CLOICH FOREST WIND FARM

EIA Report – Volume 1 – EIA Report Text

Chapter 16

Climate Change and Carbon Balance

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16 CLIMATE CHANGE AND CARBON BALANCE

16.1 INTRODUCTION

1. This Chapter of the Environmental Impact Assessment Report (EIA Report) evaluates the effects of the Cloich Wind Farm ('the Development') on climate change and carbon balance resource, and presents a Climate Change Impact Assessment (CCIA).

2. This assessment was undertaken by Arcus Consultancy Services Limited (Arcus).

3. This Chapter of the EIA Report is supported by Technical Appendix A16.1: Carbon Balance Calculations provided in Volume 3.

4. This Chapter includes the following elements:

- Legislation, Policy and Guidance;
- Assessment Methodology and Significance Criteria;
- Baseline Conditions;
- Assessment of Potential Effects;
- Mitigation and Residual Effects;
- Cumulative Effect Assessment;
- Summary of Effects; and
- Statement of Significance.

16.2 LEGISLATION, POLICY AND GUIDANCE

5. The following legislation, policy and guidance have been considered in carrying out this assessment:

- Institute of Environmental Management and Assessment (IEMA) Environmental Impact Assessment Guide to Climate Change Resilience and Adaptation 2020[1];
- Electricity Act 1989[2];
- Electricity Works (Environmental Impact Assessment) (Scotland) Regulations 2017, as amended[3] (the EIA Regulations);
- The 2020 Routemap for Renewable Energy in Scotland (2011)[4] and as updated in 2013[5] and 2015[6];
- The Electricity Generation Policy Statement (2013)[7];
- Letter from Chief Planner to all Heads of Planning in relation to energy targets and SPP (November 2015)[8];

[1] IEMA (2020) Environmental Impact Assessment Guide to Climate Change Resilience and Adaption 2020 [Online]. Available at: https://www.iema.net/resources/reading-room/2020/06/26/iema-eia-guide-to-climate-change-resilience-and-adaptation-2020 (Accessed 12/02/21)
[2] UK Government (1989) Electricity Act 1989 [Online] Available at: https://www.legislation.gov.uk/ukpga/1989/29/contents (Accessed 12/02/2021)
[3] UK Government (2017) Electricity Works (Environmental Impact Assessment) (Scotland) Regulations 2017 [Online] Available at: https://www.legislation.gov.uk/ssi/2017/101/contents/made (Accessed 12/02/2021)
[4] Scottish Government (2011). 2020 Routemap for Renewable Energy in Scotland [Online]. Available at: https://www2.gov.scot/Publications/2011/08/04110353/0 (Accessed 12/02/2021)
[5] Scottish Government (2013). 2020 Routemap for Renewable Energy in Scotland – Update 2013 [Online]. Available at: https://www2.gov.scot/Resource/0044/00441628.pdf (Accessed 12/02/2021)
[6] Scottish Government (2015). 2020 Routemap for Renewable Energy in Scotland – Update 2015 [Online]. Available at https://www2.gov.scot/Resource/0048/00485407.pdf (Accessed 12/02/2021)
[7] Scottish Government (2013) Electricity Generation Policy Statement 2013 [Online] Available at: https://www.gov.scot/publications/electricity-generation-policy-statement-2013/ (Accessed 12/02/2021)
[8] Scottish Government (2015) Letter from Chief Planner to all Heads of Planning in relation to energy targets and SPP [Online] Available at: https://www.gov.scot/publications/energy-targets-and-scottish-planning-policy-chief-planner-letter/ (Accessed 12/02/2021)

- Scottish Energy Strategy (December 2017)[9];
- Onshore Wind Policy Statement (December 2017)[10];
- European Commission Guidance on Integrating Climate Change and Biodiversity into Environmental Impact Assessment (2013)[11];
- HM Government UK Climate Change Risk Assessment Government Report (2012);[12]
- Scottish Government's Scottish Climate Change Adaption Programme[13]
- The Scottish Climate Change Plan (2018)[14];
- The Scottish Government's declaration of a Climate Emergency (April 2019)[15];
- The Climate Change (Emissions Reduction Targets) (Scotland) Act 2019[16] and the legally binding net zero target for 2045 and interim targets for 2020, 2030 and 2040;
- Achieving Net Zero (2020)[17];
- Energy White Paper: Powering our net zero future (2020)[18];
- Securing a green recovery on a path to net zero: climate change plan 2018–2032 – update (2020)[19]; and
- The Committee on Climate Change (CCC) Reducing UK emissions: 2020 Progress Report (2020)[20].

6. Notable information sources containing baseline and projected climate data include:

- Digest of United Kingdom Energy Statistics (DUKES) 2020[21];
- State of the UK Climate 2018[22];
- Met Office UK Climate Projections 2018 (UKCP18) (updated September 2019)[23]; and

