Figures are based on currently available wind turbines and assume a consistent supplier for all wind turbine locations (i.e. wind turbine types are chosen by manufacturer). Note that, within the calculation spreadsheet, the expected, maximum and minimum values have been adjusted to suit the input parameter.

12.5.23 The capacity factor used within the calculation spreadsheet is based on measured onsite wind data giving a capacity factor of 42.6%.

12.5.24 The input parameters for the Scottish Government calculation spreadsheet are detailed in **Technical Appendix 12.2: Carbon Calculator**. The choice of methodology for calculating the emission factors uses the 'Site Specific methodology' defined within the calculation spreadsheet.

Results

12.5.25 This section presents a summary of the carbon assessment which has been undertaken in respect of the Proposed Development. The purpose of the 'carbon calculator' is to assess, in a comprehensive and consistent way, the carbon impact of wind energy developments. This is undertaken by comparing the carbon costs of manufacture and construction with the carbon savings attributable to a development through operation. An assessment has been undertaken to calculate the carbon emissions which would be generated in the construction, operation and possible decommissioning of the Proposed Development after an illustrative 40 years.

12.5.26 The carbon calculations spreadsheet is provided in **Technical Appendix 12.2: Carbon Calculator.** A summary of the anticipated carbon emissions and carbon payback of the Proposed Development relative to the current Department for Business, Energy & Industrial Strategy published figures is provided in **Table 12.4**.

Table 12.4: CO_2 Emissions and Payback Time

Results	Expected	Minimum	Maximum
Net emissions of carbon dioxide (t CO_2 eq) (carbon losses minus carbon gains) per annum.	266,169	14,103	389,814
Carbon Payback Time			
…coal-fired electricity generation (years)	0.4	0.0	0.6
…grid-mix of electricity generation (years)	1.8	0.1	2.7
…fossil fuel - mix of electricity generation (years)	0.9	0.0	1.3
Ratio of CO_2 eq. emissions to power generation (g/kWh) (Target ratio by 2030 (electricity generation) <50 g/kWh)	10	1	14

Interpretation of Results

12.5.27 The calculations of total carbon dioxide emission savings and payback time for the Proposed Development indicates the overall payback period of a development with 26 wind turbines with an average (expected) installed capacity of around 7.2MW each would be approximately 0.9 years (11 months), when compared to the fossil fuel mix of electricity generation.

12.5.28 This means that the Proposed Development is expected to take around 11 months to repay the carbon exchange to the atmosphere (the CO_2 debt) through construction of the wind turbines; the Proposed Development would in effect be in a net gain situation following this time period and would contribute to national CO_2 reduction targets.

12.5.29 The potential savings in CO_2 emissions (see Table 4.1 of **Technical Appendix 12.2**) due to the Proposed Development replacing other electricity sources over the lifetime of the wind turbines (assumed to be 40 years for the purpose of the carbon calculator) are approximately:

- 660,163 tonnes of CO_2 per year over coal-fired electricity (approximately 26,406,520 tonnes assuming a 40-year lifetime for the purposes of the carbon calculator);
- 144,607 tonnes of CO_2 per year over grid-mix of electricity (approximately 5,784,280 tonnes assuming a 40-year lifetime for the purposes of the carbon calculator); and
- 296,200 tonnes of CO_2 per year over a fossil fuel mix of electricity (approximately 11,848,000 tonnes assuming a 40-year lifetime for the purposes of the carbon calculator).

Summary

12.5.30 The Proposed Development is expected to take around 11 months to repay the carbon exchange to the atmosphere (the CO_2 debt) through construction of the wind turbines. Following that 11 month repayment period, the Proposed Development would in effect be in a net gain situation and would contribute to national CO_2 emission reduction targets.

12.5.31 Over the estimated 40 year life time of the Proposed Development, CO_2 emissions would be reduced (as a result of the Proposed Development) by approximately 26,406,520 tonnes when compared to the current grid-mix of electricity.

12.5.32 Over its estimated 40 year life time, the Proposed Development would therefore be a net positive with regards reducing carbon emissions from generating electricity. No mitigation is therefore proposed for the Proposed Development in relation to climate and carbon balance.

