atmos CONSULTING

Environmental Impact Assessment Report

Swarclett Wind Farm

Chapter 13: Climate Change and Carbon Balance

Swarclett Wind Energy Limited

wind2

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Contents

Contents

Tables

Figures

None

Appendices

Glossary of Terms

Term	Definition
The Applicant	Swarclett Wind Energy Limited
Environmental Advisors and Planning Consultants	Atmos Consulting Limited
Capacity Factor	Capacity factor is the ratio of the actual energy produced in a given period, to the hypothetical maximum possible, *i.e.*, running full time at rated power.
Environmental Impact Assessment	Environmental Impact Assessment (EIA) is a means of carrying out, in a systematic way, an assessment of the likely significant environmental effects from a development.
Environmental Impact Assessment Regulations	The Electricity Works (Environmental Impact Assessment) (Scotland) Regulations 2017 (EIA Regulations)
Environmental Impact Assessment Report	A document reporting the findings of the EIA and produced in accordance with the EIA Regulations
The Proposed Development	The Swarclett Wind Farm
The Proposed Development Footprint	The area within which the Proposed Development will be located.
The Proposed Development Site	The full application boundary, i.e. the red line boundary (Figure 1-1 Site Location).
The Planning Act	The Town and Country Planning (Scotland) Act 1997 (as amended)

List of Abbreviations

Abbreviation	Description
CCC	Climate Change Committee
CCIA	Climate Change Impact Assessment
CCRA3	Climate Change Risk Assessment 2022
CO_2	Carbon dioxide
CO_2/kWh	Carbon dioxide per Kilowatt hour
EnvCoW/ECoW	Ecological/Environmental Clerk of Works
ECU	Energy Consents Unit
EIA	Environmental Impact Assessment
EIAR	Environmental Impact Assessment Report
European Commission	EC
GB	Great Britain
gCO_2/kw	Grams of Carbon dioxide per Kilowatt
gCO_2e/kWh	Grams of Carbon dioxide Equivalent per Kilowatt hour
GHG	Greenhouse Gas
GVA	Gross Value Added
MWh	Megawatt Hour
NDC	Nationally Determined Contribution
NPF	National Planning Framework
PMP	Peat Management Plan
OWPS	Onshore Wind Policy Statement
RCP	Representative Concentration Pathways

Abbreviation	Description
THC	The Highland Council
SES	Scottish Energy Strategy
tCO_2 eq.	Total Carbon dioxide Equivalent
Tonnes CO_2 eq.	Tonnes of Carbon dioxide Equivalent
UK	United Kingdom
UKCP	UK Climate Projections

13 Climate Change and Carbon Balance

13.1 Introduction

This Chapter of the EIA Report assesses the effects of the Proposed Development on climate change and estimating the contribution the Proposed Development would make to reducing CO_2 emissions, by an assessment of the whole life carbon balance of the Proposed Development.

It has been completed by Atmos, and is supported by Technical Appendix 13-1: Carbon Calculator Inputs.

The following assessments are considered in this Chapter:

- the vulnerability of the Proposed Development to climate change, with the Proposed Development as a receptor;
- the influence of the Proposed Development on climate change, in terms of overall balance of greenhouse gas (GHG) emissions, as estimated by the results of utilising the Scottish Government Carbon Calculator.

The carbon calculator is an online tool produced by the Scottish Government for use in processing the determination of onshore wind farm developments in Scotland. The purpose of the tool is to comprehensively assess the predicted carbon impact, positive or negative, of the Proposed Development.

The tool is typically used for applications for onshore wind farm development proposals of over 50MW installed capacity (which are subject to consent under Section 36 of the Electricity Act 1989). Whilst, the capacity of the Proposed Development does not align with this established threshold, we continue to employ the tool in adherence to best practices.

