STRATHY SOUTH WIND FARM

Technical Appendix 12.1

Carbon Calculator

Prepared for: **SSE Generation Ltd**

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1.0 Introduction

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.

The assessment presented in this Technical Appendix 12.1 has been produced to provide an update in the carbon emission calculation generated in the construction, operation and decommissioning of the Proposed Varied Development at Strathy South. The carbon calculator spreadsheet and online tool calculates payback time for wind farms sited on peatlands using methods given in Nayak et al, 2008[1] and revised equations for Greenhouse Gas (GHG) emissions (Nayak et al, 2010[2] & Smith et al ,2011[3], and the Wind Farm and Carbon Savings Technical Note[4] v.2 2.10.0.

Input Parameters

The carbon calculator (Online version H823-UAJR-7P81) allows a range of data to be input 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.

The final turbine choice is not yet finalised but would likely be 5.6 MW. For this reason, the factors which have been used in this assessment include the following:

- The recommended capacity factor within the calculation spreadsheet has been amended to site-specific values, ranging between 40 and 50 %.
- Site-specific measurements for carbon content of peat have been undertaken previously at the site. The anticipated content of 48% has therefore been used as the expected value. To ensure variations are accounted for with regard to peat, variable parameters have been used, based on those recorded from samples taken on-site, ranging from 38% (minimum) to 56% (maximum). This reflects a range of values typical of the carbon content anticipated from Scottish Peatlands (Birnie et al 1991)[5]. The value of 48% is generally consistent with an average value for Scottish peatlands and is representative of a typical peat from the area. This value is also consistent with peat values researched by Lindsay (2010)[6].
- Generic hydrological parameters have been used for average groundwater. A value of 0.1 m has been used as the expected value. A 'maximum' value of 0.05 m has been used to represent areas of intact

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[1] Nayak D.R., Miller D., Nolan A., Smith P., Smith J.U. (2008) *Calculating carbon savings from windfarms on Scottish peat lands: 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

[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

peat (the higher the water table the longer the payback period), and a 'minimum' value of 0.3 m has been used to represent areas of eroded peat.

- The extent of drawdown on drainage features due to excavations on-site is based on the analysis in the Chapter 10: Soil and Water (EIAR Volume 2). Assuming an average peat thickness of 1.23 m 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 5 m.
- The most recent values for the three required counterfactual factors provided in the online carbon calculator have been included and are: Grid mix: 0.25358 t CO_2 MWh^{-1}, fuel mix: 0.45 t CO_2 MWh^{-1} and coal: 0.92 t CO_2 MWh^{-1}
- Access tracks. Modifications of track length, the extent of floating road and excavated roads have been used as outlined in Chapter 2: Description of Development (EIAR Volume 2).
- 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 860 m^3 concrete being required for each foundation.
- The choice of methodology for calculating the emission factors uses the 'Site-Specific methodology' defined within the calculation spreadsheet.

2.0 Results

A summary of the anticipated carbon emissions and carbon payback of the Proposed Varied Development are presented in Plate 2-1.

Plate 2-1
Estimated Payback Period for 35 No. 5.6 MW Turbines

RESULTS	Exp.	Min.	Max.
Net emissions of carbon dioxide (t CO2 eq.)	506,066	245,542	681,390
Carbon Payback Time			
...coal-fired electricity generation (years)	0.7	0.3	1.1
...grid-mix of electricity generation (years)	2.6	1.1	3.9
...fossil fuel-mix of electricity generation (years)	1.5	0.6	2.2
Ratio of soil carbon loss to gain by restoration (not used in Scottish applications)	1.67	0.26	No gains!
Ratio of CO2 eq. emissions to power generation (g/kWh) (for info. only)	13.10	5.72	19.84

3.0 Conclusions

The calculations of total carbon dioxide emission savings and payback time for the Proposed Varied Development indicates the overall payback period for 35 turbines with an installed capacity around 5.6 MW would be around 0.6 to 2.2 years, when compared to the fossil fuel mix of electricity generation.

This means that the Proposed Varied Development is anticipated to take around 18 months (1.5 years) to repay the carbon exchange to the atmosphere (the CO_2 debt) following its construction; the site would, in effect, be in a net gain situation following this time period and could then claim to contribute to Scottish Government's national objectives on reducing emissions[7].

The results of the carbon calculator for the Proposed Varied Development can be compared against the Consented Scheme assessment which indicated the overall payback period for 35 turbines with an installed capacity around 3.4 MW would be around -0.5 to 4.6 years, when compared to the fossil fuel mix of electricity generation.

This shows that the Proposed Varied Development would have a significantly shorter estimated maximum payback time.

[7] Climate Change (Emissions Reduction Targets) (Scotland) Act 2019

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