12.6 Major Accidents and Disasters

Introduction

12.6.1 The vulnerability of the Proposed Development to major accidents and natural disasters, such as flooding, sea level rise, or earthquakes, is considered to be low due to its geographical location and the fact that its purpose is to ameliorate some of these issues.

12.6.2 In addition, the nature of the proposals and location of the Site means there would be negligible risks on the factors identified by the EIA Regulations. For example:

population and human health – the Site is away from major population centres with low population density and the required safety clearances around turbines has been a key consideration throughout the design process;
biodiversity – receptors and resources would be unaffected as there would be little risk of polluting substances released or loss of habitat in a turbine failure scenario (highly unlikely);
land, soil, water, air and climate – there would be little risk of polluting substances released or loss of habitat in a turbine failure scenario (highly unlikely); and
material assets, cultural heritage and the landscape – there would be no adverse effects on these features in a turbine failure scenario (highly unlikely).

Public Safety and Access

12.6.3 The Renewable UK Onshore Wind Health and Safety Guidelines (2015) note that wind farm development and operation can give rise to a range of risks to public safety including:

traffic (especially lorries during construction, and abnormal loads for the transport of wind turbine components; including beyond the Site boundary);

construction site hazards (particularly to any people entering the Site without the knowledge or consent of the Site management);

effects of catastrophic wind turbine failures, which may on rare occasions result in blade throw, tower topple or fire; and

ice throw, if the wind turbine is operated with ice build-up on the blades.

12.6.4 The RenewableUK guidance (2015) states that *"Developers should ensure that risks to public safety are considered and managed effectively over the project lifecycle, and should be prepared to share their plans for managing these risks with stakeholders and regulators; effective engagement can both build trust, and help to reduce the level of public safety risk by taking account of local knowledge"*.

12.6.5 Site security and access during the construction period would be governed under Health and Safety at Work Act 1974 and associated legislation. Public access along the existing access tracks would remain in place as far as possible during construction (subject to temporary health and safety restrictions during certain construction activities) and would reopen to the public fully once construction of the wind farm is complete. No public access would be permitted along the new access track to the Site during construction. However, the Land Reform (Scotland) Act (2003) which came into effect in February 2005 establishes statutory rights of responsible access on and over most land. The legislation offers a general framework of responsible conduct for both those exercising rights of access and for landowners. Once the construction period and commissioning of the wind farm is complete, no special restrictions on access are proposed.

12.6.6 Informal recreational access would benefit from the presence of the turbines within the Site by providing improved signage and information boards for the walking routes across the Site. Appropriate warning signs would be installed concerning restricted areas such as the substation compound, switchgear and metering systems. All onsite electrical cables would be buried underground with relevant signage.

Traffic

12.6.7 Accident data for the roads local to the Site (U2856 from the Site access junction to the A9) has been reviewed and is presented in **Chapter 10: Traffic and Transport**. An assessment of the potential effects on road safety has been undertaken. In summary, the Proposed Development would create an increase to HGV traffic levels within the study area, but these levels would remain well within the design capacity of the local road network.

Construction

12.6.8 With regard to risks and accidents during the construction phase, the construction works for the Proposed Development would be undertaken in accordance with primary health and safety legislation, including the Health and Safety at Work Act 1974 and the Construction (Design and Management) (CDM) Regulations 2015 which will include a requirement to produce emergency procedures in a Construction Phase (Health & Safety) Plan in accordance with the Regulations.

12.6.9 Nonetheless, the risk of accidents and other disasters is covered where relevant in individual topic Chapters, for instance, the potential for environmental incidents and accidents such as spillages are considered in **Chapter 7: Ecology** and Biodiversity, **Chapter 8: Ornithology** and **Chapter 9: Geology, Hydrology and Hydrogeology**. Flood risk is also assessed with **Chapter 9**.

Extreme Weather

12.6.10 As far as the risk of turbine failure during high winds is concerned, the turbines would cut-out and automatically stop as a safety precaution in wind speeds over 25 m/s.

