Environmental Impact Assessment Report

Lairdmannoch Energy Park

Chapter 13: Climate Change and Carbon Balance

Lairdmannoch Energy Park Limited

May 2025

Contents

Contents

Tables

Appendices

Glossary of Terms

Term	Definition
The Applicant	Lairdmannoch Energy Park Limited
The Agent	Atmos Consulting Limited
Environmental Advisors and Planning Consultants	Atmos Consulting Limited
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	Lairdmannoch Energy Park
The Proposed Development Site	The full application boundary as per Figure 1-1
Solar Development	The area of the Proposed Development that contains the Solar Arrays and associated infrastructure. As shown on Maps 7, 8 and 9 of Figure 3-1.
Wind Development	The area of the Proposed Development that contains the Wind Turbines and associated infrastructure. As shown on Maps 1, 2 and 4 of Figure 3-1.

List of Abbreviations

Abbreviation	Description
CO_2/kWh	Carbon dioxide per Kilowatt hour
EIA	Environmental Impact Assessment
EIAR	Environmental Impact Assessment Report
gCO_2e/kWh	Grams of Carbon dioxide Equivalent per Kilowatt hour
GHG	Greenhouse Gas
NPF4	National Planning Framework 4
PMP	Peat Management Plan
RCP	Representative Concentration Pathways
SC	Stirling Council
SEPA	Scottish Environment Protection Agency
tCO_2 eq.	Total Carbon dioxide Equivalent
Tonnes CO_2 eq.	Tonnes of Carbon dioxide Equivalent

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 estimates 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.

The Scottish Government's Online Carbon Calculator is an online tool 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 of the Proposed Development.

The Scottish Government's Online Carbon Calculator is currently unavailable with no current timeframe for it being back online. This was confirmed in correspondence between Wind 2 Limited and the Energy Consents Unit (ECU) during an email exchange dated 11th April 2025. In the absence of the Carbon Calculator being available, the ECU has provided a replica spreadsheet (noting that the spreadsheet does not replicate the results of the online tool because of differences relating to the precision of constants). Given the current circumstances, the ECU note that the spreadsheet may be used by developers in lieu of the online tool to present the payback period of a proposed wind farm development.

This Chapter has been completed by Atmos and is supported by **Technical Appendix 13-1: Carbon Calculator Inputs** in **Volume 3** of this EIA Report.

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 the Scottish Government Carbon Calculator.

13.2 Legislation, Planning Policy and Guidance

The relevant planning policy at a national and local level and its application to the environmental design and assessment of the Proposed Development is discussed in **Chapter 4 (Planning and Energy Policy)** in **Volume 2** this EIAR.

The key planning legislation, 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);

- COP28 - Long-term climate finance (UNFCC, 2023);
- 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);
- Progress in reducing UK emissions - 2023 Report to Parliament (CCC, 2023);
- Calculating potential carbon losses and savings from wind farms on Scottish peatlands Technical Note (Scottish Government 2018);
- Windfarm Carbon Calculator Web Tool User Guidance (SEPA, undated); and
- UKCP18 Guidance: Representative Concentration Pathways (Met Office, 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.

In June 2019 Dumfries and Galloway (D&GC) also declared a climate emergency and subsequently incorporated this into all future policies in line with their Council Plan for 2023 to 2028.

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 aimed to enhance Scotland's climate change targets for reducing emission levels. Specifically, the 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, with the Scottish Government setting out its ambition for 20GW of installed onshore wind capacity in the country by 2030.

On 18 April 2024, the Scottish Government (2024) announced that whilst the interim climate change target to reduce emissions by 75% by 2030 was "*out of reach*" and would be removed, the overarching commitment to reach Net Zero by 2045 would remain. NPF4 Policy 1 'Tackling the climate and nature crises', states the approach to development proposals:

"When considering all development proposals significant weight will be given to the global climate and nature crises".

13.3 Methodology and Approach

13.3.1 Consultation

No direct commentary on climate change or carbon balance was made as part of the Pre-Application Advice (received April 2021) or Scoping Opinion (received January 2024).

Within the Scoping Opinion SEPA stated:

"We do not validate carbon balance assessments except in exceptional circumstances where requested by Scottish Government. Our advice on minimising peat disturbance and peatland restoration may need to be taken into account when you consider such assessments."

