Chapter 14: Other Environmental Considerations

Contents

14 Other Environmental Considerations

14.1 Introduction

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

- Shadow Flicker;
- Carbon Balance;
- Major Accidents and Disasters;
- Population and Human Health;
- Air Quality; and
- Television and Telecommunications.

14.1.2 Elements relating to major accidents and disasters have also been addressed in the individual technical discipline chapters where relevant.

14.1.3 Impacts on population and human health have also been addressed in the individual EIA topic chapters where relevant.

14.1.4 This assessment has been undertaken by Green Cat Renewables Ltd.

14.1.5 The chapter is supported by Figure 14.1 and Technical Appendix 14.1 that are referenced in the text where appropriate.

14.2 Shadow Flicker

Introduction

14.2.1 This chapter assesses shadow flicker impacts predicted to occur as a result of the proposed wind turbines at Giants Burn Wind Farm, located in Argyll and Bute, approximately 1.3 km north-west of Dunoon. Shadow flicker has the potential to arise during the operational phase of the Proposed Development.

14.2.2 No third-party wind farms were found within a distance at which cumulative shadow flicker effects would occur; as such a cumulative impact assessment has not been included in the following report.

14.2.3 Tall structures such as wind turbines cast shadows. The shadows vary in length according to the sun's altitude and azimuthal position. Under certain combinations of geographical position and time of day, the sun may pass behind the rotor of a wind turbine and cast a moving shadow over neighbouring properties. Where this shadow passes over a narrow opening such as a window, the light levels within the room affected will decrease and increase as the blades rotate, hence the shadow causes light levels to 'flicker' - an effect commonly known as 'shadow flicker'.

14.2.4 Whilst the moving shadow can occur outside, the shadow flicker effect is only experienced by indoor receptors where the shadow passes over a window opening. The seasonal duration of this effect can be calculated from the geometry of the machine and the latitude of the site. A single window in a single building is likely to be affected for a few minutes at certain times of the day for limited periods of the year. The likelihood of this occurring and the duration of such an effect depend upon:

- The direction of the building relative to the turbine(s);
- The distance from the turbine(s);
- The turbine hub-height and rotor diameter;
- The time of year;
- The proportion of hours in which the turbine operates;
- The frequency of bright sunshine and cloudless skies (particularly at low elevations above the horizon); and
- The prevailing wind direction.
- The further the observer is from the turbine the less pronounced the effect will be. There are several reasons for this:
- There are fewer times when the sun is low enough to cast a long shadow;

- When the sun is low it is more likely to be obscured by either cloud on the horizon or intervening buildings and vegetation; and,
- The centre of the rotor's shadow passes more quickly over the land reducing the duration of the effect.

14.2.5 At a distance, the blades do not cover the sun but only partly mask it, substantially weakening the shadow. This effect occurs first with the shadow from the blade tip, the tips being thinner in section than the rest of the blade. The shadows from the tips extend the furthest and so only a weak effect is observed at a distance from the turbines.

Policy and Guidelines

14.2.6 The Scottish Government's online planning guidance for renewable energy (Scottish Government, 2014) specifically the 'Onshore Wind Turbines' note, states that:

14.2.7 "Where this [shadow flicker] could be a problem, developers should provide calculations to quantify the effect. In most cases however, where separation is provided between wind turbines and nearby dwellings (as a general rule 10 rotor diameters), "shadow flicker" should not be a problem…"

14.2.8 This has been appraised by ClimateXChange on behalf of the Scottish Government in the 'Review of Light and Shadow Effects from Wind Turbines in Scotland' (ClimateXChange, 2017) which concluded that the guidance is still relevant. No guidance has emerged since the conclusion if this study.

14.2.9 Studies have shown that even in UK latitudes, shadows from wind turbines can only be cast approximately 130 degrees either side of north relative to the turbine due to the orientation of the earth's axis and the positioning of the sun (Department of Environment and Climate Change (DECC), 2011). This equates to a region between 50 degrees either side of due south where a wind turbine will not cast a shadow. Properties within this region will not experience shadow flicker effects, regardless of their distance from the turbine. While DECC has now been replaced by the Department for Energy Security and Net Zero (DESNZ), which does not provide guidance on shadow flicker, these findings are still considered relevant.

Consultation

14.2.10 Consultation was undertaken through the EIA Scoping Report (Application Reference: ECU00005007) submitted to The Scottish Government Energy Consents Unit in February 2024. No further consultation has been undertaken.

14.2.11 A scoping opinion was received by Scottish Ministers and Argyll and Bute Council in May 2024, who provided the following responses prior to the shadow flicker assessment being undertaken:

- Q13/1: Do the Council and consultees agree with the proposed methodology to conduct the shadow flicker assessment?
  - Yes
- Q13/2: Do the Council and consultees agree that the recycling centre to the north of Turbine 9 is not sensitive to shadow flicker effects?
  - Yes
- Q13/3: Do the Council and consultees agree that 30 hours of flicker is a suitable threshold below which no mitigation is required?
  - Yes

Assessment Methodology

<u>Candidate Turbine</u>

14.2.12 The dimensions of the candidate turbine selected for the shadow flicker assessment include a tip height of 200 m and a rotor diameter of 162 m. These are considered to be the maximum applicable dimensions of the proposed turbines and are selected to provide a worst-case assessment of potential effects. A micro-siting allowance of 100 m is typically allowed and has been added to the 10-rotor diameter study area, resulting in a study area radius of 1720 m for each turbine.