[9] 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 12/02/2021)
[10] Scottish Government (2017) Onshore Wind: Policy Statement [Online] Available at: https://www.gov.scot/publications/onshore-wind-policy-statement-9781788515283/ (Accessed 12/02/2021)
[11] European Commission (2013). Guidance on Integrating Climate Change and Biodiversity into Environmental Impact Assessment (2013) [Online]. Available at: https://ec.europa.eu/environment/eia/pdf/EIA%20Guidance.pdf (Accessed 12/02/2021)
[12] HM Government (2012). UK Climate Change Risk Assessment: Government Report [online]. Available at: https://www.gov.uk/government/publications/uk-climate-change-risk-assessment-government-report (Accessed 12/02/2021)
[13] Scottish Government (2014). Scottish Climate Change Adaption Programme (SCCAP) [online]. Available at: https://www.gov.scot/publications/climate-ready-scotland-scottish-climate-change-adaptation-programme/ (Accessed 12/02/2021)
[14] Scottish Government (2018) Climate Change Plan: Third Report on Proposals and Policies 2018 – 2031 (RPP3) [Online[Available at: https://www.gov.scot/publications/scottish-governments-climate-change-plan-third-report-proposals-policies-2018-9781788516488/ (Accessed 12/02/2021)
[15] Scottish Government (2019) Action to Address Climate Emergency [Online] Available at: https://www.gov.scot/news/action-to-address-climate-emergency/ (Accessed 12/02/2021)
[16] Scottish Government (2019) Climate Change (Emissions Reduction Targets) (Scotland) Act 2019 [Online] Available at: http://www.legislation.gov.uk/asp/2019/15/enacted (Accessed 12/02/2021)
[17] National Audit Office (2020) Achieving Net Zero [Online] Available at: https://www.nao.org.uk/report/achieving-net-zero/ (Accessed 30/03/2021)
[18] UK Government (2020) Energy White paper: powering our net zero future [Online] Available at: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/945899/201216_BEIS_EWP_Command_Paper_Accessible.pdf (Accessed 30/30/2021)
[19] Scottish Government (2020) 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 30/03/2021)
[20] The CCC (2020) Reducing UK emissions: 2020 Progress Report to Parliament [Online] Available at: https://www.theccc.org.uk/publication/reducing-uk-emissions-2020-progress-report-to-parliament/#key-findings (Accessed 12/02/2021)
[21] UK Government (2020) Digest of United Kingdom Energy Statistics 2020 [Online] Available at: https://www.gov.uk/government/statistics/digest-of-uk-energy-statistics-dukes-2020 (Accessed 12/02/2021)
[22] International Journal of Climatology, volume 39, Issue S1 (July 2019) ed. Radan Huth. Wiley
[23] Met Office (2018). UK Climate Projections [Online]. Available at: https://www.metoffice.gov.uk/research/collaboration/ukcp (Accessed 12/02/2021)

- The Met Office UKCP18 Science Overview Report[24].

7. Other information sources are referenced throughout the Chapter.

16.3 ASSESSMENT METHODOLOGY AND SIGNIFICANCE CRITERIA

16.3.1 Scoping Responses and Consultation

8. Consultation for this EIA Report topic was undertaken with various consultees however, not all responded. Responses relevant to climate change are detailed in Table 16.1.

Table 16.1: Consultation Responses

Consultee	Type and Date	Summary of Consultation Response	Response to Consultee
Scottish Environment Protection Agency (SEPA)	Scoping Response 30/10/2019	Scottish Planning Policy states (Paragraph 205) that "Where peat and other carbon rich soils are present, applicants must assess the likely effects of development on carbon dioxide (CO_2) emissions. Where peatland is drained or otherwise disturbed, there is liable to be a release of CO_2 to the atmosphere. Developments must aim to minimise this release".	Noted. This Chapter provides a CCIA which includes a Carbon Balance Assessment.
		The planning submission must a) demonstrate how the layout has been designed to minimise disturbance of peat and consequential release of CO2 and b) outline the preventative/mitigation measures to avoid significant drying or oxidation of peat through, for example, the construction of access tracks, drainage channels, cable trenches, or the storage and re-use of excavated peat.	Whilst the Site is largely not underlain with peat; the Carbon Balance Assessment takes into account any peat disturbance and consequential release of CO_2.

[24] Lowe, J.A. *et al.* (2018). UKCP18 Science Overview Report. The Met Office. Available at: https://www.metoffice.gov.uk/pub/data/weather/uk/ukcp18/science-reports/UKCP18-Overview-report.pdf (Accessed 12/02/2021)

16.3.2 Scope of Assessment

9. The following assessments are considered in terms of the Development:

- The influence of the Development on climate change; and
- A summary of effects on environmental receptors sensitive to climate change.

10. These assessments consider effects on environmental receptors as a result of the Development.

16.3.3 Elements Scoped Out of Assessment

11. The assessment of the influence of the Development on climate change focusses on the overall balance of greenhouse gas (GHG) emissions as climate change is directly linked to these emissions. No further analysis is undertaken of how climate parameters change in direct response to the emissions balance of the Development.

12. An assessment of the vulnerability of the Development to climate change has been scoped out of assessment, on the basis that none of the identified climate change trends could affect the Development, with the exception of increased windstorms. Any risk to the turbines from windstorms can be mitigated by installing braking mechanisms on the turbines, which would allow them to be operated only under specific wind speeds. Should severe windstorms be experienced, the turbines would be shut down. Additionally, flooding is not expected to pose a significant risk to the operation of the wind farm.

13. In relation to the effects on other environmental receptors, a qualitative review is undertaken in this Chapter of whether projected climate change will modify the future baseline without the Development sufficiently to change the results of the assessments undertaken in other chapters. The assessments are not repeated in this Chapter, which should be read in conjunction with the other technical chapters.

14. Of the technical assessments included within this EIA Report, receptors within ecology, ornithology and hydrology have been identified as having a potential for the baseline to be modified as a result of climate change. Effects of climate change on ecology, ornithology and hydrology are included in this chapter, with all other technical areas scoped out of further consideration as baseline receptors are unlikely to be affected by the climate changes forecast during the operational phase of the Development.

16.3.4 Study Area / Survey Area

15. The Study Area considered for the assessment of vulnerability of the Development to climate change consists of all infrastructure proposed within the site boundary ('the Site'). The assessment will consider the forecast climate changes over the planned operational phase of the Development i.e. until approximately 2055. Information on climate trends and projections at the Scottish and local scale (where available) are utilised.

16. The Study Area for the assessment of the influence of the Development on climate change considers GHG emissions (current levels and targets) within the Scottish and UK spatial scale. Reference is made to the global context as appropriate.

17. For the environmental receptors sensitive to the Development, the study area for the assessment on future baseline for these receptors is outlined in individual technical chapters, specifically:

- Ecology;
- Ornithology; and
- Hydrology.