In addition to this, the Scoping Response from Save Mochrum Fell Group requested:

"There should be a full carbon balance calculation to include all the mining of materials necessary for the wind farm in all countries; the processing and manufacturing of components, international shipping and transportation as well as all the construction in this country including processing for cement production." And "The carbon balance should also include the CO2 emissions from backup generation needed when there is no wind".

Within Their Scoping Response SEPA requests ""*demonstrate how the layout has been designed to minimise disturbance of peat and consequential release of CO2" and "The submission must also include a detailed map of peat depths with all the built elements and excavation areas overlain so it can clearly be seen how the development minimises disturbance of peat and the consequential release of CO2"*

These have been considered as part of the EIA and reported in this chapter and in **Chapter 8: Hydrology, Geology and Hydrogeology** in **Volume 2** of this EIA Report, **Technical Appendix 8-2: Peat Landslide Hazard Risk Assessment (PLHRA) and Technical Appendix 8-3: Peat Management Plan (PMP)** in **Volume 3** of this EIA Report where relevant.

13.3.2 Assessment Methodology and Significance Criteria

Scope of the Assessment

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

- The vulnerability of the Proposed Development to climate change; and
- The influence of the Proposed 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, as climate change is recognised to be directly linked to these emissions. No specific analysis is undertaken of how climate conditions might change in direct response to the emissions balance of the Proposed Development.

Consideration of the effects of the Proposed Development on environmental receptors that may in themselves be sensitive to climate change are considered in **Chapters 5 to 14** in **Volume 2** of this EIA Report where relevant.

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, changes over the operational lifetime of the Proposed Development (40 years from commissioning) are considered.

Spatially, 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, at the National Scottish scale. Temporal scope, again, reflects the operational lifetime of the Proposed Development.

Future Baseline Methodology

The UK Climate Projections (UKCP18) is a set of tools and published data, which predicts how the UK climate may change in the future (Met Office, 2018).

UKCP18 uses scenarios for future greenhouse gas emissions called Representative Concentration Pathways (RCPs). 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 socio-economic development and commitment to emissions reductions.

Over the 40-year anticipated lifetime of the Proposed Development, the choice of scenario is not critical, thus, the medium emissions scenario (RCP6.0) is considered most appropriate for use as the future baseline. This scenario assumes after 2030, no further emission reductions are achieved whilst allowing for some further increase in emissions (Met Office 2018).

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 are, therefore, scoped out of further consideration.

Influence of the Proposed Development on Climate Change Methodology

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, a spreadsheet version of the Scottish Government's Carbon Calculator v2.14.1 was used to calculate the carbon cost and payback period of the Proposed Development.

The Scottish Government's Online Carbon Calculator is currently unavailable with no current timeframe for it being back online. In the absence of the Carbon Calculator being available, the Energy Consents Unit (ECU) has provided a replica spreadsheet (noting that the spreadsheet does not replicate the results of the online tool because of differences relating to the precision of constants). However, given the current circumstances, the ECU note that the spreadsheet may be used by developers in lieu of the online tool to present the payback period of their proposed wind farm development.

Developed and refined based on published research (Nayak *et al*., 2008; Nyak *et al*., 2010; Smith *et al*., 2011), the calculator is a highly effective tool, which determines the balance of total carbon savings and costs over the life of the Proposed Development.

The potential carbon savings and costs associated with wind farms, solar developments and BESS 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. 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, solar PV Panels, and BESS systems in addition to construction;
- Loss and/or saving 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, i.e., 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 'payback period' and the 'carbon intensity' of the Proposed Development. The payback period is the length of time (in years) it will take the Proposed Development to offset the carbon 'costs' incurred as a result of its construction, and begin displacing grid-based electricity generated from non-renewable sources. 'Carbon intensity' is a measure of how many units of CO2 are released to produce a unit of electricity.

Where practicable, site-specific data (such as peat depths and length of tracks as detailed in **Chapter 3: Description of Development** in **Volume 2** of this EIA Report and

Chapter 8: Hydrology, Geology and Hydrogeology in **Volume 2** of this EIA Report), 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. In these instances, 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** in **Volume 3** of this EIA Report.

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** in **Volume 2** of this EIA Report, **Table 2-2**) of the receptor, and the magnitude of the impact (Table 2-3), taking into account uncertainty. This is based on the professional judgement of the assessor (see Table 13-1).