13.2 Legislation, Planning Policy and Guidance

The relevant planning policy at a national and local level, and how it applies to the environmental design and assessment of the Proposed Development, is discussed in Chapter 4 (Planning and Energy Policy) of this EIAR. The key planning policies and guidance relevant to this Chapter are set out below:

- The Electricity Act 1989 (UK Government , 1989);
- The Town and Country Planning (Environmental Impact Assessment) (Scotland) Regulations 2017 (the EIA Regulations) (UK Government, 1997);
- Fourth National Planning Framework (NPF4) (Scottish Government, 2023a);
- Onshore Wind Policy Statement 2022 (Scottish Government, 2022);
- The Draft Energy Strategy and Just Transition Plan (Scottish Government, 2023);
- COP26 – The Glasgow Climate Pact (UNFCC, 2021);
- COP27 – The Sharm el-Sheikh Implementation Plan (UNFCCC, 2022);
- Sixth Carbon Budget 2020 (CCC, 2020);
- Climate Change Committee's (CCC) Net Zero – The UK's Contribution to Stopping Global Warming 2019 (CCC, 2019);
- Net Zero Strategy: Build Back Greener (UK Government, 2021);

- UK Climate Change Risk Assessment 2022 (CCRA3) (UK Government, 2022);
- Climate Change (Emission Reduction Targets) (Scotland) Act 2019 (Scottish Government, 2019b);
- The Scottish Government's Energy Strategy Update (2021) (Scottish Government, 2021a);
- Scotland's Climate Assembly: Recommendations for Action (2021) (Scottish Government, 2021b;
- Update to the Climate Change Plan 2018-2032: Securing a Green Recovery on a Path to Net Zero (Scottish Government 2020a);
- Towards a Robust, Resilient Wellbeing Economy for Scotland, a report of the Advisory Group on Economic Recovery (June 2020) (Scottish Government 2020b);
- Scottish Energy Strategy (2017) (Scottish Government, 2017); and
- Progress in reducing UK emissions - 2023 Report to Parliament (CCC, 2023).

Both the UK and Scottish Governments have declared a Climate Emergency (UK Government, 2019a; Scottish Government, 2019a). While this imposes no formal obligation to act, it emphasises a public and political desire to increase efforts to combat climate change.

The Highland Council (THC) also declared a climate emergency in May 2019 and published a Net Zero Strategy (THC, 2021), which sets out their vision to achieve Net Zero Greenhouse Gas emissions by 2045.

The Committee on Climate Change (CCC) Report to Parliament in June 2023: 'Progress in reducing emissions' (CCC, 2023) found that although carbon emissions were 9% below pre-pandemic levels; emissions actually increased by 0.8% between 2021 and 2022. The report highlights that the only reason that emissions from the power sector stayed static was due to the contribution of renewables.

In 2019, the Scottish Government enacted the Climate Change (Emission Reduction Targets) (Scotland) Act 2019 (Scottish Government, 2019), amending the Climate Change (Scotland) Act 2009 (Scottish Government, 2009).

These amendments result in an increase to Scotland's climate change targets for reducing emission levels. Specifically, a target was strengthened from an 80% reduction by 2050, as initially set out in the Climate Change (Scotland) Act 2009, to achieving a 100% reduction by 2045.

An interim target of a 75% reduction by 2030 was also introduced. The Scottish Government considers onshore wind farms as critical to ensuring that this interim target is met and has set out its ambition for 20GW of installed onshore wind capacity in the country by 2023. It has also given explicit recognition to the potential for windfarms to significantly impact peatlands, and the need to balance the benefits of onshore wind deployment and impacts on carbon rich habitats (Scottish Government, 2022).

13.3 Consultation

The assessment process has been informed by consultation with THC and relevant stakeholders including through the Pre-Application Advice (November 2021) and the

Scoping Opinion (March 2022). A summary of the key consultation responses is described in Table 13-1.