16.3.5 Design Parameters

18. The design of the Development is a balance of technical, resource, and environmental considerations. Those of relevance for the assessments in this Chapter include:

- Installed capacity and capacity factor - for calculation of carbon balance;
- Turbine spacing in relation to prevailing wind direction - for effects on generation, turbulence and vulnerability to damage with potential changes to wind speed direction and storminess;
- Amount and layout of new track and infrastructure in relation to peat – for calculation of carbon balance;
- Permanent Felling associated with the Development – for calculation of carbon balance;
- Buffers to watercourses – for assessing vulnerability to flooding due to changes in precipitation events; and
- Construction Management commitments particularly in relation to minimisation of disturbance and re-use of peat, and potential for flooding (as embedded in a Construction Environmental Management Plan (CEMP), and the submitted Peat Management Plan (PMP), etc.) – for assessing potential emissions and vulnerability to flooding.

16.3.6 Baseline Survey Methodology

19. Climate trends and projections are published by the Met Office through the UK Climate Projections website. The UKCP18 became available in November 2018, and was most recently updated in September 2019[25]. The UKCP18 provide the most up to date assessment of how the climate of the UK may change over this century.

20. 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. The sensitivity of the scenario responses is much more pronounced in the second half of the 21st Century, where the responses diverge more rapidly than in the first half of the century. The four RCPs are as follows:

- RCP2.6: assumes an increase in global mean surface temperature of 1.6°C (-0.9-2.3) by 2081-2100 (no change scenario)[26];
- RCP4.5: assumes an increase in global mean surface temperature of 2.4°C (1.7-3.2) by 2081-2100 (low emissions scenario)[26];
- RCP6.0: assumes an increase in global mean surface temperature of 2.8°C (2.0-3.7) by 2081-2100 (medium emissions scenario)[26]; and
- RCP8.5: assumes an increase in global mean surface temperature of 4.3°C (3.2-5.4) by 2081-2100 (high emissions scenario)[26].

21. Over the 30-year anticipated lifetime of the Development, the choice of scenario is therefore not fundamental to the assessment but, where appropriate, the medium emissions scenario RCP6.0 is utilised as the future baseline. Reflecting the Paris Climate Agreement[27], in which most countries including the UK pledged to reduce emissions by

[25] Met Office (2020) UK Climate projections (UKCP) [Online] Available at: https://www.metoffice.gov.uk/research/approach/collaboration/ukcp/index (Accessed 25/02/2021)
[26] Met Office (2018) UCKP18 Guidance: Representative Concentration Pathways [Online] Available at: https://www.metoffice.gov.uk/binaries/content/assets/metofficegovuk/pdf/research/ukcp/ukcp18-guidance---representative-concentration-pathways.pdf (Accessed 25/02/2021)
[27] United Nations (2016) Framework Convention on Climate Change. Adoption of the Paris Agreement, 21st Conference of the Parties, Paris [Online] Available at: https://unfccc.int/resource/docs/2015/cop21/eng/10a01.pdf (Accessed 12/02/2021)

2030, this scenario assumes no further emissions reductions after 2030 and allows for some increase in emissions.

22. Projections are reported for 20-year time periods through to 2100. The 2021 – 2040 and 2041 - 2060 periods provide the closest projections to the operational phase of the Development. For the purpose of this CCIA, where appropriate the 2040 - 2059 time period is used as the impacts of climate change are anticipated to be more evident with time.

23. Projected climatic changes at the 50% probability level (central estimate) are utilised, unless otherwise indicated. This is the level where there is as much evidence pointing to a lower outcome as a higher one. There is substantial evidence that the actual climatic change outcome will be in the 10th to 90th percentile range and this is also utilised for limited assessment parameters[28].

16.3.6.1 Influence of the Development of Climate Change

24. This section of the CCIA seeks to quantify the effect of the Development on climate change.

25. In Scotland, applications submitted under Section 36 of the Electricity Act 1989 are required to undertake the carbon balance assessment using the Scottish Government's carbon calculator tool. This has been completed for the Development using the latest version of the calculator (C-CalcWebV1.6.1)[29]. The Development's carbon calculator reference number is 3MBU-ZUMC-V243, as detailed within Appendix A16.1. The carbon assessment methodology used is consistent with that published by the Rural and Environment Research and Analysis Directorate of the Scottish Government entitled 'Calculating carbon savings from wind farms on Scottish peat lands – a new approach'[30]. This publication sets out the approach and assumptions that should be used to estimate potential carbon losses[31] and savings from wind farms on Scottish peatlands. The carbon balance assessment is included as Appendix A16.1.

26. The calculation evaluates the balance of total carbon savings and carbon losses over the life of the Development. The potential carbon savings and carbon costs associated with wind farms are as follows:

- Carbon emission savings due to generation (based on displacing emissions from different power sources);
- Lifetime costs associated with manufacture of turbines and construction;
- Loss of carbon from backup power generation;
- Loss of carbon-fixing potential of peatland;
- 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 forestry clearance; and
- Carbon gains due to proposed habitat improvements such as bog restoration.

[28] Lowe et al (2018) UKCP18 Science Overview Report (Page 13)
[29] Scottish Government & SEPA. Carbon Calculator Tool v1.6.1 [Online]. Available at: https://informatics.sepa.org.uk/CarbonCalculator/index.jsp (Accessed 12/02/2021)
[30] Nayak et al (2008) Calculating carbon savings from wind farms on Scottish peat lands: a new approach (Scottish Government) [Online] Available at: https://www.gov.scot/publications/calculating-carbon-savings-wind-farms-scottish-peat-lands-new-approach/pages/13/ (Accessed 12/02/2021)
[31] Carbon losses are defined within the Scottish Governments Technical Note Version 2.10.0 on Calculating potential carbon losses and savings from wind farms on Scottish peatlands. 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-guidance/govscot%3Adocument/Calculating%2Bpotential%2Bcarbon%2Blosses%2Band%2Bsavings%2Bfrom%2Bwind%2Bfarms%2Bon%2BScottish%2Bpeatlands%2B-%2Btechnical%2Bguidance.pdf (Accessed 16/04/2021)

27. The calculation of the carbon balance of a proposed wind farm provides a mechanism by which the carbon costs of a wind farm development can be weighed against the carbon savings attributable to the wind farm during its lifetime. This calculation is summarised as 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'. This information can then inform decision makers of the viability of a wind farm development in terms of overall carbon savings.