Table 13-1: 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, 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.

13.4 Baseline

Chapter 8: Hydrology, Geology and Hydrogeology in **Volume 2** of this EIA Report and its supporting technical appendices set 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.

In general terms, it is widely acknowledged that peatlands sequester and store carbon, and the amount sequestered by peat bog varies depending on its condition.

In terms of the site-specific baseline for determining the vulnerability of the Proposed Development to climate change a future baseline has been considered based on the maximum predicted lifetime of the Proposed Development.

Climate projections show that the trends over the 21st century in the UK are towards warmer, 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 (2014-2023). Key findings are:

- The most recent decade (2014–2023) has been on average 0.42°C warmer than the 1991–2020 average and 1.25°C warmer than 1961–1990;
- The most recent decade (2014–2023) has had almost a week fewer air frosts per year than the 1991–2020 average, and over a fortnight fewer than 1961–1990;
- The most recent decade (2014 – 2023) has had over a week fewer ground frosts per year than the 1991 – 2020 average and almost a month fewer than 1961 – 1990;
- The most recent decade (2014–2023) has been on average 2% wetter than 1991–2020 and 10% wetter than 1961–1990;
- For the most recent decade (2014–2023), UK winters have been 9% wetter than 1991-2020 and 24% wetter than 1961-1990, with smaller increases in summer and autumn and none in spring;
- 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 UKCP18 Fact Sheet for Wind (Met Office, 2022d), states that global projections 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, change 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 UKCP18 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. The Proposed Development Site being closer to Northern Scotland than

Southern England would therefore be expected to experience lesser increases in maximum summer temperatures but relatively more than the northern most extents of Scotland.

13.5 Assessment of Effects

13.5.1 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).

The magnitude of effect on the operation of the Proposed Development is assessed as low, and the overall significance of effect is Negligible. The effect is therefore **Not Significant** 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 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. The effect is therefore **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.

Solar PV efficiency drops by 0.5% with an increase to temperature for every 1°C (Patt, 2023), the UK is likely to experience warmer wetter winters and drier hotter summers (UKCP, 2022c). The magnitude of effect on efficiency due to temperature change is assessed to be low.

The significance of effect is Negligible and **Not Significant** in terms of the EIA Regulations.

13.5.2 Influence of the Proposed Development on Climate Change

Renewable Energy Generation

The Proposed Development will consist of nine wind turbines with a total rated output of approximately 60MW, and solar PV panels with a total rated output of approximately 20MW, for a total generation capacity of 80MW. The average capacity factor from 2018 to 2023 for onshore wind is 26.2% and for solar is 10.5% based on DUKES 6.3 (BEIS, 2024).

To calculate the energy generation of the Proposed Development the above capacity factors have been used in the following equation:

$$\text{Annual Generation} = MW \text{ x } Capacity\ Factor \text{ x } Hours\ per\ Year$$

Wind Development

The Wind Development aspect of the Proposed Development has a generating capacity of 60MW, with an average capacity factor of 26.2% (BEIS, 2024), and there being 8,760 hours in a common year, the equation is the following:

$$\text{Annual Generation} = 60 \text{ x } 0.262 \text{ x } 8760$$

As a result the estimated average electricity generation of the Wind Development for an entire year is 137,707.2 MWh

Solar Development

The Solar Development aspect of the Proposed Development has a generating capacity of 20MW, with an average capacity factor of 10.5% (BEIS, 2024).

As the Solar Development will only generate electricity during daylight hours, the average site-specific daylight hours on the Proposed Development Site during 2024 was 12 hours 17 minutes per day (Time&Date, 2025). As such the number of hours of generation in a common year for an average day length of 12 hours 17 minutes is 4,482.2 hours. Therefore the equation is the following:

$$\text{Annual Generation} = 20 \text{ x } 0.105 \text{ x } 4482.2$$

As a result the estimated average electricity generation of the Solar Development over an entire year is 9,412.62 MWh.

Households Powered

The Proposed Development on a common year will produce an estimated average 147,119.82 MWh from both the Wind Development and Solar Development combined.