Table 13-1: EIA Consultation – Climate Change and Carbon Balance

Consultee	THC Preapplication Comment (November 2021)	Scoping Opinion (March 2022)	Applicant Response
SEPA	N/A	Request that Peat depth survey and re-use proposals including measures to reduce the disturbance of peat and release of CO_2 are included in the EIAR.	Noted. An assessment of the impact on carbon balance and climate change is included in this chapter of the EIAR.
THC	The EIAR should demonstrate how the layout has been designed to minimise disturbance of peat and consequential release of CO_2 and outline mitigation measures to avoid significant drying or oxidation of peat.	N/A	Noted. An assessment of the impact on carbon balance and climate change is included in this chapter of the EIAR.

13.4 Methodology and Approach

13.4.1 Scope of the Assessment

The assessment considers the following in terms of the potential effects of the Proposed Development:

- The vulnerability of the Development to climate change; and
- The influence of the Development on climate change.

The assessment of the influence of the Proposed Development on climate change considers the overall balance of greenhouse gas (GHG) emissions such that climate change is recognised to be directly linked to these emissions. No specific analysis is undertaken of how climate parameters might change in direct response to the emissions balance of the Proposed Development.

Consideration of effects on environmental receptors sensitive to climate change is included in EIA Chapters 5 to 14 where relevant.

13.4.2 Temporal and Spatial Study Area

The study area considered for the assessment of vulnerability of the Proposed Development to climate change consists of the infrastructure within the Proposed Development Site. With regards to the temporal scope, this considers changes over the operational lifetime of the Proposed Development, 30 years from commissioning.

Information on climate trends and projections at the Scottish and local scale (where available) are utilised.

The study area for the assessment of the influence of the Proposed Development on climate change considers GHG emissions (current levels and targets), along with renewable energy generation and grid mix.

13.4.3 Future Baseline Methodology

The UK Climate Projections (UKCP) is a set of tools and published data, that predicts how the UK climate may change in the future (DEFRA, 2020).

UKCP18 uses scenarios for future greenhouse gas emissions called Representative Concentration Pathways (RCPs). The four RCPs attempt to capture a range of potential alternative futures and outcomes linked to global temperature increases and include a wide variety of assumptions on socioeconomic development and commitment to emissions reductions.

Over the 30-year anticipated lifetime of the Proposed Development, the choice of scenario is not critical, but where appropriate the medium emissions scenario RCP6.0 is utilised as the future baseline. This scenario assumes after 2030, no further emission reductions are achieved whilst allowing for some further increase in emissions (DEFRA, 2020).

13.4.4 Vulnerability of the Proposed Development to Climate Change Methodology

The following climate related parameters are considered to have the potential to impact upon the operation of the Proposed Development:

- Wind (speed, direction and gustiness);
- Temperature; and
- Precipitation.

The construction and decommissioning stages of the Proposed Development are not considered to be vulnerable to climate change and scoped out of further consideration.

13.4.5 Influence of the Proposed Development on Climate Change

In order to assess the sustainability of the Proposed Development and the contribution which will be made towards reducing GHG emissions and the statutory requirements of The Climate Change (Scotland) Act 2009 the Scottish Government's Online Carbon Calculator v1.8.1 (updated in December 2023) was used to calculate the carbon cost and payback period of the Proposed Development.

As stated in the Onshore Wind Policy Statement 2022 (OnWPS) (Scottish Government, 2022), work has begun within the Scottish Government to "*assess the operation of, and if necessary, update or replace, the carbon calculator.*" The Scottish Government advise within the OnWPS 2022, that;

> "an *expert group will be convened, including representatives from industry, agencies and academia, to provide advice on how guidance could be developed to support both peatland and onshore wind aims*".

In lieu of this, the most recent Scottish Government's Online Carbon Calculator (v 1.8.1) has been utilised for the purposes of this assessment.

The online Reference for the completed Carbon Calculator is KC8T-U38N-WFSA v1.