<u>Cumulative Assessment</u>

14.2.13 Cumulative shadow flicker occurs when a property falls within a recommended distance of 10 rotor diameters of both the Proposed Development and a third-party wind development, inclusive of 100 m micro-siting allowance. Where a property lies within the Study Area of the Proposed Development and a third-party project, a cumulative impact assessment is normally conducted. At a distance exceeding 10-rotor diameters, flicker effects are expected to be of low intensity and not significant.

14.2.14 The nearest third-party development relative to the Proposed Development, is Inverchaolain Wind Farm (ECU00006012). At present, the development is in the early stages of planning, and a candidate machine has yet to be determined. However, is it noted that in the scoping layout, Inverchaolain Wind Farm turbines are situated more than 3 km south of the nearest shadow flicker receptors identified relative to the Proposed Development. Given the considerable setback distance, there is no prospect of cumulative effects. As such, a cumulative impact assessment has been scoped out of the following report.

ReSoft WindFarm Software

14.2.15 ReSoft Windfarm software has been used to model the shadow flicker effects. The program uses simple geometric considerations: the position of the sun at a given date and time; the size and orientation of the windows that may be affected; and the size of the turbines that may cast the shadows. The model adopts a conservative approach by assuming that:

- Turbines are facing the sun at all times of the day;
- It is always sunny;
- The turbines are always operating; and
- There is no local screening.

Modelling of Facades

14.2.16 Given that the glazed area at each property is not known, windows have been modelled with conservative 4 m x 4 m dimensions for all project-facing facades.

14.2.17 The orientation of each facade has been included in the model, measured in terms of degrees from north. This means, for example, that if a window faces due west, it is 270 degrees from north.

14.2.18 Facades orientated towards the Proposed Development are detailed in Table 14.2.

Modifying Factors

14.2.19 The degree of shadow flicker impact that will typically occur in practice is always much less than the maximum possible flicker calculated by the model. Modifying factors take into account actual annual hours of sunlight for the project area and hours of turbine operation. These factors have been applied to the modelling results to demonstrate an in-practice estimate of shadow flicker impact while still providing a conservative assessment.

14.2.20 The modifying factors are derived from the following:

- The average sunlight hours for the local area have been taken as 1,333 hours, based on meteorological data obtained from Rothesay (14.5 km south-west of the Proposed Development) (Met Office, 2020). Therefore, on average, it is sunny for ~30% of the daylight hours. The sunshine hours per month are shown in Table 14.2;
- The rotor of a modern wind turbine can be expected to turn approximately 90% of the time; and
- No adjustment has been made regarding wind direction, and it has been assumed that the turbines are always yawed such that flicker is possible.

14.2.21 Therefore, the realistic hours of flicker were estimated to be <27% of the theoretical maximum (0.30 x 0.90 = 0.27).

Table 14.1 - Average Monthly Sunshine Hours

Month	Mean Hours	Total Hours[1]	Percentage
January	41	239	17%
February	68	267	25%
March	102	366	28%
April	151	424	36%
May	201	504	40%
June	172	524	33%
July	156	525	30%
August	155	467	33%
September	116	385	30%
October	81	325	25%
November	54	251	22%
December	36	221	16%
Total	**1333**	**4497**	**30%**

[1] Taken from Forsythe et al.(1995) A model comparison for daylength as a function of latitude and day of year. Ecological Modelling. 80: 87 - 95

Assessment of the Impact

14.2.22 There is currently no standard UK Guidance on acceptable levels of exposure to shadow flicker. The only guidance that provides suggested levels is Northern Ireland’s Best Practice Guidance to Renewable Energy (Department of the Environment, Northern Ireland, 2009), which recommends that shadow flicker at neighbouring offices and dwellings within 500 m should not exceed 30 hours per year. This threshold, 30 hours per year, is utilised in this assessment to provide context to the predictions and the likelihood of adverse impact as a result of shadow flicker effects.

14.2.23 This document also comments that at distances greater than 10 rotor diameters, the potential for shadow flicker is very low. This position is based on research by Predac (Predac, n.d.), a European Union sponsored organisation promoting best practice in energy use and supply which draws on experience from Belgium, Denmark, France, the Netherlands, and Germany. In 2017, this research was reviewed by ClimateXChange and remains an industry standard (ClimateXChange, 2017). This is further supported by the online planning advice from the Scottish Government, which concludes that at a separation distance of 10 rotor diameters, shadow flicker is not likely to be an issue.

Baseline Conditions

14.2.24 In accordance with the guidance referenced above, the shadow flicker study area has been defined as a 1,720 m radius (10 rotor diameters + 100 m micro-siting) centred on each turbine and extending 130° to either side of true north. Within this area, three properties have been identified as potentially affected.

14.2.25 Each identified receptor is shown in Figure 14.1 and detailed in Table 14.2.

Table 14.2 - Potentially sensitive receptors located within the study area

Receptor Name	Receptor ID	Easting	Northing	Orientation of Façade (degrees from north)			Distance from development (m)
Stronsaul Cottage	H1	213082	679842	125	35	215	1025
Glenkin Cottage	H2	212892	679926	85	175	355	1235
Chromain Cottage	H3	215939	680008	190	280	100	1605
Altinev	H4	215978	679989	250	340	160	1625

Receptors Brought Forward for Assessment

14.2.26 All properties located within the Shadow Flicker Study Area and identified within Table 14.2 have been brought forward for assessment.

Potential Effects

Construction and Decommissioning

14.2.27 Shadow flicker occurs during operation and therefore is not considered during the construction and decommissioning phases.