The average domestic electricity consumption per household in Scotland is approximately 3.7MWh annually (BEIS, 2022). Given that the estimated average generation from the Proposed Development is 147,119.82 MWh per year, the Proposed Development is therefore estimated to generate electricity equivalent to that required to power an average of 39,762 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 completed Carbon Calculator can be found in **Technical Appendix 13-1**.

The Carbon Calculator only considers the wind element of the Proposed Development within its calculations, as such the below tables only consider the Wind Development. However, the beneficial and adverse effects of the Solar Development and BESS are discussed below.

The electricity produced from the Proposed Development is assumed to substitute energy production from fossil-fuel powered energy generation within the wider mixed source grid.

A renewable energy development would have maximum potential to save carbon emissions when substituting coal fired generation. However, due to uncertainty in future grid mix and energy policy, it is not possible to define the electricity source for which the Proposed Development would substitute generation. Additionally, the current grid-mix of the United Kingdom is a mixture of renewables, nuclear, and natural gas, so comparing the Proposed Development to offsetting coal fired generation only is not comparable to the current actual UK grid-mix (UK Government, 2024).

For this reason, carbon emission savings are calculated by the Scottish Government Calculator for each fuel-mix. The potential annual carbon emission savings due to wind for the Proposed Development are provided in **Table 13-2.**

It is shown in **Table 13-2** that displacement of a grid mix of electricity generation due to the Proposed Development is expected to result in a CO_2 emission saving over time of 54,259 tonnes CO_2 equivalent from the wind element when compared to a mixed grid comprising both renewable and fossil fuel sources.

The inclusion of the solar and BESS will increase emissions displacement due to less reliance on fossil fuel electricity generation therefore having a positive effect, however these are not accounted for in the below table due to input limitations of the Carbon Calculator.

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

	Expected	Minimum	Maximum
Coal Fired electricity Generation	12,807	11,527	14,088
Grid mix of electricity generation	**54,259**	48,833	59,685
Fossil fuel mix of electricity generation	88,412	79,571	97,254
Energy output from windfarm over lifetime (40 years) (MWh)	5,508,563	4,957,707	6,059,420

As noted above, the Carbon Calculator is limited to considering displacement of energy generation exported to the electricity grid; 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.

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

Carbon Releases

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

Carbon releases are also associated with the loss of soil organic matter that occurs through disturbance and excavation of peat during construction and drainage.

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

Whilst the Solar and BESS elements of the Proposed Development are not included in the calculations below, all soil related emissions have been accounted for permanent infrastructure on the Proposed Development Site, including the Solar and BESS elements of the Proposed Development.

As such the carbon calculator should be considered a conservative assessment, as the carbon emissions as a result of constructing the Solar Development, BESS and all associated infrastructure have been included into the calculation, however the electricity generation and therefore carbon offsetting of the Solar Development and BESS have not been included in the calculations due to input limitations.

Table 13-3: 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)	51,856	51,856	51,856
Emissions due to backup	67,490	67,490	67,490
Emissions due to reduced carbon fixing potential	2,405	668	13,131
Emissions from soil organic matter**	-1,941	-8,704	11,044
Emissions due to DOC & POC leaching	110	0	817
Emissions due to felling forestry*	0	0	0

	Expected	Minimum	Maximum
Total CO2 emissions due to wind farm (tCO_2 eq.)	119,921	111,311	144,338

* Localised felling is expected on parts of the access track, the exact hectarage currently cannot be accurately calculated and has therefore been excluded from the CO_2 emission calculations, however the forestry felling is unlikely to change the overall significance of the assessment due to the minor extent of the felling when compared to the overall CO_2 emissions from all other aspects of the Proposed Development in Table 13-3.

**Negative values show carbon fixing potential (offsetting) and have been subtracted from the total emissions value, included in this table for completeness.

Avoided Carbon Releases due to Improvement of the Proposed Development Site

Table 13-4 shows the estimated avoided carbon emissions, over the lifetime of the Proposed Development, from improvements to the Proposed Development Site.

Peat reinstatement of the borrow pit will be undertaken during decommissioning. This will be dependent upon water table levels and borrow pit design and will be refined through further assessment prior to construction.

Due to this, it is assumed for the purpose of the carbon calculator that there will be no change in the water table depth and therefore no "gain" (in terms of the carbon calculator terminology) considered.