12.6.11 Wind turbines can be susceptible to lightning strike due to their height and appropriate measures are taken into account in the design of turbines to conduct lightning strikes down to earth and minimise the risk of damage to turbines. Occasionally however, lightning can strike and damage a wind turbine blade. Modern wind turbine blades are manufactured from a glass-fibre or wood-epoxy composite in a mould, such that the reinforcement runs predominantly along the length of the blade. This means that blades will usually stay attached to the turbine if damaged by lightning and in all cases turbines will automatically shut down if damaged by lightning.

12.6.12 Ice build-up on blade surfaces occurs in cold weather conditions. Wind turbines can continue to operate with a very thin accumulation of snow or ice, but will shut down automatically as soon as there is a sufficient build up to cause aerodynamic or physical imbalance of the rotor assembly. Potential icing conditions affecting turbines can be expected two to seven days per year (light icing) in Scotland (WECO, 1999). The potential for ice throw to occur after start-up following a turbine shut down during conditions suitable for ice formation is high. There are monitoring systems and protocols in place to ensure that turbines that have been stationary during icing conditions are restarted in a controlled manner to ensure public safety. The risk to public safety is considered to be very low due to the few likely occurrences of these conditions along with the particular circumstances that can cause ice throw.

Seismic Activity

12.6.13 No geological fault lines are present on or in the immediate vicinity of the Site, and there are no records of any earthquakes occurring in the vicinity of the Site within the last 25 years (Earthquake Track[8]). Earthquakes in Scotland are typically no greater than 3 on the Richter Scale and, therefore, minor and unlikely to cause significant damage to buildings and infrastructure.

12.6.14 It is very unlikely that an earthquake would occur on the vicinity of the Site resulting in any damage to the Proposed Development. Should a wind turbine be damaged, the risk to public safety is considered to be negligible due to the remote location and careful design layout of the infrastructure.

Summary

12.6.15 The Proposed Development is considered to have a low vulnerability to major accidents and natural disasters, such as flooding, sea level rise, or earthquakes

12.6.16 Once operational, the Proposed Development is expected to have no impact on public safety with regards to land access, or traffic and transport. Risk of accidents during the construction phase are covered in individual topic chapters, and the Outline CEMP.

12.6.17 No mitigation is therefore proposed for the Proposed Development in relation to major accidents and disasters, beyond the inbuilt cut-out speeds for the selected wind turbines, and ensuring that construction work is undertaken in accordance with primary health and safety legislation, and industry good practice.

12.7 Population and Human Health

12.7.1 **Chapter 5: Landscape and Visual, Chapter 9: Geology, Hydrology and Hydrogeology**, **Chapter 10: Traffic and Transport**, **Chapter 11: Acoustic** and Section 12.4 of this chapter contain assessments which relate to the health and wellbeing of the local population. These chapters assess the effects of the Proposed Development, both positive and negative, provide an analysis of the significance of these effects and also put forward measures to mitigate against negative effects on people and their health.

12.7.2 Chapter 13: Schedule of Mitigation, provides an overview of the mitigation put forward as part of these assessments in order to reduce any negative effects of the Proposed Development to an acceptable level.

12.7.3 Further to the topics covered in Chapters 5 – 12, including this chapter, it is not expected that there will be any other effects from the Proposed Development which would have significant effects on population and human health.

Air Quality

12.7.4 Construction activities can result in temporary effects from dust if unmanaged. This can result in nuisance effects such as soiling of buildings and, if present over a long period of time, can affect human health. As the nearest property is over 1,000m away from any substantial construction works (substation compound), effects associated with dust or vehicle emissions are considered to be unlikely, therefore the effects of dust and vehicle emissions from the construction, operation and decommissioning of the Proposed Development was scoped out of this assessment.

Summary

12.7.5 The Proposed Development is expected to have no impact on population and human health.

12.7.6 No mitigation is therefore proposed for the Proposed Development in relation to population and human health.

[8] https://earthquaketrack.com/gb-sct-aviemore/recent [accessed October 2024]