Operation

14.2.28 The results are presented for the theoretical maximum as well as for the adjusted scenario which factors in realistic climatic and operating conditions. These are defined as follows:

Table 14.3 - Assessment Scenario Definitions

Scenario	**Description**
Theoretical maximum	Total hours per year assuming the sun is always shining, the turbine is always operational and always yawed in a direction conducive to shadow flicker.
Adjusted scenario	Total hours per year assuming average sunlight hours and variable wind as discussed in 14.2.24. In this scenario, it is still assumed that the turbine is yawed such that flicker is possible.

14.2.29 The adjusted scenario is provided to give a real-world estimate of the number of hours of flicker likely to be experienced over a year and to determine whether any flicker is potentially significant.

14.2.30 Shadow flicker predictions for the Proposed Development are given in Table 14.4.

Table 14.4 - Predicted shadow flicker impacts

Receptor	**ID**	**Earliest Start Time (GMT)**	**Latest End Time (GMT)**	**Time of Year**	**Theoretical Maximum (hh:mm)**	**Adjusted Scenario (hh:mm)**
Stronsaul Cottage	H1	08:40	10:20	Feb,Mar,Sep,Oct,Nov	35:49	8:18
Glenkin Cottage	H2	07:09	10:03	Jan,Feb,Mar,Apr,Sep,Oct,Nov	40:26	9:39

Receptor	ID	Earliest Start Time (GMT)	Latest End Time (GMT)	Time of Year	Theoretical Maximum (hh:mm)	Adjusted Scenario (hh:mm)
Chromain Cottage	H3	15:36	17:38	Feb,Mar,Apr,Sep,Oct	22:37	5:49
Altinev	H4	15:43	16:32	Feb,Mar,Sep,Oct	11:05	2:38

Analysis of Results

14.2.31 Shadow Flicker is expected to occur during winter, spring and autumn months at all receptors. Both H1 and H2 are likely to experience shadow flicker during morning hours between 07:00 and 10:30 (GMT); whilst H3 and H4 are expected to receive shadow flicker during late afternoon between 15:30 and 17:40 (GMT).

14.2.32 Maximum shadow flicker effects of approximately 40.3 hours per year are theoretically possible at H2. However, once realistic climatic and operational conditions are considered, H2 is predicted to receive less than 10 hours per year of shadow flicker effects. In the adjusted scenario, all properties are expected to receive less than 10 hours of flicker per annum. This falls considerably below the threshold of 30 hours of significance. Therefore, the overall impact due to shadow flicker is considered to be low.

14.2.33 Shadow flicker was calculated assuming window sizes of 4 m x 4 m at each property. This is likely to be an overestimate in the majority, if not all cases. In practice, smaller window sizes will lead to a lower probability of shadow flicker occurring than modelled within this assessment.

Mitigation

14.2.34 Where shadow flicker is predicted to occur for short periods of time, it is likely that no mitigation will be required as the magnitude of resulting impacts will be low.

14.2.35 At all properties, it has been demonstrated that predicted shadow flicker from the Proposed Development will be below the threshold of significance of 30 hours of flicker per year. As such, no mitigation for the Proposed Development is proposed.

14.2.36 Should shadow flicker prove to be problematic in practice, the turbines can be fitted with a shadow stop system that can be programmed to automatically shut down when environmental conditions are conducive to shadow flicker at affected properties. This means that the turbine would be equipped with a light level sensor, which would be used to ensure the turbine shuts down during periods of sufficient light to generate shadow flicker.

14.2.37 Shadow flicker impacts could be managed through a suitable planning condition that requires a mitigation scheme to be submitted to, and approved by, the local Planning Authority in response to a reasonable complaint.

Summary

14.2.38 Four receptors were identified within the initial 10-rotor diameter shadow flicker study area, inclusive of 100m micro-siting allowance.

14.2.39 Under worst-case assumptions, the property with the largest theoretical maximum impact was H2 (Glenkin Cottage) with a result of ~40 hours of shadow flicker per year.

14.2.40 However, once realistic meteorological and operational factors are considered, a maximum of less than 10 hours per year of flicker is expected at all four properties, considerably lower than the 30 hours threshold of significance.

14.2.41 As such, shadow flicker is expected to have a **low and not significant effect** on the nearest sensitive receptors. In the event that shadow flicker subsequently becomes problematic in practice, and a complaint is received, individual turbines can be programmed to reduce flicker. Complaint investigation and mitigation would be managed through a suitable planning condition.

14.3 Carbon Balance

Introduction

14.3.1 This chapter addresses the potential effects the Proposed Development will have on climate change through the reduction of Greenhouse Gas Emissions (GHG). This chapter includes a GHG Impact Assessment which provides an estimate of the GHG emissions associated with the manufacture, construction and decommissioning of the Proposed Development. The chapter also calculates the contribution towards GHG emission savings. These two elements showcase a whole life cycle ‘carbon balance’ of the Proposed Development. Once the manufacture, construction and decommissioning emissions are offset by the wind farm, all wind-generated electricity would displace conventionally generated electricity. The carbon balance over the lifetime of the wind farm will be illustrated in detail in this chapter. All calculations are based on site specific data, where available. Where site specific data is not available, approved national/regional information has been used.

14.3.2 Scottish Environment Protection Agency (SEPA) have confirmed the calculator tool is offline and has been since September 2024 due to technical issues. As a result, this chapter has used v2.14.1 spreadsheet version of the Carbon Calculator which mirrors online V1.8.1 in the interim, as confirmed with Energy Consents Unit (ECU). This chapter should be read alongside Appendix 14.1.

14.3.3 Wind turbine generators (WTGs) are designed for optimal performance and reliability in an unpredictable environment, constructed to withstand extreme temperatures and a higher wind class than is necessary. Failure during high winds is unlikely as the turbines are designed to cut-out and automatically stop as a safety precaution in wind speeds over 25 m/s. Based on climate change trends the function of the Proposed Development is not anticipated to be adversely affected therefore no further assessment has been undertaken.