The total carbon gains are shown in **Table 13-4.** The values are negative numbers because they are atmospheric removals or avoided emissions. It should be noted that the Carbon Calculator is conservative about 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.

Permanent foundations, including those for BESS and solar have been included within the following.

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

	Expected	Minimum	Maximum
Change in emissions due to improvement of degraded bogs	-10,390	0	-28,493
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	-3,124	0	-28,966
Total change in emissions due to improvements (tCO_2 eq.)	-13,514	0	-57,459

Potential effects on peat are considered further in **Chapter 8: Hydrology, Geology and Hydrogeology** in **Volume 2** of this EIA Report.

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 losses, the Proposed Development is expected, conservatively, to payback the carbon cost in 2 years when compared to a mixed grid comprising both renewable and fossil fuel source as shown in **Table 13-5**.

There are no current guidelines on what payback time would be considered a significant effect, but this represents 5% of the operational life of the Proposed Development.

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

Table 13-5: Carbon Payback Time of the Proposed Development

	Expected	Minimum	Maximum
Grid-mix of electricity generation (years)	**2**	0.9	3
Fossil fuel-mix of electricity generation (years)	1.2	0.6	1.8

Further detail on the above information can be found in **Technical Appendix 13-1 Carbon Calculator**.

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 0.05kg CO_2e/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. (Scottish Government , 2022a) The update confirmed that the carbon intensity of electricity generated in Scotland has fallen to less than 50g CO_2e/kWh in both 2018 and 2019.

The Wind Development aspect of the Proposed Development is expected to have a carbon intensity of 19g CO_2e/kWh as shown in **Table 13-6** and **Technical Appendix 13-1**, a figure below the achieved carbon intensity target. Therefore, the Proposed Development is anticipated to further support Scotland's Climate Change Plan by maintaining and exceeding the target already achieved.

The Solar Development adds low carbon electricity to the grid, helping decarbonise the grid and lower the carbon intensity. The BESS element can release energy when generation from other renewables drops allowing the grid to rely less on carbon-intensive backup power sources,

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 Intensity of the Proposed Development (g CO_2e/kWh)

	Expected	Minimum	Maximum
Carbon Intensity (gCO_2e/kWh)	16	7	24

Summary

Climate and the atmosphere are 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, which is a **Significant** positive effect under the EIA Regulations.

The Proposed Development will, therefore, make a material contribution to reducing Scotland's CO_2 emissions, and contribute directly to efforts to reduce the extent and rate of global climate change, while also generating economic and social benefits.

13.6 Assessment of Cumulative Effects

The Proposed Development will contribute up to 100 MW further installed renewable generation capacity through the installation of 9 wind turbines, Solar PV and BESS, noting that the generation output from the wind and Solar is 80MW.

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.

13.7 Mitigation and Residual Effects

This Chapter identified that negative effects are of such limited and negligible nature that they are not significant and 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 Proposed Development layout to avoid siting infrastructure on peat where possible, thus minimising disturbance of peat soils and associated carbon releases. Further micro-siting to reduce the impact on peat will be informed by detailed pre-construction ground investigations.

Additionally, **Chapter 3: Description of Development** in **Volume 2** of this EIA Report proposes reinstatement and demonstrates that arrangements will be refined through further assessment prior to construction.

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

13.8 Summary and Statement of Significance

The assessment of the vulnerability of the Proposed Development to Climate Change was considered to be negligible for projected changes to wind speed, 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 v2.14.1. This found that there is a Moderate (beneficial) influence of the Proposed Development on Climate Change and national and international targets to combat climate change.

The influence of the Proposed Development on Climate Change was therefore **Significant** (Beneficial) under the EIA Regulations.

Table 13-7: 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	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 Development Site and impact on operation through changes to precipitation.	Negligible	Not Significant
Influence of the Proposed Development on Climate Change			
Climate and Atmosphere	Reduction in GHG emissions through offsetting of existing conventional generation.	Moderate	Significant (Beneficial)
Climate and Atmosphere (Cumulatively with other renewable developments)	Reduction in GHG emissions through offsetting of existing conventional generation.	Major	Significant (Beneficial)

13.9 References

BEIS (2021). Subnational electricity consumption, Great Britain, 2005 - 2020. [Online]. Available at: https://www.gov.uk/government/statistical-data-sets/regional-and-local-authority-electricity-consumption-statistics [Accessed 09/04/2025]