The methodology calculates the balance of total carbon savings and losses over the life of the Proposed Development. The potential carbon savings and costs associated with wind farms are:

- Carbon emission savings due to generation (based on displacing emissions from different power sources). The Carbon Calculator is limited to considering displacement of energy generation exported to the electricity grid and although carbon intensive energy for heat and transport will be increasingly decarbonised by electrification and therefore effectively displaced by green electricity, the tool does not (yet) take account of this in calculating emission savings;
- Lifetime costs associated with manufacture of turbines and construction;
- Loss of carbon from backup power generation;
- Loss and/or saving of carbon stored in peatland (by peat removal or changes in drainage);
- Loss and/or saving of carbon-fixing potential as a result of tree felling; and
- Carbon gains due to proposed habitat improvements.

The inputs and outputs of the calculator are presented with 'Expected' values – the best estimate of the anticipated value, based on the current understanding of the Proposed Development – along with 'minimum' and 'maximum' values to give a range of possible outputs, dependant on the variables within the model.

Other outputs of the calculator include the length of time (in years) it will take the carbon savings to amount to the carbon costs and is referred to as the 'payback period', and the carbon intensity of the Proposed Development in gCO_2/kw.

Where practicable, site-specific data (such as peat depths and length of tracks as detailed in Chapter 3 Description of Development and Chapter 8: Hydrology and Hydrogeology), have been used in the assessment.

However, there are several factors which would require extensive measurements taken over long periods, such as water table depths across the Proposed Development Site. Therefore, either standard (default) data or, in some cases, an informed estimate has been used.

The input values, sources and assumptions made are provided in Technical Appendix 13-1 Carbon Calculator Inputs.

13.4.6 Significance Criteria

To determine whether effects are significant under the EIA Regulations, it is appropriate to consider the sensitivity (see Chapter 2: EIA Approach and Methodology, Table 2-2) of the receptor and the magnitude of the impact (Chapter 2, Table 2-3), taking into account uncertainty. This is based on the professional judgement of the assessor (see Table 13-2).

Table 13-2: Categories of Significance of Effect

Significance	Definition
Major	A fundamental change to location, environment, species or sensitive receptor
Moderate	A material, but non-fundamental change to a location,

Significance	Definition
	environmental, species or sensitive receptor
Minor	A detectable but non-material change to a location, environment, species or sensitive receptor
Negligible	No detectable or material change to a location, environment, species or sensitive receptor

Effects assessed can be both beneficial (positive) and adverse (negative). Significant Effects are only considered to be classified as 'Major' or 'Moderate'. Effects classified as 'Minor' or 'Negligible' are considered to be Not Significant.

13.5 Baseline

Chapter 8: Hydrology and Hydrogeology and supporting Technical Appendix 8-1 Peat Survey Results sets out the baseline for the peat conditions onsite.

As the Proposed Development Site is currently largely undeveloped, baseline carbon emissions to the atmosphere are considered to be minimal. However, it is widely acknowledged that peatlands sequester, and store carbon and the amount sequestered by peat bog varies depending on its condition.

Two very small areas of peat soil >0.5m were identified in the Proposed Development footprint. These were up to 0.8 m deep peat immediately adjacent to Turbine 2, and 0.86m peat 370m due west of Turbine 2, towards the Burn of Durran. The locations of turbines and associated infrastructure have been carefully chosen to avoid parts of the Proposed Development Site where peat is present.

There is no forestry located on the Proposed Development Site therefore no felling will take place and restocking is not required.

13.5.1 Future Baseline

In the future, it is expected the GHG/carbon intensity will continue to decline in Scotland due to legislative and policy changes and decarbonisation of industry, energy supply and transportation.

However, climate projections show that the trends over the 21st century in the UK are towards warmer and wetter winters and hotter, drier summers, with an increase in frequency and intensity of extremes.

The climate parameters considered most relevant to the assessments referenced within this chapter are wind speed, temperature and precipitation.