28. Calculations are provided for expected, best case and worst-case scenarios of Development. The expected scenario is based on the layout of 12 turbines and candidate turbine (Nordex N133, 4.8 MW) described in **Chapter 3: Project Description**, and has an estimated installed capacity of approximately 57 MW. The other scenarios are based on varying assumptions regarding wind energy capacity factor, characteristics of peatland and Development land-take.

29. The data sources and assumptions used in the carbon balance assessment are detailed in Appendix A16.1. The assessment was informed by an iterative peat probing process, as described in **Chapter 9: Geology, Ground Conditions and Peat**.

16.3.6.2 Effects on Environmental Receptors Sensitive to Climate Change

30. This section of the CCIA identifies where climate change has the potential to significantly impact the findings of assessments undertaken and reported elsewhere in this EIA Report. Reference is made to the specific assessment chapters, where the baseline conditions and sensitivity of receptors are discussed, assessments are not repeated.

16.3.7 Methodology of Assessment Effects

31. To determine whether effects are significant under the EIA Regulations, it is appropriate to consider the sensitivity (vulnerability and susceptibility) of the receptor and the magnitude of the impact, taking into account uncertainty. This is based on the professional judgement of the assessor.

16.3.7.1 Sensitivity of Receptors

32. The sensitivity of the baseline conditions, including the importance of environmental features on or near to the Site or the sensitivity of potentially affected receptors, will be assessed in line with best practice guidance, legislation, statutory designations and / or professional judgement.

33. Table 16.2 details the criteria for determining the sensitivity of receptors.

Table 16.2: Criteria for Determining Sensitivity of Receptors

Sensitivity of Receptor	Definition
Very High	The receptor has little or no ability to absorb change without fundamentally altering its present character, is of very high environmental value, or of international importance.
High	The receptor has low ability to absorb change without fundamentally altering its present character, is of high environmental value, or of national importance.
Medium	The receptor has moderate capacity to absorb change without significantly altering its present character, has some environmental value, or is of regional importance.
Low	The receptor is tolerant of change without detriment or benefit to its character, is low environmental value, or is of local importance.
Very Low	The receptor is resistant to change and is of little environmental value.

16.3.7.2 Magnitude of Change

34. The magnitude of change will be identified through consideration of the Development, the degree of change to baseline conditions predicted as a result of the Development, the duration and reversibility of an effect and professional judgement, best practice guidance and legislation.

35. The criteria for assessing the magnitude of an effect are presented in Table 16.3.

Table 16.3: Criteria for Determining Magnitude of Change

Magnitude of Change	Definition
Very High	A national-level change to the baseline condition of a receptor.
High	A fundamental change (positive or negative) to the baseline condition of the receptor, leading to total loss or major alteration of character.
Medium	A material change (positive or negative) leading to partial loss or alteration of character.
Low	A slight, detectable, alteration of the baseline condition which may be positive or negative.
Negligible	A barely distinguishable change from baseline conditions.

16.3.7.3 Significance of Effect

36. The sensitivity of the asset and the magnitude of the predicted change will be used as a guide, in addition to professional judgement, to predict the significance of the likely effects.

37. The IEMA guidelines for CCIA state the following with regards to the assessment of significance:

> *"This guidance is not proposing changes to the significance criteria used in the EIA process. However, the susceptibility or resilience of the receptor to climate change must be considered as well as the value of the receptor.*
>
> *Therefore, a high-value receptor that has very little resilience to changes in climatic conditions should be considered more likely to be significantly affected than a high-value receptor that is very resilient to changes in climatic conditions.*
>
> *The uncertainty of the combined effect needs to be taken into account. If uncertainty about how a receptor will adapt to a changing climate is high, then it is recommended that a conservative threshold of significance is adopted within the evaluation".*

38. Table 16.4 outlines the framework for the assessment of significance of effects, which is supported heavily by professional judgement.

Table 16.4: Framework for Assessment of the Significance of Effects

Magnitude of Effect	Sensitivity of Resource or Receptor				
	Very High	**High**	**Medium**	**Low**	**Negligible**
Very High	Major	Major	Major	Moderate	Minor
High	Major	Major	Moderate	Moderate	Minor
Medium	Major	Moderate	Moderate	Minor	Negligible
Low	Moderate	Moderate	Minor	Negligible	Negligible
Negligible	Minor	Minor	Negligible	Negligible	Negligible

39. Those predicted to be of major or moderate significance are considered to be 'significant' in the context of the EIA Regulations, and are shaded in light grey in the above table.

40. The categories of significance are described in Table 16.5:

Table 16.5: 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.

41. Effects assessed can be either positive, negative or neutral. Whilst receptors may be considered "high-value", a non-material magnitude of the impact would result in any effect being considered not significant.

16.3.8 Assessment Limitations

42. The climate change projections are based on global models for a range of GHG emissions scenarios and generally consider regional responses to climate change rather than local responses. This is based on best scientific knowledge at this time and judgements on datasets and future socioeconomic drivers.

43. Downscaling adds another level of uncertainty. There may be more detail, but the uncertainty of the science may be higher. As understanding of the climate system and the ability to model it improves, it is likely that future projections will be refined.

44. The probabilities presented and the estimated ranges are based on a set of modelling, statistical and dataset choices with expert judgement playing an important role. However, as some potential influences on future climate are not yet known some choices may change as the science develops[32].