BEIS (2022). Digest of United Kingdom Energy Statistics (DUKES) 2021. Subnational electricity consumption, Great Britain, 2005 – 2021. [Online]. Available at: https://www.gov.uk/government/statistics/regional-and-local-authority-electricity-consumption-statistics [Accessed 09/04/2025]

BEIS (2024). Digest of UK Energy Statistics (DUKES). Load Factors for Renewable Energy Generation (DUKES 6.3). Available at: https://www.gov.uk/government/statistics/renewable-sources-of-energy-chapter-6-digest-of-united-kingdom-energy-statistics-dukes [Accessed 20/04/2025]

Climate Change Committee (CCC) (2019). Net Zero - The UK's Contribution to Stopping Global Warming, May 2019. [Online]. Available at: https://www.theccc.org.uk/wp-content/uploads/2019/05/Net-Zero-The-UKs-contribution-to-stopping-global-warming.pdf . [Accessed 09/04/2025]

Climate Change Committee (CCC) (2023). Progress in reducing UK emissions 2023 Report to Parliament. [Online]. Available at: https://www.theccc.org.uk/publication/2023-progress-report-to-parliament/ [Accessed 09/04/2025]

Climate Change Committee (CCC). (2020). The Sixth Carbon Budget. [Online]. Available at: https://www.theccc.org.uk/publication/sixth-carbon-budget/ [Accessed 09/04/2025]

Climate Change Committee (CCC). (2021). Progress Report to Parliament. [Online] Available at: https://www.theccc.org.uk/publication/2021-progress-report-to-parliament/ [Accessed 09/04/2025]

European Parliament and Council of the European Union (2014) (EC) EIA Directive 2014/52/EU1 [Online]. Available at https://www.legislation.gov.uk/eudr/2014/52/2020-01-31 [Accessed 09/04/2025]

Met Office (2018) UKCP18 Guidance: Representative Concentration Pathways. [Online] Available: https://www.metoffice.gov.uk/binaries/content/assets/metofficegovuk/pdf/research/ukcp/ukcp18-guidance---representative-concentration-pathways.pdf [Accessed 09/04/2025]

Met Office (2022a) UKCP18 Science Overview Report. [Online]. Available at: https://www.metoffice.gov.uk/pub/data/weather/uk/ukcp18/science-reports/UKCP18-Overview-report.pdf [Accessed 09/05/2025]

Met Office (2022b) UKCP18 Fact Sheet: Precipitation. [Online]. Available at: https://www.metoffice.gov.uk/research/approach/collaboration/ukcp/data/factsheets [Accessed 09/04/2025]

Met Office (2022c) UKCP18 Fact Sheet: Temperature. [Online]. Available at: https://www.metoffice.gov.uk/binaries/content/assets/metofficegovuk/pdf/research/ukcp/ukcp18-fact-sheet-temperature.pdf [Accessed 22/05/2025]

Met Office (2022d) UKCP18 Fact Sheet: Wind. [Online]. Available at: https://www.metoffice.gov.uk/research/approach/collaboration/ukcp/data/factsheets [Accessed 09/04/2025]

Met Office (2023) Historical Weather Station Data – Dundrennan. [Online]. Available at: https://www.metoffice.gov.uk/research/climate/maps-and-data/location-specific-long-term-averages/gctpubd4w [Accessed 09/04/2025]

NatureScot. (2016). Carbon and Peatland 2016 map. [Online]. Available at: https://map.environment.gov.scot/Soil_maps/?layer=10 [Accessed 09/04/2025]

Nayak D.R., Miller D., Nolan A., Smith P., Smith J.U. (2010). Calculating carbon budgets of wind farms on Scottish peatlands. Mires and Peat 4(09), 1-23. Available at: https://www.researchgate.net/publication/228488008_Calculating_carbon_budgets_of_wind_farms_on_Scottish_peatlands [Accessed 09/04/2025]

Nayak et al. (2008). Calculating carbon savings from wind farms on Scottish peat lands – a new approach, The Scottish Government {Online} Available at: https://www.gov.scot/publications/calculating-carbon-savings-wind-farms-scottish-peat-lands-new-approach/pages/13/ [Accessed 09/04/2025]

Patt, A., Pfenninger, S., Lilliestam, J. (2013): Vulnerability of solar energy infrastructure and output to climate change.