The State of the UK Climate 2022 (RmetS, 2023) provides the latest report on observed UK climate data for the most recent decade (2012-2021). Key findings are:

- The most recent decade (2012–2021) has been on average 0.2°C warmer than the 1991–2020 average and 1.0°C warmer than 1961–1990;
- The most recent decade (2012–2021) has had 5% fewer days of both air and ground frost compared to the 1991–2020 average, and 21%/18% fewer compared to 1961–1990;
- The most recent decade (2012–2021) has been on average 2% wetter than 1991–2020 and 10% wetter than 1961–1990 for the UK overall;

- For the most recent decade (2012–2021), UK summers have been on average 6% wetter than 1991–2020 and 15% wetter than 1961–1990. UK winters have been 10%/26% wetter; and
- There have been fewer occurrences of max gust speeds exceeding 40/50/60 Kt for the last two decades compared to the 1980s and 1990s.

Wind Speed

The latest UKCP Fact Sheet for Wind (Met Office, 2022d), states that the global projections over the UK show an increase in near surface (10 metre [m] height) wind speeds over the UK in the second half of the 21st century, in the winter season when higher wind speeds are experienced.

This would be accompanied by an increase in frequency of winter storms over the UK. The increase is modest when compared to inter-annual variability.

There are no significant changes forecast in the wind speeds over the first part of the century.

Precipitation

UKCP18 Science Overview Report (Met Office, 2022a) states that throughout the UK, the changes to precipitation projected for 2041-2060 (compared to 1981-2000) for RCP8.5 (unmitigated scenario) are an increase of 7% in winter for the 50th percentile (results for the 10th to 90th percentile range are between -5% and +21%).

For summer precipitation, this is projected to decrease by 15% (results for the 10th to 90th percentile range are between -35% and +0%).

Temperature

UKCP18 Science Overview Report (Met Office, 2022a) states that for period 2041-2060, projected changes to annual mean temperature (compared to 1981-2000) is projected at +1.8 °C (50th percentile) for RCP8.5 (unmitigated scenario) (page 16). Results for the 10th to 90th percentile range are between +0.9°C to +2.7°C.

Other key observations from the latest UKCP Fact Sheet for Temperature (Met Office, 2022c) are that:

- Both winters and summers will be warmer, with more warming in the summer; and
- In summer there is a pronounced north/south divide with greater increases in maximum summer temperatures over the southern UK compared to Northern Scotland.

13.6 Assessment of Effects

13.6.1 Vulnerability of the Proposed Development to Climate Change

Wind Speed

Small increases in wind speed can result in large increases in wind power and beneficial effects for energy generation.

Wind turbines are designed to capture wind energy and built to withstand extreme conditions associated with exposed locations. However, wind energy developments could potentially be sensitive to changes in variables, including atmospheric circulation as well as changes in the frequency of extreme events (*e.g.*, storms), which could damage wind turbines or alter their efficiency.

Over the lifetime of the Proposed Development, UKCP18 shows the change in wind speeds and storms is limited to well within the limits of current inter-annual variability. These changes will have a low/negligible magnitude of effect on energy projections and on the efficient operation of the Proposed Development (Met Office, 2022d).

Given the low/negligible magnitude of the impact and the low sensitivity of the Proposed Development as a receptor, the significance of the potential beneficial effect is assessed as Negligible and therefore is **not significant** effect in terms of the EIA Regulations.

Precipitation

The risk from increased precipitation is the potential for flooding, particularly if it is associated with extreme events. For the Proposed Development this increases the risk for potential destruction/disruption of infrastructure, *e.g.*, flooding to control building, access tracks and other infrastructure.

Appropriate buffers from watercourses are embedded in the design of the Proposed Development. Drainage and track design will be built to accommodate a 1 in 200 year flood event or as set out by the technical experts developing the detailed drainage strategy and track design ahead of construction. As such the Proposed Development has low sensitivity to increase in precipitation.

UKCP18: Precipitation (UKCP, 2022b) shows that over the winter season precipitation in the UK is projected to increase by up to 7% at the 50th percentile. Given the embedded mitigation, the magnitude of effect on the operation of the Proposed Development is assessed as low and the overall significance of effect is Negligible and therefore is **not significant** in terms of the EIA Regulations.

Temperature

Wind energy developments are sensitive to cold weather events and ice forming on blades, although in the UK this has rarely been an issue. With the projected trend towards warmer, wetter winters and hotter, drier summers, the predicted magnitude of effect is negligible. The significance of effect is Negligible and **not significant** in terms of the EIA Regulations.