Legislation, Policy and Guidelines

Legislation

14.3.4 Relevant legislation and guidance documents have been reviewed and taken into account as part of this Carbon Balance assessment. Of particular relevance are:

Climate Change Act 2008

- The Climate Change Act 2008 commits the United Kingdom to significant reductions in GHG emissions. Specific net zero targets have been introduced by amendments made by The Climate Change Act 2008 (2050 Target Amendment) Order 2019. It sets legally binding targets to reduce emissions to ensure that the 'net UK carbon account' is reduced by at least 100% by 2050, relative to 1990 levels. The Act establishes a system of 'Carbon Budgets' to guide emission reductions over five-year periods. This legislation aims to tackle climate change and transition the UK towards a low-carbon future through ambitious and sustained decarbonisation efforts.
- The six carbon budgets which have been placed into UK law through secondary legislation under the 2008 Act are identified in Table 14.5 below.

Table 14.5 - UK Carbon Budgets (Climate Change Committee)

Budget	Carbon Budget Level ($MtCO_2e$)	Reduction below 1990 Levels (UK Targets)	Targets Met
1st Carbon Budget (2008 to 2012)	3,018	26%	Yes
2nd Carbon Budget (2013 to 2017)	2,782	32%	Yes
3rd Carbon Budget (2018 to 2022)	2,544	38%	Yes
4th Carbon Budget (2023 to 2027)	1,950	52%	To be assessed in the CCC 2029 Progress Report
5th Carbon Budget (2028 to 2032)	1,725	58%	To be assessed in the CCC 2034 Progress Report

The Climate Change (Scotland) Act 2009

- The Climate Change (Scotland) Act 2009 is key legislation which creates the statutory framework for GHG emissions reductions to achieve 'net zero' in Scotland. In 2019 the Climate Change (Emissions Reduction Targets) (Scotland) Act 2019 Bill was passed which states; Scottish Ministers must ensure that the net Scottish emissions account for the net-zero emissions target year is at least 100% lower than the baseline which is secured through. The 2020 target was amended to 48.5% in 2023.
- The Progress in Reducing Emissions in Scotland Report (2022) by the Climate Change Committee, states that in 2019 the Scottish Parliament legislated an interim target of a 75% reduction on 1990 levels by 2030. This report finds this is an extremely challenging target and proposes a 65-67% reduction in Scotland's emissions by 2030 to be more feasible. The Report also finds that Scotland must do more to reach this ambitious target, particularly through making homes more energy efficient and through the restoration of peatland. Following a Climate Change Committee report submitted in March 2024, it was found that Scotland has no comprehensive strategy to decarbonise towards net zero and will miss its statutory 2030 goal to reduce emissions by 75%. The Scottish Government has now created the Climate Change (Emissions Reduction Targets) (Scotland) Bill which changes the system of targets for the reduction of GHG emissions. The Bill will replace those targets with a system of targets based on carbon budgets. The Bill was introduced on 5 September 2024 and has now become an Act of the Scottish Parliament on 22 November 2024.

Planning Policy

14.3.5 Planning policy relevant to this chapter are as follows:

Onshore Wind Policy Statement

- The Onshore Wind Policy Statement was published in December 2022 and sets out the Scottish target to deploy a minimum of 20GW of onshore wind by 2030. The Scottish Government wants to accelerate the transition to renewable energy and a net zero society to combat climate change. Scotland currently has 9 GW of operational onshore wind which highlights this is a cheap and reliable source of zero carbon electricity. This policy is supported by the Onshore Wind Sector Deal 2023 which sets out commitments from the Scottish Government to deliver 20 GW of onshore wind while delivering maximum benefits to Scotland.

Draft Energy Strategy and Just Transition Plan

- The Scottish Government published a new Draft 'Energy Strategy and Just Transition Plan: Delivering a fair and secure zero carbon energy system for Scotland' on 10 January 2023. This draft Strategy and Plan presents the vision for Scotland's future decarbonised energy system and the actions the government and communities need to take to deliver net zero. The new Strategy is to replace the one previously published in 2017. The Foreword sets out the main objectives for Scotland's future including:
  - More than 20 GW of additional renewable electricity on- and offshore by 2030.
  - An ambition for hydrogen to provide 5 GW or the equivalent of 15% of Scotland's current energy needs by 2030 and 25 GW of hydrogen production capacity by 2045.
  - Increased contributions from solar, hydro and marine energy to our energy mix.
  - Accelerated decarbonisation of domestic industry, transport and heat.
  - Establishment of a national public energy agency – Heat and Energy Efficiency Scotland.
  - By 2030, the need for new petrol and diesel cars and vans phased out and car kilometres reduced by 20%.
  - Generation of surplus electricity, enabling export of electricity and renewable hydrogen to support decarbonisation across Europe.
  - Energy security through development of our own resources and additional energy storage.
  - A just transition by maintaining or increasing employment in Scotland's energy production sector against a decline in North Sea production.
  - Maximising the use of Scottish manufactured components in the energy transition, ensuring high-value technology and innovation.
- This document aligns with the policy included within the Onshore Wind Policy Statement and NPF4.

Argyll and Bute Council

- Argyll and Bute Council are working in line with the Climate Change (Scotland) Act to reduce their Greenhouse Gas Emissions across the region. The council's Decarbonisation Plan 2022-2025 sets out actions and commitments which there are working to deliver for a low-carbon and environmentally friendly Argyll and Bute. The Plan sets out an approach which is based on six themes, including Waste, Energy and Water Consumption and Transport emissions.

