14 Climate Change

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14.1 Introduction

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

14.1.2 Each unit of wind generated electricity would displace a unit of conventionally generated electricity, therefore, reducing traditional power station emissions. Table 14.1 provides a breakdown of the estimated emissions displaced per annum and over the assumed lifespan for the Proposed Development. The Proposed Development is seeking consent for an operational lifespan of 50 years after which it would be appropriately decommissioned.

Carbon and Peatland

14.1.3 Windfarms in upland areas tend to be sited on peatlands which hold stocks of carbon and so have the potential to release carbon into the atmosphere, in the form of CO_2, if the peat is disturbed.

14.1.4 In order to minimise the requirement for the extraction of peat, the site design process has avoided areas of deeper peat (>1m) where possible. The site design process is described in Chapter 2 (Design Iteration and Proposed Development). Specific details on the peat depths of the Site are included in Chapter 10 (Geology and Soils) and Appendices 10.2 and 10.3, and Figures 10.2a-g: Peat Depth.

Effects of Carbon Emission from Construction

14.1.5 Emissions arising from the fabrication and manufacture of the turbines and the associated components are based on a full life analysis of a typical turbine and include CO_2 emissions resulting from fabrication, transportation, erection, operation, dismantling and removal of turbines and foundations and transmission grid connection equipment from the existing electricity grid system. The assessment has used Nayak *et al* (2008) default values for 'turbine life' emissions, calculated with respect to the Site's installed capacity (in excess of 100 MW).

Characteristics of Peatland

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

14.1.7 To calculate the carbon emissions attributable to the removal or drainage of peat from the Site as a result of the Proposed Development, emissions occurring if the soil had remained in situ and undisturbed are subtracted from the carbon emissions occurring after removal or development-related drainage.

14.1.8 The indirect loss of CO_2 uptake (fixation) by plants originally on the surface of the Site but eliminated by construction activity, is calculated using site-specific data collected as part of the EIA process. For the purposes of the carbon calculator, it is based on blanket bog as identified as the key habitat on-site during the Phase 1 Habitat Survey (as detailed in Chapter 5 (Ecology and Nature Conservation)).

14.1.9 Emissions due to the indirect, long term liberation of CO_2 from carbon stored in peat due to drying and oxidation processes caused by construction of the Proposed Development, can also be calculated from site-specific data (the habitat loss calculations are included in Chapter 5 (Ecology and Nature Conservation)). This figure is a worst-case scenario, as the peat would be re-used on-site to minimise carbon losses. Further details on site specific proposed mitigation measures for the management of peat storage and handling, and the calculated volumes of peat to be re-used on Site are provided in Appendix 10.3 (Peat Management Plan).

14.2 Legislation, Policy and Guidance

6.1.1 The key legislation and guidance for the Scottish Government's renewable targets are:

- the Climate Change (Scotland) Act, 2009;
- the Climate Change (Emissions Reductions Targets) (Scotland) Act 2019;
- the Fourth National Planning Framework (NPF4) Position Statement (2020); and
- the Update to the Climate Change Plan 2018 – 2032 (2020).

6.1.2 These create the statutory framework for greenhouse gas emissions reductions in Scotland and the recent Climate Change (Scotland) Act set a target of net-zero emissions by 2045 and a 75% reduction by 2030. This requires a doubling of the response to meeting emissions reductions targets between 2020 to 2030. Decarbonisation of grid electricity through increasing the percentage of electricity generated by renewables is identified as one of the key ways to deliver carbon emission reductions.

14.3 Assessment Methodology

14.3.1 The purpose of the 'carbon calculator' is to assess, in a comprehensive and consistent way, the carbon impact of wind farm developments. This is undertaken by comparing the carbon costs of wind farm developments with the carbon savings attributable to the wind farm.

14.3.2 The methodology to calculate carbon emissions generated in the construction, operation and decommissioning of a wind farm is based on '*Calculating carbon savings from windfarms on Scottish peat lands - A New Approach*' (Nayak et al, 2008), prepared for the Scottish Government Science, Policy and Co-ordination Division. This was superseded in 2011 by the document *'Calculating Carbon Savings from Wind Farms on Scottish Peatlands - A New Approach'*, (Nayak et al, 2008 and 2010) and (Smith et al, 2011).

14.3.3 In terms of carbon footprint, the 'carbon calculator' is the Scottish Government's online tool provided to support the process of determining the carbon impact of wind farm developments in Scotland. The SEPA Guidance *'Assessment of peat volumes, reuse of excavated peat and minimisation of waste'* (SEPA, 2014) and *'Guidance on Developments on Peatland - Site Surveys'* (Scottish Natural Heritage, SEPA and The James Hutton Institute, 2017) were also considered during the preparation of the carbon calculator.

Input Parameters

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

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

14.3.5 As part of their methodology, Nayak et al (2010) have provided a spreadsheet 'Scottish Government Windfarm Carbon Assessment Tool' to calculate whole life carbon balance assessments for windfarms on peatlands. The calculator has progressed to an online tool. Version 1.6.1 of the carbon calculator is the current model and was used in this assessment. The online calculation tool (project reference 2K6B-E55Z-NBQO) allows a range of data to be input to address the expected, minimum and maximum values as a result of the Proposed Development. However, it should be noted that if several parameters are varied together, this can have the effect of 'cancelling out' a single parameter change. For this reason, the approach for this assessment has been to include 'maximum values' as those values which would result in the longest (maximum) payback period; and 'minimum values' as those values which would result in the shortest (minimum) payback period.

14.3.6 This tool provides generic values for CO_2 emissions associated with some components (such as turbine manufacture) and requires site-specific information for other components (such as habitat type, extent of peat disturbance and groundwater levels).

14.3.7 This assessment draws on information detailed in this EIA Report, including:

- Chapter 2: Design Iteration and Proposed Development;
- Chapter 5: Ecology and Nature Conservation; and
- Chapter 10: Geology and Soils.

14.3.8 For the purpose of the assessment, it is assumed that all embedded good practice measures outlined in Chapters 5 and 10 and within Chapter 2, Appendix 2.1 (Outline Construction Environmental Management Plan (OCEMP)) would be employed.

14.3.9 The candidate turbine used for this assessment has an indicative 5.6 MW capacity, and the Proposed Development would consist of up to 18 turbines with an indicative total installed capacity in excess of 100 MW. The greenhouse gas savings and carbon payback are based on these input parameters. Figures are based on currently available turbine specifications and assume a single turbine model supplied by a consistent turbine manufacturer.

14.3.10 The capacity factor (i.e. the ratio of the actual electrical energy output over a given period to the maximum possible electrical energy output over that period) within the online calculation tool is based on values of between 23.96% and 29.28%.

14.3.11 The input parameters for the Scottish Government online calculation tool are detailed in Appendix 14.1. The choice of methodology for calculating the emission factors uses the 'Site Specific Methodology' defined within the online calculation tool.

14.4 Results

14.4.1 An assessment has been undertaken to calculate the carbon emissions which would be generated during the construction, operation and decommissioning (i.e. assumed to be after 50 years for the purpose of the calculator) of the Proposed Development as well as the carbon payback period resulting from the operation of the Proposed Development.

14.4.2 The carbon calculations results are provided in Appendix 14.2 and can be viewed online at www.informatics.sepa.org.uk/CarbonCalculator/index.jsp (using the project reference code 2K6B-E55Z-NBQO). A summary is provided in Table 14.1.

Table 14.1: Anticipated Carbon Emissions

Results	Expected	Minimum	Maximum
Net emissions of carbon dioxide (t CO_2 eq.)	259,871	211,028	364,782
Carbon Payback Period of Proposed Development Comparison			
Displacing Coal-fired electricity generation (years)	1.2	0.8	1.9
Displacing Grid-mix of electricity generation (years)	4.4	2.7	6.9
Displacing Fossil fuel - mix of electricity generation (years)	2.5	1.5	3.9

Interpretation of Results

14.4.3 The calculations of total CO_2 emission savings and payback time for the Proposed Development indicates the overall payback period of a windfarm with up to 18 turbines with an average (expected) installed capacity of 5.6MW per turbine would be approximately 2.5 years, when compared to the fossil fuel mix (the existing energy mix within the UK) of electricity generation.

14.5 Conclusions

14.5.1 The Proposed Development is expected to take around 30 months (2.5 years) to repay the carbon exchange to the atmosphere (the CO_2 debt) through construction of the wind farm. There are no current guidelines about what payback time constitutes a significant effect. However, this is a small percentage (5.0%) of the 50-year lifespan of the Proposed Development.

14.5.2 Compared to fossil fuel electricity generation projects, which also produce embodied emissions during the construction phase and significant emissions during operation due to combustion of fossil fuels, the Proposed Development has a very low carbon footprint and after 2.5 years, the electricity generated is estimated to be carbon neutral and will displace grid electricity generated from fossil fuel sources. The Site would in effect be in a net gain situation following this time period and will then be contributing to national objectives of reducing greenhouse gas emissions and meeting the 'net zero' carbon targets by 2045, therefore the Proposed Development is evaluated to have an overall **beneficial** effect on climate change.

14.6 References

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