45. Specifically, in relation to wind, the UKCP18 Wind Fact sheet[33] states that local variations due to the land surface are hard to model, particularly in very exposed or sheltered locations. This can be particularly relevant in high wind speed situations where local gusts can result from small scale weather events such as thunderstorms.

16.3.9 Embedded Mitigation

46. As detailed in **Chapter 2: Site Selection & Design**, the Development has been driven by the key objective of capturing the maximum energy possible, while balancing environmental and technical constraints. The design choices made as a consequence of the key constraints are considered to be mitigation which is 'embedded' in the design; the following are most relevant for the CCIA:

- Development infrastructure is built to withstand strong windspeeds and to harness energy;
- Turbine spacing is sufficient to reduce turbulence effects on turbines downwind;

[32] Lowe *et al* (2018) UKCP18 Science Overview Report
[33] UKCP18 (2019) Factsheet: Wind [Online]. Available at: https://www.metoffice.gov.uk/binaries/content/assets/metofficegovuk/pdf/research/ukcp/ukcp18-fact-sheet-wind_march21.pdf (Accessed 12/02/2021)

- The turbines are located to maximise energy generation while minimising environmental impacts;
- The Development design aims to minimise environmental impacts e.g., through use of existing track layout;
- Turbines, and associated infrastructure, have not been sited in areas of peat with depths greater than 0.5 m to minimise peat disturbance;
- 50 m buffers from watercourses incorporated in layout design, protecting water quality and also protecting Development infrastructure from flooding; and
- Implementation of a Construction Environmental Management Plan (CEMP) (to be agreed with authorities prior to construction), Peat Management Plan (PMP) etc. during construction to minimise environmental impacts.

16.4 BASELINE CONDITIONS

47. The State of the UK Climate 2019[34] provides the latest report on observed climate data for UK. Key findings are as follows:

- The decade 2010-2019 was on average 0.3°C warmer than the 1981-2010 average and 0.9°C warmer than 1961-1990. The ten warmest years on record have occurred since 2002;
- The decade 2010–2019 has been on average 1% wetter than 1981–2010 and 5% wetter than 1961–1990 for the UK overall. Six of the ten wettest years for the UK in a series from 1862 have occurred since 1998;
- In the context of seasonal changes, for the most recent decade (2010-2019):
  - UK summers have been on average 11% wetter than 1981–2010 and 13% wetter than 1961–1990;
  - UK winters have been on average 4% wetter than 1981–2010 and 12% wetter than 1961–1990; and
- In the UK, there is no strong evidence for trends in storminess as determined by maximum gust speeds over the last five decades.

48. 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.

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

16.4.1 Wind Speed

50. 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 generally experienced. The increase is modest when compared to inter-annual variability. This would be accompanied by an increase in frequency of winter storms over the UK[35]. There are no significant changes forecast in the wind speeds over the first part of the century.

51. These projections are in line with earlier findings by Pryor and Barthelmie (2010)[36] who concluded that in the near-term (i.e., until the 2050s) there will be no detectable significant change in the wind resource of northern Europe.

[34] International Journal of Climatology, volume 39, Issue S1 (July 2020) ed. Radan Huth. Wiley
[35] UKCP18 (2018) Factsheet: Wind.
[36] Pryor, S.C. and Barthelmie, R. J. (2010) Climate Change Impact on Wind Energy: A Review. Renewable and Sustainable Energy Review, 14(1): 430-437

16.4.2 Temperature

52. At a UK level, for period 2041-2060 projected changes to annual mean temperature (compared to 1981-2000) is projected at +1.8°C (50% probability) for RCP8.5 (unmitigated scenario). Results for the 10th to 90th percentile range are between +0.9°C to +2.7°C[37]. Key observations 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 Scotland.

16.4.3 Precipitation

53. Rainfall patterns over the UK are not uniform and vary on regional and seasonal scales, which will continue in the future. Future changes are uncertain but point to wetter winters and drier summers in general. Drying in summer will be strongest in the South of England, whilst Scotland is generally associated with increased precipitation in winter[38].

54. Over the UK, the changes to precipitation projected for 2041-2060 (compared to 1981-2000) for RCP8.5 (unmitigated scenario) are:

- Winter precipitation – increase of 7%. Results for the 10th to 90th percentile range are between -5% and +21%.
- Summer precipitation – decrease of 15%. Results for the 10th to 90th percentile range are between -31% and +0%.

16.4.4 Greenhouse Gas Emissions and Renewable Energy

55. The central aim of the Paris Agreement is to strengthen the global response to the threat of climate change by keeping a global temperature rise this century well below 2°C above pre-industrial levels and to pursue efforts to limit the temperature increase even further to 1.5°C[39].

56. A substantial reduction in greenhouse gas emissions is imperative to avoid irreversible damage caused by the impacts of climate change. *"When it comes to rises in global average temperature, every fraction of a degree matters"* was stated in a recent publication providing analysis for the Global Carbon Budget 2018[40].

57. The 2018 IPCC Special Report[41] highlighted that to limit global warming to below 1.5°C by the end of the century, emissions would need to decline by approximately 45% by 2030 and reach net zero around 2050. This is the temperature rise when a variety of increasingly severe effects are considered to occur and the IPCC identifies that rapid and far-reaching transitions are required in all sectors including energy. Action is required immediately to reduce emissions by 50% by 2030. Figures from the Global Carbon Project however report that global CO_2 emissions from fossil fuels and industry have increased every decade from an average of 11.4 gigatonnes of equivalent carbon dioxide ($GtCO_2$) in the 1960s to an average of 34.7$GtCO_2$ during 2009-2018. Emissions in 2018 reached a new record high of 36.6$GtCO_2$. Though global emissions in 2019 have been

[37] Lowe *et al* (2018) UKCP18 Science Overview Report November 2018 (Updated March 2019) (Table 2.2, Page 16)
[38] Lowe *et al* (2018) UKCP18 Science Overview Report
[39] UN Climate Change (2015) the Paris Agreement [Online] Available at: https://unfccc.int/process-and-meetings/the-paris-agreement/the-paris-agreement (Accessed 12/02/2021)
[40] Figueres, C., C. Le Quéré, G. P. Peters, G. Whiteman, A. Mahindra, D. Guan, et al. (2018) Carbon Budget 2018**:** Emissions are still rising: ramp up the cuts, Nature, vol 564, 27-30.
[41] Intergovernmental Panel on Climate Change (IPCC) (2018) Global Warming of 1.5°C: Summary for Policymakers [Online] Available at: https://www.ipcc.ch/sr15/ (Accessed 12/02/2021)

projected to increase by an additional 6%, which is a slower growth than in the past two years[42].

