Glenburnie Wind Farm

AEI Technical Appendix 14.2

Carbon Balance Assessment

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1 Introduction

1.1.1 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.

1.1.2 The assessment presented in this Technical Appendix has been produced to calculate the carbon emissions generated in the construction, operation and decommissioning of Glenburnie Wind Farm (the revised proposed development).

1.1.3 The carbon calculator spreadsheet and online tool calculates payback time for wind farm sites on peatland, using methods given in Nayak et al[1] and revised equations for Greenhouse Gas (GHG) emissions (Nayak et al, 2010[2] and Smith et al, 2011[3] , and the Wind Farm and Carbon Savings Technical Note[4] v2.2.10.0.

1.1.4 At the time of submission, the online tool is not accessible, and therefore the assessment has been undertaken using the Carbon Assessment Tool spreadsheet (v2.14.1), issued by SEPA.

2 Input Parameters

2.1.1 The carbon calculator submitted allows a range of data to be input to utilise expected, minimum and maximum values, where relevant and applicable. If several parameters are varied together, however, 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 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.

2.1.2 Information relating to the revised proposed development (including consideration of design, operation, and construction) has been collated, and includes details of the proposed infrastructure, local ecology, and restoration proposals associated with the revised proposed development. This collated information has been entered into the carbon calculator spreadsheet and is outlined below.

- The recommended capacity factor within the calculation spreadsheet has been amended to a site-specific value (46.4%).

[1] Nayak D.R., Miller D., Nolan A., Smith P., Smith J.U. (2008) Calculating carbon savings from windfarms on Scottish peatlands: a new approach. Scottish Government.

[2] Nayak D.R., Miller D., Nolan A., Smith P., Smith J.U. (2010) Mires and Peat., Article 09 4, 1-23 http://www.mires-and-peat.net/, ISSN 1819-754X.

[3] 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.

[4] Scottish Government (2016). Calculating Potential carbon losses and savings from wind farms on Scottish peatlands. Technical Note – Version 2.10.0

- The choice of methodology for calculating the emission factors used the 'site-specific methodology' defined within the calculation spreadsheet.
- Default values for carbon content and bulk density of peat have been used for the assessment. The carbon content ranges from 49% to 62% with an expected value of 55% used. This reflects a range of values typical of the carbon content anticipated from Scottish Peatlands (Birnie et al 1991[5] and Lindsay 2010[6]). Typical bulk density values have been sourced from the Windfarm Carbon Calculator Web Tool, User Guidance.
- Generic hydrological parameters have been used for average groundwater. A value of 0.3 m has been used as the expected value. A 'minimum' value of 0.1 m has been used to represent areas of intact peat (the higher the water table, the longer the payback period), and a 'maximum' value of 0.5 m has been used to represent areas of eroded peat. Although limited peat was identified through peat probing, ecological surveys identified much of the site to comprise degraded blanket bog.
- A review of the available literature (Nayak et al., 2008) found that the extent of drainage effects is reported as being anything from 2 m to 50 m horizontally around a site of disturbance. Research into the effects of moor gripping and water table data from other sites yielded a horizontal draw down distance typically of about 2 m. It is thought that in extreme cases, this may extend between 15 m and 30 m, though 15 m is considered an appropriate distance.
- Smith et al. (2011), identified the average extent of drainage impact at three sites (Cross Lochs, Farr Windfarm and Exe Head) as ranging from 3 m to 9 m. However, the actual extent of drainage at any given location will be dependent on local site conditions, including underlying substrata and topography.
- As site specific values are not available, the standard values from 'Windfarm Carbon Calculator Web Tool, User Guidance' have been used. Therefore, the expected value is 10 m (minimum 5 m, maximum 50 m).
- The most recent values for the three required counterfactual factors provided in the online carbon calculator have been included are: Grid Mix 0.19338 t CO_2 MWh^{-1}, fuel mix: 0.432 t CO_2 MWh^{-1} and coal: 1.002 t CO_2 MWh^{-1}.
- Infrastructure dimensions, including estimated excavation size for turbine foundations, hardstands and track lengths is outlined in **AEI Chapter 3**. Although not all proposed borrow pits are sited on peatland, conservatively, each location has been included in the assessment. The final dimensions of each borrow pit have yet to be defined. Average dimensions from the search areas identified have been used, however it is unlikely that actual borrow pits would be as large.
- The assessment is based on a series of average soil depths taken from peat surveys undertaken at the site. Probe locations sited on mineral / organic soils (<0.5 m) are conservatively included within the averages.

[5] Birnie R.V., Clayton P., Griffiths P., Hulme P.D., Robertson, R.A., Sloane B.D., and S.A. Ward. (1991). Scottish peat resources and their energy potential. Department of Energy

[6] Lindsay, R. (2010). Peatbogs and Carbon: a critical synthesis. RSPB

3 Results

3.1.1 A summary of the anticipated carbon emissions and carbon payback of the revised proposed development is presented in **Plate 1** and can be viewed in the Carbon Calculator Spreadsheet, included as Annex 1.

Plate 1 Estimated Payback Period

RESULTS	*Exp.*	*Min.*	*Max.*
Net emissions of carbon dioxide (t $CO_{2\ eq.}$)	**121429**	**26353**	**175778**
Carbon Payback Time			
…coal-fired electricity generation (years)	0.4	0.1	0.5
…grid-mix of electricity generation (years)	2.0	0.4	2.8
…fossil fuel - mix of electricity generation (years)	**0.9**	**0.2**	**1.3**
Ratio of soil carbon loss to gain by restoration (TARGET ratio (Natural Resources Wales) < 1.0)	**No gains!**	**No gains!**	**No gains!**
Ratio of CO_2 eq. emissions to power generation (g / kWh) (TARGET ratio by 2030 (electricity generation) < 50 g /kWh)	**7.54**	**1.63**	**10.94**

4 Conclusion

4.1.1 The calculations of total carbon dioxide emission savings and payback time for the revised proposed development indicates the overall payback period for the revised proposed development is between 0.2 and 1.3 years, when compared to the fossil fuel mix of electricity generation.

4.1.2 This means that the revised proposed development is anticipated to take a a period of 0.9 years (approximately 11 months) to repay the carbon exchange to the atmosphere (the $C0_2$ debt) following its construction. This is the period of time for which a wind farm needs to be in operation before it has, by displacing generation from fossil-fuelled power stations, avoided as much carbon dioxide as was released in its lifecycle.