13.6.2 Influence of the Proposed Development to Climate Change

Renewable Energy Generation

The Proposed Development will consist of two wind turbines with an indicative output of approximately 9.6MW and an indicative battery storage capacity of up to 12MW, resulting in a total capacity of 21.6MW. Based on DUKES (BEIS, 2023) average capacity factor between 2018 and 2022 an expected capacity factor of 26.4% would normally be assumed for the sites like the Proposed Development.

However, with the availability of real time wind data from the Proposed Development Site, and of energy yield assessments (EYA) of operational projects in the locality of the Proposed Development, a capacity factor of 35% is expected to be a more realistic scenario for the Proposed Development than that which is estimated by DUKES (BEIS 2023).

Based on an estimated capacity factor of 35%, the generation expected from the Proposed Development is in the region of 66,225MWh per year.

The average domestic electricity consumption per household in Scotland is approximately 3.7MWh annually (BEIS, 2022). Given that the expected generation from the Proposed Development is 66,225MWh per year, the Proposed Development is expected to generate electricity equivalent to that required to power approximately 17,898 households in Scotland annually.

This is considered to be a positive effect of Moderate significance *i.e.*, a material, but non-fundamental change of the baseline condition.

Carbon Displacement and Savings

The electricity produced from the Proposed Development is assumed to substitute energy production by entirely coal-fired generation, or a mix of fossil fuels, or the National Grid mix of energy generation.

A renewable energy development would have a maximum potential to save carbon emissions when substituting coal fired generation. However, it is not possible to define the electricity source for which the Proposed Development would substitute generation, due to uncertainty in future grid mix and energy policy.

For this reason, carbon emission savings are calculated by the Scottish Government Calculator for each fuel-mix. The potential annual carbon emission savings for the Proposed Development are provided in Table 13-3.

It is shown in Table 13-3 that a grid mix of electricity generation available as a result of the Proposed Development is expected to result in a CO_2 emission saving over time of 6,093 tonnes CO_2 equivalent.

As noted above, the Carbon Calculator is limited to considering displacement of energy generation exported to the electricity grid and although carbon intensive energy for heat and transport will be increasingly decarbonised by electrification and therefore effectively displaced by green electricity, the tool does not take account of this in calculating emission savings.

Over the 30-year lifetime of the development as the electrification of the economy continues, the overall displacement of carbon intensive energy by the Proposed Development would be expected to be higher than this.

This is considered to be a positive effect of Moderate significance *i.e.*, a material, but non-fundamental change, alteration of the baseline condition.

Table 13-3: CO^2 Emission Saving over (tonnes CO_2 eq.) due to the Proposed Development

	Expected	Minimum	Maximum
Coal Fired electricity Generation	27,815	25,033	30,596
Grid mix of electricity generation	6,093	5,483	6,702

	Expected	Minimum	Maximum
Fossil fuel mix of electricity generation	12,480	11,232	13,728
Energy output from windfarm over lifetime (30 years) (MWh)	883,008	794,707	971,309

Carbon Emissions

The manufacturing, construction and installation of the wind turbines and associated infrastructure has a carbon cost, and carbon emissions are also generated by the requirement for extra capacity to back up wind power generation.

Carbon emissions are also associated with the loss of soil organic matter that occurs through disturbance and excavation of peat during construction and drainage. Carbon emissions as a result of the Proposed Development may also be associated with felling of existing forestry however, as discussed in Section 13.4 of this Chapter, no felling is anticipated to take place.

The Carbon Calculator does not allow for all the reinstated peat to be accounted for. This results in all excavated peat being treated as if it was lost. Therefore, the estimates of carbon emissions are conservative, higher than is likely to be the case in practice (Table 13-4).

This is considered to be an adverse effect of Minor significance *i.e.*, a slight, detectable, alteration of the baseline condition.

Table 13-4: Total CO_2 emissions due to the Proposed Development (tCO_2 eq.)