Renewables UK (2021) The onshore wind industry prospectus. [Online]. Available at: https://www.renewableuk.com/media/c55ckdrg/onshore-wind-industry-prospectus_2021.pdf [Accessed 09/04/2025]

RMetS (2024). State of the UK Climate 2023. International Journal of Climatology. [Online]Available at https://www.metoffice.gov.uk/research/climate/maps-and-data/about/state-of-climate. [Accessed 09/04/2025]

Scottish Government (2014) Onshore wind turbines: planning advice. [Online]. Available at: https://www.gov.scot/publications/onshore-wind-turbines-planning-advice/ [Accessed 09/04/2025]

Scottish Government (2017) Onshore wind: policy statement. [Online]. Available at: https://www.gov.scot/publications/onshore-wind-policy-statement-9781788515283/ [Accessed 09/04/2025]

Scottish Government (2017) The future of energy in Scotland: Scottish energy strategy. [Online]. Available at: https://www.gov.scot/publications/scottish-energy-strategy-future-energy-scotland-9781788515276/ [Accessed 09/04/2025]

Scottish Government (2018) Calculation potential carbon losses and savings from wind farms on Scottish peatlands. Technical Note – Version 2.10.0. Available at: https://www.gov.scot/binaries/content/documents/govscot/publications/advice-and-guidance/2018/12/carbon-calculator-technical-guidance/documents/calculating-potential-carbon-losses-and-savings-from-wind-farms-on-scottish-peatlands-technical-guidance/calculating-potential-carbon-losses-and-savings-from-wind-farms-on-scottish-peatlands-technical- [Accessed 16/04/2025]

Scottish Government (2018a). Climate Change Plan. The Third Report on Proposals and Policies 2018-2032. Available at: https://www.gov.scot/publications/scottish-governments-climate-change-plan-third-report-proposals-policies-2018-9781788516488/ [Accessed 09/04/2025]

Scottish Government (2019a). The Global Climate Emergency - Scotland's Response: Climate Change Secretary Roseanna Cunningham's statement. Available at: https://www.gov.scot/publications/global-climate-emergency-scotlands-response-climate-change-secretary-roseanna-cunninghams-statement/ [Accessed 09/04/2025]

Scottish Government (2019b) Climate Change Emission reduction (Scotland) Act. [Online]. Available at: https://www.legislation.gov.uk/asp/2019/15/2020-03-23?view=extent [Accessed 09/04/2025]

Scottish Government (2020a) Securing a green recovery on a path to net zero: climate change plan 2018–2032 – update. [Online]. Available at: https://www.gov.scot/publications/securing-green-recovery-path-net-zero-update-climate-change-plan-20182032/ [Accessed 09/04/2025]

Scottish Government (2020b) Towards a Robust, Resilient Wellbeing Economy for Scotland, a report of the Advisory Group on Economic Recovery. [Online]. Available at: https://www.gov.scot/publications/towards-robust-resilient-wellbeing-economy-scotland-report-written-submissions-advisory-group-economic-recovery/ [Accessed 09/04/2025]

Scottish Government (2021) Agriculture, Environment and Marine: Scottish Greenhouse Gas Statistics 2021. Available at: https://www.gov.scot/binaries/content/documents/govscot/publications/statistics/2023/06/scottish-greenhouse-gas-statistics-2021/documents/scottish-greenhouse-gas-statistics-2021/scottish-greenhouse-gas-statistics-2021/govscot%3Adocument/scottish-greenhouse-gas-statistics-2021.pdf [Accessed 09/04/2025]

Scottish Government (2021a) Energy strategy: position statement. [Online]. Available at: https://www.gov.scot/publications/scotlands-energy-strategy-position-statement/ [Accessed 09/04/2025]

Scottish Government (2021b). Scottish Government Response to Scotland's Climate Assembly: Recommendations for Action. [Online]. Available at: https://www.gov.scot/publications/scottish-government-response-scotlands-climate-assembly-recommendations-action/#:~:text=The%20Scottish%20Government%20remains%20committed,bring%20Scottish%20society%20with%20us. [Accessed 09/04/2025]

Scottish Government (2022). Onshore wind policy statement 2022. [Online]. Available at: https://www.gov.scot/publications/onshore-wind-policy-statement-2022/documents/ [Accessed 09/04/2025]

Scottish Government (2023). Scottish Government Carbon Calculator Assessment Tool – Version 2.14.1. Offline version.

Scottish Government (2023a) Fourth National Planning Framework. [Online]. Available at: https://www.gov.scot/publications/national-planning-framework-4/ [Accessed 16/04/2025]

Scottish Government (2023b). Draft Energy Strategy and Just Transition Plan. [Online]. Available at: https://www.gov.scot/publications/draft-energy-strategy-transition-plan/documents/ [Accessed 09/04/2025]

Scottish Government (2024). Meeting of the Parliament Thursday April 18 2024. Available at: https://www.parliament.scot/chamber-and-committees/official-report/search-what-was-said-in-parliament/meeting-of-parliament-18-04-2024?meeting=15804&iob=134937 [Accessed 17/04/2025]

Scottish Government, various, Planning Advice Notes. [Online] Available at: https://www.gov.scot/collections/planning-advice-notes-pans/ [Accessed 09/04/2025]

SEPA. (n.d.) Windfarm Carbon Calculator Web Tool User Guidance [Online]. Available at: https://informatics.sepa.org.uk/CarbonCalculator/assets/Carbon_calculator_User_Guidance.pdf [Accessed 09/04/2025]

Smith J.U., Graves P., Nayak D.R., Smith P., Perks M., Gardiner B., Miller D., Nolan A., Morrice J., Xenakis S., Waldron S., Drew S. (2011). Carbon implications of windfarms located on peatlands – update of the Scottish Government Carbon Calculator tool. Final Report, RERAD Report CR/2010/05. Available at: https://www.researchgate.net/publication/256473182_Carbon_Implications_Of_Windfarms_Located_On_Peatlands_-_Update_Of_The_Scottish_Government_Carbon_Calculator_Tool [Accessed 09/04/2025]

Stirling Council (SC) (2021) Climate and Nature Emergency Plan 2021-2045. Available at: https://www.stirling.gov.uk/environment-pollution-and-pest-control/climate-action-and-sustainability/climate-action-and-sustainability-documents/climate-and-nature-emergency-plan/ [Accessed 09/04/2025]

Time&Date (2025). 54°56'17.9"N, 4°05'22.4"W — Sunrise, Sunset, and Daylength 2024. Available at: https://www.timeanddate.com/sun/@54.93831,-4.08956?month=1&year=2024 [Accessed 20/04/2025]

UK Government (1989) The Electricity Act 1989 (with amendments), Section 36. Available at: https://www.legislation.gov.uk/ukpga/1989/29/section/36 [Accessed : 09/04/2025].

UK Government (1997) Town and Country Planning (Scotland) Act 1997 (as amended) [Online}. Available at: https://www.legislation.gov.uk/ukpga/1997/8/contents [Accessed 09/04/2025]

UK Government (2021) Net Zero Strategy. [Online]. Available at: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/1028157/net-zero-strategy.pdf [Accessed 09/04/2025]

UK Government (2021a). The Carbon Budget Order 2021. [Online]. Available at: https://www.legislation.gov.uk/uksi/2021/750/article/2/made [Accessed 09/04/2025]

UK Government (2022) UK Climate Change Risk Assessment 2022. [Online] Available at: https://www.gov.uk/government/publications/uk-climate-change-risk-assessment-2022 [Accessed 09/04/2025]UK Government (2024) Digest of UK Energy Statistics (DUKES): electricity. Available at: https://www.gov.uk/government/statistics/electricity-chapter-5-digest-of-united-kingdom-energy-statistics-dukes [Accessed 30/04/2025]

UNFCCC, (2021) Report of the Conference of the Parties serving as the meeting of the Parties to the Paris Agreement on its third session, held in Glasgow from 31 October to 13 November 2021 [Online]. Available at https://unfccc.int/sites/default/files/resource/cma2021_10_add1_adv.pdf [Accessed 09/04/2025]

UNFCCC, (2022). Decision -/CP.27, Sharm el-Sheikh Implementation Plan, Sharm el-Sheikh Climate Change Conference - November 2022, Sessional proceedings. [Online]. Available at: https://unfccc.int/documents/624444 [Accessed 09/04/2025]