Consultation

Table 14.6 - Consultation

Consultee and Date	Consultation Response	Applicant Response
Argyll and Bute Council	*'The EIAR should include a statement which outlines the main development alternatives studied by the applicant and an indication of the main reasons for the final project choice. This is expected to highlight the following: the range of technologies that may have been considered; locational criteria and economic parameters used in the initial site selection; options for access; design and locational options for all elements of the proposed development (including grid connection); and the environmental effects of the different options examined. Such assessment should also highlight sustainable development attributes including for example assessment of carbon emissions / carbon savings.'*	– The Scottish Government Carbon Calculator will be utlised to undertake an assessment of carbon emissions and carbon savings of the Proposed Development

Consultee and Date	Consultation Response	Applicant Response
Development and Economic Growth – Argyll and Bute Council	*'Please note that in terms of National Planning Framework 4 and the Argyll & Bute Local Development Plan 2 and associated Supplementary Guidance, renewable energy developments will be assessed against the following criteria:* *… - Impacts on carbon rich soils, using the carbon calculator…'*	– The Scottish Government Carbon Calculator will be utlised to calculate the impacts on carbon rich soils.

Assessment Methodology

Context

14.3.6 Embedded Carbon and GHGs: This refers to the emissions resulting from the entire life cycle of the wind turbine components and their associated physical infrastructure. From the extraction and refinement of raw materials to the manufacturing processes, there are GHG emissions associated with the production of wind turbine generators and other components. This includes emissions from mining, transportation, manufacturing, and construction processes.

14.3.7 Operational Emissions: Once the wind farm is operational, there are ongoing emissions related to the combustion of fuels and energy used in various activities. These emissions arise from activities such as operating and maintaining the wind turbines, as well as from general site operations and maintenance. Over the lifetime of the wind farm, there will be continuous energy consumption and fuel use, contributing to operational emissions.

14.3.8 Decommissioning Emissions: When the wind farm reaches the end of its useful life and is decommissioned, there are additional emissions associated with dismantling and removing the infrastructure. The process of decommissioning may also involve transportation and disposal of materials, leading to emissions.

14.3.9 The manufacturing phase of wind turbines has the most significant environmental impact across various impact categories and indicators, including global warming potential, acidification potential, eutrophication potential, and non-renewable primary energy demand. This category encompasses the production of several wind turbine components such as the foundation, tower, nacelle, hub, and rotor blades. The transportation and manufacturing processes of these components also contribute to the large environmental impact.

14.3.10 The main reason for this substantial impact is the production of significant quantities of materials, particularly concrete and metals like steel, cast iron, stainless steel, aluminium, and copper. These materials' extraction, processing, and manufacturing result in high greenhouse gas emissions and energy consumption, leading to a considerable environmental footprint during the wind turbine manufacturing phase.

14.3.11 Other stages of wind farm development, such as the manufacturing of substations, maintenance (including spare parts provision), transportation, logistics, installation, and dismantling, have relatively smaller contributions to the overall environmental impact. The construction of wind turbines also has the potential to create GHG emissions through other pathways such as disturbance of peatlands (carbon stores) and the removal of woodland and forestry.

14.3.12 In efforts to reduce the environmental impact, the use of recycled materials during the manufacturing phase, particularly metals, has a positive effect. By giving end-of-life credits for recycled materials, the overall environmental impact of wind turbines can be partially mitigated. This underscores the importance of sustainable practices and recycling in the wind energy industry to promote a more environmentally friendly approach to wind farm development and operation.

Carbon Emission Assessment

14.3.13 The annual carbon dioxide emissions saving of a wind turbine are estimated as:

CO_2 Emissions Saving =

$$\text{Total electricity generation expected [MWh]} \times \text{Emission Factor of Displaced Generation [}tCO_2\text{/MWh]}$$

14.3.14 The NatureScot Technical Guidance Note states that "in most circumstances, it is not possible to define the electricity source for which a renewable electricity project will substitute", although it does state that as nuclear power generation is not affected by renewable energy generation "this suggests that carbon emission savings from wind farms should be calculated using the fossil fuel sourced grid mix as the counterfactual". NatureScot's Technical Note presents the result for each of the three sets of figures, as shown in Table 14.7.

Table 14.7 - Counterfactual Emission Factors

Energy	Emission Factor (tCO2 per kWh)
Grid Mix	0.207
Fossil Fuel Mix	0.424
Coal Fired	0.945

14.3.15 The GHG Assessment of the Proposed Development would typically be completed using the latest version of the Scottish Government's Carbon Calculator Tool. This is the standard method for calculating carbon costs and savings for onshore wind farms sited on Scottish peatlands. The tool assesses the carbon costs of a wind farm against the carbon savings attributed to the wind farm development. The calculator takes into account peat disturbance and felling of forestry, which enables a life-cycle analysis of the Proposed Development. A description of the carbon calculator and the calculator inputs can be seen in Appendix 14.1.

14.3.16 Once GHG emission savings and costs have been compared, the Carbon Calculator will calculate the overall net GHG emission savings of the Proposed Development. The Calculator also produces a carbon payback time, which is an estimate of how long it will take a renewable energy project to offset the carbon emissions emitted as a result of its construction, operation and decommissioning.

Carbon Calculator Results

Operation

14.3.17 The operation stage of the Proposed Development is where most carbon savings will occur. Carbon costs of construction activities would no longer exist, and the operation of the turbines and BESS would generate zero-carbon electricity. The carbon savings results are presented below and are rounded to two significant figures. Results for both the grid-mix and fossil-fuel mix counterfactual are presented below; however the grid-mix shows a more conservative and realistic estimate as this the same as the national grid where there are many main sources of energy.

14.3.18 A wind project capacity factor must be determined in order for the total electricity generation of the wind project to be calculated. This is the ratio of the actual energy generated to the theoretical amount that the machine would generate if running at full-rated power during a given period of time. The site area is estimated to have higher than average wind speeds for the UK, and as such, a capacity factor of 40.8% has been estimated based on wind yield assessments undertaken by Statkraft.

Table 14.8 - Calculated Carbon Emission Savings

Power Generation Characteristics	
Number of turbines	7
Turbine capacity	7.2MW
Capacity factor	40.8%
Duration of Consent	50 years

Project estimated CO_2 emission savings per year:	Expected	Minimum	Maximum
Coal fired electricity generation ($tCO_2\ yr^{-1}$)	170,226	153,120	186,915
Grid mix electricity generation ($tCO_2\ yr^{-1}$)	37,288	33,541	40,943
Fossil fuel mix electricity generation ($tCO_2\ yr^{-1}$)	76,377	68,702	83,865
Energy output from Wind Farm over lifetime (MWh)	9,006,682	8,101,598	9,889,690

Construction and Decommissioning

Backup Power Generation

14.3.19 Wind-generated electricity is inherently variable, therefore as the NatureScot Technical Guidance Note states, extra capacity is required for backup power generation to meet consumer demand. Backup power generation is assumed to be by fossil-fuel mix of electricity generation. The additional CO_2 output is calculated using the Scottish Government Carbon Calculator.

Disruption of Peatlands

14.3.20 Peatlands contain large reservoirs of carbon, containing about one-third of the global amount of carbon in all soils. Undisturbed, peatlands sequester carbon from the atmosphere through photosynthesising vegetation. This carbon is then stored in the soil. This accumulates primarily in waterlogged conditions, where there is a low potential for decomposition. This element of the calculation accounts for the loss of carbon fixing potential of the peat that is removed during construction of access tracks, hardstandings, turbine foundations and other site infrastructure. It also factors in the impact of areas of peat that might be drained as a result of the wind turbines.

14.3.21 To establish peat depth at the Site, a Phase 1 and Phase 2 peat probing survey was undertaken, with locations probed across the Site to ascertain the depth of peat, concentrating on potential access track routes and turbine locations. Maximum and minimum inputs for average peat depths were inputted to the carbon calculation. The results of the peat probes and site conditions are discussed in EIA Report Chapter 8.

Forestry

14.3.22 Forests and trees are stores for carbon therefore when they are felled this carbon dioxide is released back into the atmosphere. This element of the calculation accounts for the loss of carbon storage potential of the forests that is removed during the construction of access tracks, hardstandings, turbine foundations and other site infrastructure.

14.3.23 Chapter 12 proposes a total of 32.94 ha will require to be felled to enable the construction and operation of the Proposed Development. Permanent felling of 3.85 ha is required with a further 21.68 ha proposed for to be felled to restore peatland.

14.3.24 The SNH Technical Guidance Note includes estimated figures for carbon sequestration of different species of tree, and in this case the majority species that is proposed to be felled comes under the Sitka category. According to the carbon sequestration rate for Sitka of 13.2 tonnes of CO_2 per hectare per year.

Summary of Carbon Losses and Gains

14.3.25 The carbon losses due to turbine life occur from multiple phases. The carbon losses from the wind turbine itself comes from the raw materials used to construct the turbine during the manufacturing phase. Carbon losses from construction and decommissioning arise from the transportation and machinery used.

14.3.26 Dissolved and particulate organic carbon (DOC and POC) are important components in the carbon cycle and serve as a primary food source for aquatic food webs. Carbon losses can arise if leaching of DOC and POC into groundwater occurs.

14.3.27 Total carbon dioxide losses and savings are noted below in Table 14.9 and Table 14.10 below.

Table 14.9 - Total CO_2 losses due to wind farm (t CO_2 eq.)

Activity	Expected	Minimum	Maximum
Losses due to turbine life (e.g., manufacture, construction, decommissioning)	44,924	44,814	45,035
Losses due to backup	46,799	46,799	46,799
Losses due to reduced carbon fixing potential	1,501	400	2,930
Losses from soil organic matter	12,374	-5198	118,666
Losses due to DOC & POC leaching	867	0	9,396
Losses due to felling forestry	2,541	2,036	3,102
Total Losses of Carbon Dioxide	**109,006**	**88,852**	**225,928**

Table 14.10 - Total CO_2 gains due to improvement of site (tCO_2 eq.)

Activity	Expected	Minimum	Maximum
8a. Change in emissions due to improvement of degraded bogs	-12,892	0	-28,930
8b. Change in emissions due to improvement of felled forestry	-5,999	0	-13,463
Total change in emissions due to improvements	**-18,890**	**0**	**-42,393**

Net GHG Emissions and Payback Period

14.3.28 Net carbon dioxide emissions and payback period for the Proposed Development are summarised in Table 14.11.

Table 14.11 - Carbon Calculator Results

	Expected	Minimum	Maximum
Net emissions of carbon dioxide (tCO2 eq.)	90,116	46,459	225,928
Carbon Payback Time			
…coal-fired electricity generation (years)	0.5	0.2	1.5
…grid-mix of electricity generation (years)	2.4	1.1	6.7
…fossil fuel - mix of electricity generation (years)	1.2	0.6	3.3

14.3.29 The carbon payback time is an estimate of how long it will take a renewable energy project to offset the carbon emissions emitted as a result of its construction, operation and decommissioning. The carbon payback time of all the emissions associated with the lifetime operation of the Proposed Development is expected to be 1.2 years based on the fossil fuel mix and 2.4 years based on a grid-mix of electricity generation.

Embedded Mitigation

14.3.30 An iterative design approach was taken for the layout of the Proposed Development therefore turbines and associated infrastructure were placed to avoid the deeper areas of peat and avoid watercourses, as well as utilising existing infrastructure where possible. Chapter 8 outlines the measures to be taken to mitigate water pollution and flood risk during construction activities. Technical Appendix 8.1 is an Outline Peat Management Plan (OPMP) has been prepared as part of the EIA submission. The OPMP provides details of how peat will be excavated on the Site, the characteristics of the peat that could be excavated, and outlines suitable methods for reusing and managing excavated peat in line with good practice methods. This document should be considered a live document throughout the development phase of the wind farm. As such, additional information may be incorporated following the results of any further investigations carried out as part of the detailed design process that provide further information across infrastructure locations.

14.3.31 To mitigate potential effects during the construction phase, an Outline Construction Environmental Management Plan (Technical Appendix 3.1) has been prepared and will be implemented ahead of the commencement of construction. The CEMP outlines a range of optimal practices, encompassing environmental best practices such as the efficient processing and reuse of all reclaimed materials on-site whenever feasible. By incorporating training and contractual obligations, the project aims to uphold the highest standards of environmental protection and water management throughout the construction phase. This approach underscores the Proposed Development's commitment to minimising its environmental impact and ensuring responsible construction practices.

14.3.32 The Proposed Development is expected to have a beneficial effect on climate change in terms of offsetting greenhouse gas emissions and no adverse effects are predicted. Therefore, no additional mitigating actions are proposed.

Summary

14.3.33 The Proposed Development is expected to produce GHG emissions due to manufacture, construction and decommissioning activities but these emissions to be offset in approximately 1.2 years which is equivalent to 2.4% of its 50-year operational lifespan against a fossil fuel-mix counterfactual of electricity. Thereafter the Proposed Development will contribute to national reduction CO_2 targets for the remainder of its operational lifetime.

14.3.34 The assessment demonstrates that the Proposed Development would make a positive contribution to Argyll and Bute's Decarbonisation Plan 2022-2025, meanwhile contributing to the wider national target of achieving net zero by 2050. The Proposed Development will also help meet the Scottish Government's target of securing an overall ambition of 20GW of installed onshore wind capacity in Scotland by 2030, as set out in the Onshore Wind Policy Statement (2022).

14.4 Major Accidents and Disasters

14.4.1 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.

14.4.2 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).

Battery Storage Fire Safety

14.4.3 Safety measures would be incorporated within the proposed Battery Energy Storage System (BESS) facility in order to minimise the risk of fire and the risk of contamination to surface water receptors. The BESS compound would be constructed with an impermeable lining and with stormwater storage provided above this. This will include an automatic fire suppression system with a control point or shut off valve so that in the unlikely event of a leak or pollution event occurring it can be retained within this area. Contained pollution or firewater would be pumped to a tanker and removed from the site for treatment and disposal at a suitable licenced facility.

14.4.4 The Applicant will comply with all relevant laws and regulations concerning fire safety. In their decision notice for Shetland Battery Energy Storage System (BESS) dated 21 February 2024 under application reference ECU000048812, the Scottish Ministers stated that “Fire precautions and matters relating to health and safety are covered by other legislation, are regulated by the Health and Safety Executive (HSE), and such considerations are not material to the application.”

14.5 Population and Human Health

14.5.1 Chapters 5, 8, 10 and 11 contain assessments which relate to the health and wellbeing of the local population. These chapters assess the effects of the Proposed Development, both beneficial and adverse, provide an analysis of the significance of these effects and also put forward measures to mitigate against adverse effects on people and their health.

14.5.2 Chapter 15 provides an overview of the mitigation put forward as part of these assessments in order to reduce any adverse effects of the Proposed Development to an acceptable level.

14.5.3 Further to the topics covered in Chapters 5 to 14, including this chapter, it is not expected that the Proposed Development would have significant effects on population and human health.

Public Safety and Access

14.5.4 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.

14.5.5 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”.

14.5.6 Site security and access during the construction period would be governed under Health and Safety at Work Act 1974 and associated legislation. During construction, measures would be required to ensure that the public understand that restricted access to the forestry tracks would be in place throughout the works. There is no option for alternative access in place of the Core Paths due to the presence of forestry and limited alternative routes within the area. Plans for temporary access management, including traffic management and access restrictions, would be communicated with the public prior to taking place, where feasible. The Applicant will aim to keep all access restrictions and limitations to a minimum. The Applicant is committed to safeguarding the safety of members of the general public, whilst also ensuring that construction progress is not compromised.

14.5.7 An Outline Access Management Plan (AMP) is provided in Technical Appendix 10.2 with the final version of the AMP to be agreed with Argyll and Bute Council in advance of construction.

14.5.8 During operation the site would be open to the public, appropriate warning signs would be installed concerning restricted areas of the site such as the substation compound, BESS, switchgear and metering systems. All on-site electrical cables would be buried underground with relevant signage.

Traffic

14.5.9 In summary, the Proposed Development would create an increase to HGV traffic levels within the study area during construction, but these levels would remain well within the design capacity of the local road network.

Construction

14.5.10 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.

14.5.11 Nonetheless, the risk of accidents is covered where relevant in individual topic chapters, for instance, the potential for environmental incidents and accidents such as spillages and flood risk are considered in Chapter 8. Good practice measures to prevent incidents and spillages are set out in the outline CEMP.

Extreme Weather

14.5.12 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.

14.5.13 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.