58. The Scottish Government has introduced a number of policies aimed at reducing GHG emissions and meeting renewable energy targets set at Scotland, UK, European and International levels with ambitious targets for reductions in greenhouse gas emissions. The Climate Change Act (Emissions Reduction Targets) (Scotland) Act 2019 amends the Climate Change (Scotland) Act 2009 and was introduced to Parliament in May 2018. The Bill was passed in September 2019 and received Royal Assent in October 2019. Following the Committee on Climate Change (CCC) recommendation, the Act was amended to set a new target to cut Scottish greenhouse gas emissions to net zero by 2045, five years ahead of the target date set for the whole of the UK, with interim targets now set to cut emissions by 75% and 90% by 2030 and 2040 respectively (in relation to 1990 levels).

59. The 2nd Scottish Climate Change Adaptation Programme 2019 - 2024 was published in September 2019. This document sets out the Scottish Government's policies and proposals for climate change adaptation, building on the 1st five-year programme.

60. In October 2020 the CCC published its latest report to the Scottish Parliament on progress in reducing carbon emissions[43]. The report notes the significant progress which the power sector has made towards reducing carbon emissions in Scotland and the UK as a whole. The switch to low carbon generation has contributed two thirds of the total fall in emissions in Scotland, driven by the increase in renewable generation from wind power, and the reduction in fossil fuel capacity – including the closure of all of Scotland's remaining coal fired plants.

61. Renewable generation capacity in Scotland has more than trebled in the last 10 years with 11.9 GW of installed generation capacity across the country as of June 2020[44]. It is estimated that renewables generated the equivalent of 90.1% of Scotland's gross electricity demand in 2019.

62. However, Scotland has a target to reduce GHG emissions to net-zero by 2045, which includes electricity generation. As stated in the 2020Progress Report to Parliament by the CCC, Scotland must reduce its emissions by an average of 1.9 million metric tonnes ($MtCO_2e$). In 2017, emissions fell by 1.5 $MtCO_2e$ in Scotland, less than the Scottish Government's annual reduction targets. To be able to meet its 2045 target, Scotland must further reduce its GHG emissions.

63. The CCC published the 2020 report to Parliament[45], assessing progress in reducing UK emissions over the past year. The report highlights that although a limited number of steps have been taken over the past year to support the transition to a net-zero economy and improve the UK's resilience to the impacts of climate change, much remains to be done. The report indicates that reaching net zero emissions in the UK will require all energy to be delivered to consumers in zero-carbon form, i.e., renewables and nuclear, bioenergy and fossil fuels combined with carbon capture and storage.

64. GHG emissions from the UK electricity sector have been decreasing over the last years, and this is primarily because of a reduction in GHG emissions from power stations.

[43] Climate Change Committee (October 2020) Reducing emissions in Scotland Progress Report to Parliament [Online] Available at: https://www.theccc.org.uk/publication/reducing-emissions-in-scotland-2020-progress-report-to-parliament/ (Accessed 23/11/2020)
[44] Scottish Government (2020) Annual Compendium of Scottish Energy Statistics 2020 [Online]. Available at: https://www.gov.scot/binaries/content/documents/govscot/publications/statistics/2019/05/annual-compendium-of-scottish-energy-statistics/documents/annual-compendium-december-2020/annual-compendium-december-2020/govscot%3Adocument/ACSES%2B2020%2B-%2BDecember.pdf (Accessed 12/02/2021)
[45] The CCC (2020) Reducing UK emissions: 2020 Progress Report to Parliament [Online] Available at: https://www.theccc.org.uk/publication/reducing-uk-emissions-2020-progress-report-to-parliament/#key-findings (Accessed 12/02/2021)

Between 2018 and 2019 there was a 13.2% decrease in emissions from power stations – this is mainly attributed to a change from fossil fuel generation to renewables.[46] Cities for Climate Protection (CCP) set out policies and proposals to reduce emissions from this sector by a further 28% between 2018 and 2032, taking the overall reduction within the sector to 87% compared to 1990.

65. With the continued development of onshore wind farms, in the planning and pre-construction phases, it is anticipated that onshore wind farms will continue to make a sizeable contribution to the energy generated from renewable energy technologies within Scotland. The CCP sets out as one of the policy outcomes for this sector that from 2020 onwards, Scotland's electricity generation intensity will be less than 50 grams of carbon dioxide equivalent per kilowatt hour (CO_2eq/kWh), powered by a high penetration of renewables. The CCP latest figures for 2018 show intensity has seen a slight increase to 44.6CO_2e/kWh[47] compared to 2017 which was 24gCO_2e/kWh[48]; however, it still remains below 50 grams of CO_2eq/kWh.

16.5 ASSESSMENT OF POTENTIAL EFFECTS

66. As a large energy asset of generation in excess of 50 Megawatts (MW), the Development can be classed as an asset of regional importance and classed as Medium sensitivity for the following assessments.

16.5.1 Influences of the Development on Climate Change

16.5.1.1 Carbon Savings

67. Every unit of electricity produced by a wind farm development displaces a unit of electricity which would otherwise have been produced by a conventional (coal or gas) power station, and therefore presents carbon savings.

68. The electricity produced from the wind farm 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, which is a possibility if coal is at the bottom of the cost merit order of generation.

69. However, it is not appropriate to define the electricity source for which this renewable electricity project would substitute, due to uncertainty in future grid mix. For this reason, carbon emission savings are calculated for each scenario in the carbon calculator.

70. The potential annual carbon emission savings for the Development are provided in Table 16.6, and within Appendix A16.1. Based on the latest DUKES Statistics[49] and an average capacity factor of 27% (based on DUKES Statistics[45]), it is expected the Development would result in the production of approximately 136,236 megawatt hour (MWh) annually, equating to approximately 4,087,066 MWh over the operational life of the Development (30 years). This equates to displacing approximately 1,839,180 tonnes of fossil fuel mix generation equivalent CO_2 emissions, over the operational life which is a positive

[46] UK Government (2020) 2019 UK greenhouse gas emissions, provisional figures [Online] Available at: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/875485/2019_UK_greenhouse_gas_emissions_provisional_figures_statistical_release.pdf (Accessed 30/03/2021)
[47] Scottish Government (2020) 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 12/02/2021)
[48] Scottish Government (2019) Climate Change Plan: monitoring report 2019 [online] Available at: https://www.gov.scot/publications/climate-change-plan-monitoring-report-2019/pages/3/#:~:text=Renewable%20electricity%20generation%20capacity%20in,2008%20to%2051.7%25%20in%202017 (Accessed 12/02/2021)
[49] UK Government (2019) Regional Statistics 2009-2019: Standard Load Factors [Online] Available at: https://www.gov.uk/government/statistics/regional-renewable-statistics (Accessed (05/03/2021)

environmental effect. The projected change in wind speeds as a result of climate change over the operational phase of the Development is considered to be non-material for the purposes of this assessment.

Table 16.6: Carbon Savings for the Development (Expected Scenario)

	Expected CO_2 Saving (t $C0_2yr^{-1}$)
Coal fired electricity generation	125,337
Grid mix electricity generation	34,547
Fossil fuel mix electricity generation	61,306

71. It should be noted that the average capacity factor of 27% is likely to represent a significant underestimation when compared to the actual capacity factor experienced at the Site. Consequently, carbon savings are also likely to be conservative.

16.5.1.2 Carbon Losses

72. As detailed within the Scottish Government's Technical Note Version 2.10.0 on Calculating potential carbon losses and savings from wind farms on Scottish peatlands[31], the manufacturing, construction and installation of the wind turbines on Site has an associated carbon cost, and carbon losses are also generated by the requirement for extra capacity to back up wind power generation. Carbon losses associated with reduced carbon fixing potential and loss of soil organic matter occurs through drainage effects and excavation of peat for construction. Carbon losses at this site may also be associated with felling of existing forestry.

73. Organic soils (peatlands) in Scotland act as carbon sinks, whereby they absorb carbon dioxide in their formation. They may also release carbon due to land use change, such as drainage for agriculture or the establishment of forestry. The Development is located within a Site where limited peat deposits are present, as per survey findings discussed in **Chapter 9: Geology, Ground Conditions and Peat** of this EIA Report.

74. Carbon losses for the expected scenario are summarised in Table 16.7.

Table 16.7: Carbon Losses for the Development (Expected Scenario)

Losses	**t $C0_2$ Equivalent (total for wind farm lifetime)**
Losses due to turbine life (e.g. manufacture, construction, decommissioning)	50,369
Losses due to back-up	19,618
Losses due to reduced carbon fixing potential	954
Losses from soil organic matter	5,673
Losses due to Dissolved Organic Carbon (DOC) and Particulate Organic Carbon (POC) leaching	363
Losses due to felling forestry	27,966
TOTAL LOSSES OF CARBON DIOXIDE	104,943

16.5.1.3 Payback Period

75. The carbon payback period is a measurement/indicator to help assess a proposal. The shorter the payback the greater benefit the Development will have in displacing emissions associated with electricity generated by burning fossil fuels.

76. The payback period is calculated taking the total carbon cost (carbon losses) associated with the Development and dividing by the annual carbon gains from displaced fossil fuel power generation and any site improvements.

77. The estimated payback period for the Development is 3.1 years compared to grid-mix electricity generation. In comparison to fossil fuel mix and coal-fired electricity generation the payback period of the Development reduces to 1.7 years and 0.8 years respectively. Table 16.8 below goes into further detail regarding the carbon payback period for the Development.

Table 16.8: Payback in Years for each Scenario used in the Carbon Calculator

Compared to…	Expected Scenario	Best Case Scenario	Worst Case Scenario
Coal fired electricity generation	0.8	0.7	1.1
Grid-mix electricity generation	3.1	2.4	3.9
Fossil fuel-mix of electricity generation	1.7	1.3	2.2

78. The CO_2 emission savings for the operational lifetime beyond that (currently predicted as 30 years) would a net benefit of the Development to reducing climate change. This is considered a Low magnitude of effect i.e. a slight, detectable, alteration of the baseline condition.

79. Given the challenge and international urgency of climate change, as identified in the recent IPCC special report, climate is considered to have Very High sensitivity to changes in GHG emissions. The Development is therefore assessed to have Moderate, positive environmental effects, that is **significant** under the EIA Regulations.

16.5.2 Effects of Future Climate Change Scenario on Environmental Receptors Sensitive to Climate Change

80. The potential for environmental receptors to be impacted by the Development are assessed in Chapters 6-17 of this EIA Report. Of these ecological, ornithological and hydrological receptors are the most sensitive to climate change and are discussed further in Table 16.9 below.

Table 16.9: Climate Change Effects on Environmental Receptors

EIA Report Chapter	Receptor	Climate Change Effect	Effect on Receptor
7	Ecology – Habitats, Protected Species	Temperature: up to + 2°C Shift to wetter winters and dryer summers Negligible change in wind speeds	While changes in temperature could affect the composition and growth rates of plant communities and invertebrates, and hence protected species and habitats, the uncertainties are high and it is not clear that the effect of the Development on those receptors would alter substantially as a result.
8	Ornithology	Temperature: up to + 2°C Shift to wetter winters and dryer summers	A rise in temperature has the potential to impact on habitats which in turn may affect the behaviour of bird interests. As noted above uncertainties are high and the type and significance of

EIA Report Chapter	Receptor	Climate Change Effect	Effect on Receptor
		Negligible change in wind speeds	effects identified from the Development are not anticipated to alter as a result.
9 & 10	Geology, Hydrology and Hydrogeology	Shift to wetter winters and dryer summers	Limited change to future baseline and to the identified effects of the Development.

81. Given the relatively limited magnitude of change in climate parameters predicted over the operation of the Development, negligible changes to the baseline for environmental receptors are anticipated during this period. This is incorporated into the assessments undertaken in other chapters of this EIA Report.

82. No additional significant effects will occur as a result of climate change during the operational phase of the Development.

16.6 MITIGATION AND RESIDUAL EFFECTS

83. As detailed in Section 16.5.1, the Development will have a positive effect due to the CO_2 emission savings for the operational lifetime and beyond resulting in a net benefit of the Development to reducing climate change. Any adverse, negative effects as a result of the Development are of such limited, and negligible nature, that they are not significant in terms of the EIA Regulations. As such, no mitigation is required under the EIA Regulations other than that already embedded into the Development and recommended as best practice.

84. An iterative design approach was taken for the layout of the Development to avoid siting turbines and hardstanding in proximity to watercourses as well as infrastructure in deep peat to minimise disturbance of peat soils and associated carbon losses. As illustrated on Figure 2.2 of **Chapter 2: Site Selection & Design**) the only section of track associated with the Development that is located in peat greater than 1 m is existing forestry track in the east of the Site; upgrades to this section of the track are considered unlikely. Further micro-siting will be informed by detailed pre-construction ground investigations.

85. An Outline PMP has been produced and is provided in **Chapter 9: Geology, Ground Conditions and Peat**. Proposed reuses of the excavated peat are in line with the Scottish Renewables and SEPA Guidance[50] and the outline PMP demonstrates that all excavated peat can be suitably re-used on Site. Methods for handling and storing excavated peat have been described in the Outline PMP to ensure its reuse potential is maximised and any carbon losses are minimised. Monitoring of the reinstated areas will be carried out to ensure that the environmental objectives are realised.

86. The Outline PMP will be updated prior to construction once further site investigation data and detailed engineering designs are available. Temporary peat storage locations will be identified in the updated PMP and will be guided by a geotechnical engineer. The updated PMP will also include detailed method statements and phasing of works, and will be agreed with SEPA and the planning authority prior to construction commencing.

87. Under the Scottish Government's Control of Woodland Removal policy any tree crops permanently removed for the Development would require to be replanted on a like-for-like area basis either within the Site or at a suitable substitute location. Approx. 71 hectares (ha) of productive forestry would be removed for the duration of the operation of the Development, and would be replaced by a compensatory planting scheme on a

[50] Scottish Renewables, SEPA (2012) Guidance on the Assessment of Peat Volumes, Reuse of Excavated Peat and Minimisation of Waste [Online] Available at: https://www.gov.scot/Topics/Business-Industry/Energy/Energy-sources/19185/17852-1/CSavings/guidancepeatwaste (Accessed 12/02/2021)

substitute site. An additional 121 ha of forestry will be removed prior to the construction period and restocked on Site. The mitigation work to re-establish the areas of crops removed by both restocking within the Site and supplemental compensatory planting out with the Site will ensure the overall area of forestry crops is maintained.

88. Other mitigation measures will include the management of wind turbines to maintain operational efficiency during their lifetime. Maintenance plans for wind turbines would be developed to maximise turbine output and efficiency.

16.7 CUMULATIVE EFFECT ASSESSMENT

89. The Scottish and UK Governments have set ambitious targets for reducing GHG emissions by 2045 and 2050 respectively. The Development, in conjunction with other renewable energy developments, will contribute to Scotland and the UK's aims to reduce carbon emissions and achieve meet its ambitious greenhouse gas emissions targets.

90. DUKES 2020 details that renewable electricity represented 37.1% of total UK generation in 2019, with onshore wind's overall share of capacity increasing to 13.3% of all generators overall, up two percentage points on 2018.

91. The Development will contribute approximately 57 MW of installed capacity which will contribute to increasing renewable energy generation capacity within Scotland the UK.

92. The cumulative effect of the Development with other UK renewables generation is considered to be a fundamental change in the climate effects of UK energy supply and contribute to the UK's legally binding emission reduction targets. This represents a major, positive effect that is **significant** under the EIA Regulations

16.8 SUMMARY OF EFFECTS

93. Table 16.10 provides a summary of the effects detailed within this Chapter.

Table 16.10: Summary of Effects

Receptor	Potential Effect	Significance of Effect	Mitigation Proposed	Residual Effect
Influence of the Development on Climate Change				
Climate - average temperature predictions as linked to GHG emissions.	Reduction in GHG emissions through offsetting of existing conventional generation.	Moderate Major cumulatively	None Embedded mitigation has reduced payback period and maximise beneficial impact.	Significant contribution cumulatively to regional emissions and renewable energy generation targets.
Effects on Environmental Receptors				
Environmental Receptors assessed in individual chapters of EIA Report.	Change to future baseline of receptors and assessment results.	Negligible Little change over time period to baseline condition of receptors.	None Mitigation as identified in individual assessment chapters	None

16.9 STATEMENT OF SIGNIFICANCE

94. The Development will have positive effect on carbon savings and a significant positive effect when considered cumulatively with Scottish renewable energy deployment. This is significant in terms of the EIA Regulations.

No additional significant effects to those already identified within the EIA Report will occur as a result of climate change during the operational phase of the Development.