	Expected	Minimum	Maximum
Emissions due to turbine life (e.g., manufacture, construction, decommissioning)	8,240	8,240	8,240
Emissions due to backup	5,349	5,349	5,349
Emissions due to reduced carbon fixing potential	264	70	1,518
Emissions from soil organic matter	-308	-1,123	1,630
Emissions due to DOC & POC leaching	1	0	22
Emissions due to felling forestry	0	0	0
Total CO2 emissions due to wind farm (tCO_2 eq.)	13,546	12,536	16,759

Avoided Carbon Emissions due to Improvement of the Proposed Development Site

Table 13-5 shows the estimated carbon gains over the lifetime of the Proposed Development from improvements to the Proposed Development Site.

Borrow pits do not form part of the Proposed Development therefore there are currently no proposals to undertake borrow pit restoration.

The avoided emissions shown in Table 13-5 are negative numbers because they are atmospheric removals or avoided emissions. It should be noted that the Carbon Calculator is conservative in relation to estimating the gains from restoration, only accounting for changes in the balance of methane to carbon dioxide emissions from the restoration of degraded bogs.

This is considered to be a positive effect of Moderate significance *i.e.*, a material, but non-fundamental change, alteration of the baseline condition.

Table 13-5: Total CO_2 changes in emissions due to the Proposed Development (tCO_2 eq.)

	Expected	Minimum	Maximum
Change in emissions due to improvement of degraded bogs	0	0	0
Change in emissions due to improvement of felled forestry	0	0	0
Change in emissions due to restoration of peat from borrow pits	0	0	0
Change in emissions due to removal of drainage from foundations & hardstanding	-80	0	-604
Total change in emissions due to improvements (tCO_2 eq.)	-80	0	-604

Potential effects on peat are considered further in Chapter 8: Hydrology and Hydrogeology.

Payback Period

The payback period is calculated by taking the total carbon cost (carbon emissions) associated with the Proposed Development and dividing that figure by the annual carbon gains from displaced fossil fuel power generation and any site improvements. The shorter the payback period the greater benefit the Proposed Development will have in displacing GHG emissions associated with electricity generated by burning fossil fuels.

When taking into consideration the potential renewable energy generation, displacement and savings of carbon and carbon emissions, the Proposed Development is expected, conservatively, to payback the carbon cost in 2.2 years compared to grid mix electricity generation[1] (Table 13-6).

There are no current guidelines on what payback time would be considered a significant effect, however a payback period of 2.2 years represents 7.3% of the total operational life of the Proposed Development.

As noted above, the Carbon Calculator is limited to considering displacement of energy generation exported to the electricity grid and although carbon intensive energy for heat and transport will be increasingly decarbonised by electrification and therefore effectively displaced by green electricity, the tool does not take account of this in calculating the payback period.

Over the 30 year lifetime of the Proposed Development, as the electrification of the economy continues, the overall displacement of carbon intensive energy by the

[1] The annual average mix of fuels used to produce electricity for the (GB) electricity grid (including nuclear and renewables). The source for the grid-mix emission factor is the list of emission factors used to report on greenhouse gas emissions by UK organisations published by BEIS https://www.gov.uk/government/publications/greenhouse-gas-reporting-conversion-factors-2022

Proposed Development would be expected to be higher than predicted in the model and therefore the payback time is expected to be shorter than indicated by the results shown in Table 13-6.

As such, conservatively, it is expected that the Proposed Development would make a positive contribution to offsetting carbon emissions after a maximum of 3.1 years at which time it is estimated to be carbon neutral.

This is considered to be a positive effect of Moderate significance *i.e.*, a material, but non-fundamental, alteration of the baseline condition.

Table 13-6: Carbon Payback Time of the Proposed Development

	Expected	Minimum	Maximum
Coal-fired electricity generation (years)	0.5	0.4	0.7
Grid-mix of electricity generation (years)	2.2	1.8	3.1
Fossil fuel-mix of electricity generation (years)	1.1	0.9	1.5

Carbon Intensity

The Scottish Government's Climate Change Plan (2018) states that by 2030 Scotland will have a largely decarbonised electricity system with a grid carbon intensity of 50g CO_2/kWh of generation (0.05kg CO_2/kWh).

