

Appendix 5.1: Carbon Calculator Input and Results

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Client: Constantine Wind Energy (UK) Ltd

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Appendix 5.1: Carbon Calculator Input and Results

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1.1 Carbon Calculator Results

	Exp.	Min.	Max.
1. Windfarm CO2 emission saving over...			
...coal-fired electricity generation (t CO2 / yr)	5,476	5,203	5,749
...grid-mix of electricity generation (t CO2 / yr)	1,200	1,140	1,259
...fossil fuel-mix of electricity generation (t CO2 / yr)	2,457	2,334	2,580
Energy output from windfarm over lifetime (MWh)	202,816	192,698	212,934
Total CO2 losses due to wind farm (tCO2 eq.)	Exp.	Min.	Max.
2. Losses due to turbine life (eg. manufacture, construction, decommissioning)	1,345	1,316	1,373
3. Losses due to backup	975	0	975
4. Losses due to reduced carbon fixing potential	81	24	148
5. Losses from soil organic matter	-60	-348	473
6. Losses due to DOC & POC leaching	0	0	0
7. Losses due to felling forestry	0	0	0
Total losses of carbon dioxide	2,341	992	2,969
8. Total CO2 gains due to improvement of site (t CO2 eq.)	Exp.	Min.	Max.
8a. Change in emissions due to improvement of degraded bogs	0	0	0
8b. Change in emissions due to improvement of felled forestry	0	0	0
8c. Change in emissions due to restoration of peat from borrow pits	0	0	0
8d. Change in emissions due to removal of drainage from foundations & hardstanding	0	0	0
Total change in emissions due to improvements	0	0	0
RESULTS	Exp.	Min.	Max.
Net emissions of carbon dioxide (t CO2 eq.)	2,341	992	2,969
Carbon Payback Time			
...coal-fired electricity generation (years)	0.4	0.2	0.6
...grid-mix of electricity generation (years)	2.0	0.8	2.6
...fossil fuel-mix of electricity generation (years)	1.0	0.4	1.3
Ratio of soil carbon loss to gain by restoration (not used in Scottish applications)	No gains!	No gains!	No gains!
Ratio of CO2 eq. emissions to power generation (g/kWh) (for info. only)	11.54	4.66	15.41

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1.2 Carbon Calculator Inputs

Table 1 - Carbon Calculator Input Data

Input data	Expected value	Minimum value	Maximum value	Source of data
Windfarm characteristics				
Dimensions				
No. of turbines	3	3	3	EIA Report Chapter 2: Proposed Development
Duration of consent (years)	35	35	35	EIA Report Chapter 2: Proposed Development
Performance				
Power rating of 1 turbine (MW)	0.5	0.5	0.5	EIA Report Chapter 2: Proposed Development
Capacity factor	44.1	41.9	46.3	Raw Wind Resource Data
Backup				
Fraction of output to backup (%)	5	0	5	Guidance in results tab - conservative - Nayak et al. (2008)
Additional emissions due to reduced thermal efficiency of the reserve generation (%)	10	10	10	Fixed
Total CO2 emission from turbine life (tCO2 MW ⁻¹) (eg. manufacture, construction, decommissioning)	Calculate wrt installed capacity	Calculate wrt installed capacity	Calculate wrt installed capacity	Scottish Carbon Calculator
Characteristics of peatland before windfarm development				
Type of peatland	Acid bog	Acid bog	Acid bog	Appendix 7.1 - