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TABLES

TECHNICAL APPENDICES

INTRODUCTION

12.1 The 'carbon calculator' is the Scottish Government's tool provided to support the process of determining wind farm developments in Scotland. The purpose of the tool is to assess, in a comprehensive and consistent way, the carbon impact of wind farm developments. This is done by comparing the carbon costs of wind farm developments with the carbon savings attributable to the wind farm.

12.2 The methodology to calculate carbon emissions is based on 'Calculating carbon savings from windfarms on Scottish peat lands - A New Approach' (Ref 12.1), 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 This was superseded in 2011 by the document 'Calculating Carbon Savings from Wind Farms on Scottish Peatlands - A New Approach', (Ref. 12.2). In terms of carbon footprint, the 'carbon calculator' is the Scottish Government's tool provided to support the process of determining the carbon impact of wind farm developments in Scotland

12.3 This chapter has been produced to provide an assessment of the carbon emission calculation generated in the construction, operation and decommissioning of the Clashindarroch II Wind Farm (the proposed development). This spreadsheet calculates payback time for wind farms sited on peatlands using methods given in Nayak et al (Ref. 12.3)) and revised equations for GHG emissions as outlined in Calculating carbon budgets of windfarms on Scottish peatland (Ref. 12.3).

INPUT PARAMETERS

12.4 The assessment of the carbon payback 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.

12.5 The calculation spreadsheet (Version 2.9.0 and online version v1.6.0 reference number UIX6-MDEN-B4YX v6) allows a range of data to be inputted in order to utilise expected, minimum and maximum values, where relevant and applicable. However, 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. The expected value is based on the most realistic option for the Site.

12.6 To undertake this assessment 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 surface of the Site, but eliminated by construction activity (including the destruction of active bog plants on wet sites) 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 and from forestry clearance.

12.7 The final turbine choice is not yet known, but would have an installed generation capacity of around 5.5MW and the greenhouse gas savings and carbon payback are based on the input parameters of the proposed 14 turbines. Figures are based on currently available turbines and assume a consistent supplier for all turbine locations (i.e. turbine types are chosen by manufacturer). Note that within the calculation spreadsheet, the expected, maximum and minimum values have been adjusted to suit the input parameter.

12.8 For this reason, the factors which have been used include the following:

- the calculation spreadsheet has used 37.5% in order to calculate the expected payback for a 5.5MW machine;
- no Site-specific measurements for carbon content of peat have been undertaken for the proposed development. Primarily, the Site has very little peat (>0.5m) and mostly comprises peaty soils (<0.5m). The anticipated content of 55% has therefore been used as the expected value. To ensure variations are accounted for with regard to peat, variable parameters have been used ranging from 49% (minimum) to 62% (maximum). This reflects a range of values typical of the carbon content anticipated from Scottish Peatlands (Ref. 12.4). The value of 55% is consistent with an average value for Scottish peat lands and is representative of typical peat from the area. This value is also consistent with peat values researched by Lindsey (Ref. 12.5);
- generic hydrological parameters have been used for average groundwater. A value of 0.2m has been used as the expected value. A 'maximum' value of 0.1m has been used to represent areas of intact peat (the higher the water table the longer the payback period), and a 'minimum' value of 0.3m has been used to represent areas of eroded peat;
- the extent of drawdown on drainage features due to excavations onsite is based on the analysis in the EIA Report (Chapter 11). Assuming an average thickness of soils of 0.2m then the extent of drawdown around infrastructure, such as turbine bases, roads and crane pads using the Site, derived permeability values for the peat is an average of approximately 5m;
- the most recent values for the three required counterfactual factors provided in the calculation spreadsheet have been included. These are derived from the latest DUKES publication (Ref.12.7) and are: Grid mix: 0.253587t CO_2 MWh-1, fuel mix: 0.45t CO_2 MWh-1 and coal: 0.920t CO_2 MWh-1;
- access tracks - modifications of track length, the extent of floating road and excavated roads have been used as outlined in the draft Construction Environmental Management Plan 2019 (CEMP);
- detail regarding the estimated excavation size for turbine foundations and hard standings is provided;
- an estimate of the total volume of concrete has been included, based on an anticipated

450m^3 concrete being required for each foundation with additional provision for building foundations associated with the control building and substation; and

- significant tree felling is required, however equivalent replanting is also planned with an overall net loss of 87.1 hectares.

12.9 The choice of methodology for calculating the emission factors uses the 'Site Specific methodology' defined within the calculation spreadsheet.

RESULTS

Estimated Payback for a 5.5MW turbine

12.10 Table 12-1 shows the estimated payback periods for the proposed development, using a 5.5MW turbine as the candidate model. A more detailed summary of the Carbon Calculator is included as Appendix 12.1.

Table 12-1
Carbon Calculator Results

Results			
	Exp.	Min.	Max.
Net emissions of carbon dioxide (t CO_2 eq)	151,744	148,994	153,701
Carbon Payback Time Coal-fired electricity generation (years)	0.7	0.6	0.7
Grid-mix of electricity generation (years)	2.4	2.2	2.6
Fossil fuel – mix of electricity generation (years)	1.3	1.2	1.4
Ratio of CO_2 eq. emissions to power generation (g / kWh) (TARGET ratio by 2030 (electricity generation) < 50g / kWh)	20	18	22

STATEMENT OF SIGNIFICANCE

12.11 The calculations of total carbon dioxide emission savings and payback time for the proposed development indicates the overall payback period of a wind farm with 14 turbines with an installed capacity of 5.5MW would be around (1.2-1.4 years), when compared to the fossil fuel mix of electricity generation.

12.12 This means that the Site is anticipated to take around 16 months (1.3 years) expected value, to repay the carbon exchange to the atmosphere (the CO_2 debt) through construction of a wind farm. The Site would in effect be in a net gain situation following this time period and can then claim to contribute to national objectives.

REFERENCES

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Ref. 12.2 Calculating Carbon Savings from Wind Farms on Scottish Peatlands - A New Approach (2011), Nayak et al; 2008 and 2010 and Smith et al.

Ref. 12.3: Nayak, D.R., Miller, D., Nolan, A., Smith, P. and Smith, J.U., 2010, Calculating carbon budgets of wind farms on Scottish peatland. Mires and Peat 4: Art. 9. Online: http://mires-and-peat.net/pages/volumes/map04/map0409.php [accessed 25/11/2019]

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Ref. 12.6: Scottish Natural Heritage (SNH), SEPA, Scottish Government & The James Hutton Institute. (2014). Peat Survey Guidance; Developments on Peatland: Site Surveys. http://www.gov.scot/Topics/Business-Industry/Energy/Energy-sources/19185/17852-1/CSavings/PSG2011

Ref. 12.7 Digest of UK Energy Statistics (DUKES) (July 2019), https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/836332/DUKES_2019_long_term_trends_dataset.xls [accessed 25/11/2019], Department for Business, Energy & Industrial Strategy.