An update to the Climate Change Plan was issued in 2020 through the Securing a Green Recovery on a Path to Net Zero: Climate Change Plan 2018–2032 – Update. The update confirmed that the carbon intensity of electricity generated in Scotland has fallen to less than 50g CO_2/kWh in both 2018 and 2019.

The Proposed Development is expected to have a carbon intensity of 15.25g CO_2/kWh (Table 13-7). This is below achieved carbon intensity target. Therefore, the Proposed Development is anticipated to further support Scotland's Climate Change Plan by maintaining and succeeding the target already achieved.

This is considered to be a positive effect of Moderate significance i.e., a material, but non-fundamental, alteration of the baseline condition.

Table 13-7: Carbon Intensity of the Proposed Development (g CO_2/kWh)

	Expected	Minimum	Maximum
Carbon Intensity (gCO_2e/kWh)	15.25	12.29	21.09

Summary

Climate and the atmosphere is considered to have High sensitivity to changes in GHG emissions. The Proposed Development is therefore assessed to have an overall Moderate, beneficial effect on climate change, that is **significant** under the EIA Regulations.

The Proposed Development will, therefore, make a material contribution to reducing Scotland's CO_2 emissions, contribute directly to efforts to reduce the extent and rate of global climate change while also generating economic and social benefits as detailed in Chapter 12 Socio-economics, tourism and recreation.

13.7 Assessment of Cumulative Effects

The Proposed Development will contribute up to 9.6 MW further installed renewable generation capacity through the installation of two wind turbines.

The cumulative effect of the Proposed Development with other Scotland and UK renewable generation is considered to be a material change in the climate effects of Scotland and UK energy supply, which is a major, positive, environmental effect that is **significant** under the EIA Regulations.

13.8 Mitigation and Residual effects

This Chapter has identified that negative effects are of such limited and negligible nature that they are not significant and therefore no mitigation is required under the EIA Regulations other than that already incorporated into the Proposed Development and recommended as best practice.

An iterative design approach was taken for the wind farm layout to avoid siting infrastructure in peat where possible to minimise disturbance of peat soils and associated carbon losses. Further micro-siting will be informed by detailed pre-construction ground investigations.

There are potentially Moderate beneficial effects in relation to the development, construction and operation phases of the Proposed Development on carbon saving.

13.9 Summary and Statement of Significance

The assessment of the vulnerability of the Proposed Development to Climate Change was considered to be negligible (positive) for projected changes to wind speed, and negligible for changes to temperature and precipitation.

The vulnerability of the Proposed Development to Climate Change was therefore **not significant** under the EIA Regulations.

A carbon balance assessment has been undertaken using the Scottish Government Calculator v1.8.1 (reference is KC8T-U38N-WFSA v1). This found that there is a Moderate (beneficial) influence of the Proposed Development to Climate Change and national and international targets to combat climate change.

The influence of the Proposed Development to Climate Change was therefore **significant** (positive) under the EIA Regulations.

Table 13-8: Summary and Statement of Significance

Receptor	Potential Effect	Assessed Effect	Statement of Significance
Vulnerability of Proposed Development to Climate Change			
The Proposed Development	Changes to generation through changes in wind speed.	Negligible (Positive)	Not Significant
The Proposed Development	Damage to infrastructure or operation due to changes in temperature.	Negligible	Not Significant
The Proposed Development	Potential for flooding at the Proposed	Negligible	Not Significant

Receptor	Potential Effect	Assessed Effect	Statement of Significance
	Development Site and impact on operation through changes to precipitation.		
Influence of the Proposed Development on Climate Change			
Climate and Atmosphere	Reduction in GHG emissions through offsetting of existing conventional generation.	Moderate	Significant (Positive)

13.10 References

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