14.5.14 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). In the event that a turbine is shut down during conditions suitable for ice formation, there is potential for ice throw to occur after start-up. There are monitoring systems and protocols in place to ensure that turbines that have been stationary during icing conditions are re-started 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

14.5.15 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 15 years (Earthquake Track). 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.

14.5.16 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.

14.6 Air Quality

14.6.1 Construction activities can result in temporary effects from dust if un-managed. 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 500 m 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.

14.6.2 A Dust Management Plan is included within the outline CEMP (Technical Appendix 3.1) which sets out mitigation measures to be implemented on-site including for site activities and the movement of construction traffic along with regular monitoring activities to ensure that dust as a result of construction of the Proposed Development is adequately controlled.

14.7 Television and Telecommunications

Executive Summary

14.7.1 The purpose of the Television and Telecommunication section is to assess any potential impact of the Proposed Development on television and telecommunications infrastructure. Potential impact can take the form of physical obstructions, adverse effects on the overall performance of communications, navigation and surveillance (CNS) equipment, and interference with electromagnetic signals and potentially affecting television reception and fixed telecommunication links.

14.7.2 The assessment of this is initially conducted by identification of fixed links which run through the Site, which is done by consultation with the Ofcom Spectrum Information Portal, and relevant fixed link operators.

14.7.3 In the case of the Proposed Development, no fixed links were identified. As no residual effects on fixed links are anticipated.

Introduction

14.7.4 This section of the chapter considers the potential television and telecommunications effects associated with the Proposed Development.

Legislation, Policy and Guidelines

Planning Policy

14.7.5 Planning policy relevant to this chapter are as follows:

- Scottish Government (2023) 'National Planning Framework 4', Policy 11: Energy e)v;
- Argyll and Bute Council (2024) 'Argyll and Bute Local Development Plan 2', Policy 30 – The Sustainable Growth of Renewables

Guidance

14.7.6 Recognisance has been taken of the following best practice guidelines/guidance etc:

- Scottish Government (2014) 'Onshore Wind Turbines: Planning Advice;
- Ofcom (2009) 'Tall Structures and their Impact on Broadcast and other Wireless Systems' (the "Ofcom Guidance");
- PagerPower (2023) 'Telecommunications White Paper – Wind and Building Developments.

Scope of Assessment

14.7.7 Operational Effects on television: The 2009 Ofcom Report states that: "Technologies such as analogue television are quite seriously affected by signal reflections, which can give rise to an effect known as 'ghosting'. Ghosting (or delayed image interference) is where a pale shadow or shadows appear to the right of the main picture on viewers' television screens." This, and other signal interference, can occur to houses within a few kilometres of wind development if their TV aerials are oriented towards the turbines. The 2009 Ofcom Report goes on to state that: "Digital television signals are much better at coping with signal reflections, and digital television pictures do not suffer from ghosting". In the unlikely event that television signals are affected by the Proposed Development, mitigation measure will be considered by the Applicant.

14.7.8 The assessment has therefore focused on microwave fixed links. Fixed 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. They are used for the transmission of information to broadcasting masts for television and radio and for the mobile telephone networks and other use-cases.

Assessment Methodology and Significance Criteria

Desk Study

14.7.9 Consultation was undertaken with appropriate stakeholders to identify any potential impacts on telecommunication and utilities/services infrastructure during or post-construction and potential mitigation options were discussed where necessary. These stakeholders and their response are listed in Table 14.12. Table 14.12 The Ofcom Spectrum Portal was used to assess whether any existing fixed microwave/radio links ("fixed links") were in the vicinity of the wind turbines. From the service, the Licensee Company of any nearby fixed links is identified and contacted by the Green Cat Renewables (GCR) on behalf of the Applicant following which the extent of the potential impact is identified and mitigation agreed upon. Satellite imagery and Google Street View were then used to identify any telecommunications or infrastructure features left unidentified by other methods.

Assessment

14.7.10 No fixed links were identified from the Ofcom Spectrum Information Portal as running through the Site.

14.7.11 A range of other major operators were still contacted as a matter of best practice.

14.7.12 Telecommunications and broadcasting network operators were consulted once the project had met design freeze.

14.7.13 Table 14.12 summaries the consultation undertaken, and responses received from the link operators.

Table 14.12 - Consultation

Link Operator	Date of Response	Consultation Response	Applicant Response
Arqiva	02/06/2025	Arqiva is responsible for providing the transmission network for the BBC & ITV along with the majority of the UK's radio companies and is responsible for ensuring the integrity of Re-Broadcast Links. Tall infrastructure such as	N/A

Link Operator	Date of Response	Consultation Response	Applicant Response
		wind turbines and other tall structures have the potential to block radio transmission links and rebroadcasting links (through direct blocking of radio signal or deflecting signal). Our radio transmission networks normally operate with a 100m buffer either side of a radio link, free from interference by a tall development.	
Atkins	29/05/2025	The above application has now been examined in relation to UHF Radio Scanning Telemetry and Microwave communications used by our Client in that region and we are happy to inform you that we have NO OBJECTION to your proposal.	N/A
BT	28/05/2025	We have studied this proposal using the below co-ordinates with respect to EMC and related problems to BT point-to-point microwave radio links. The conclusion is that this proposal should not cause interference to BT's current and presently planned radio network.	N/A
Vodafone	27/05/2025	I can confirm that this development will not have any impact on any MW links.	N/A
JRC	26/05/2025	This proposal is *cleared* - subject to 50m Micrositing - with respect to radio link infrastructure operated by the local energy networks.	N/A

Residual Effects

14.7.14 As no fixed links have been identified to run through the Site, no residual effects are anticipated during the construction, operation, or decommissioning phases of the Proposed Development. As none were identified and relevant operators have not objected, there is no residual effect on telecommunication services

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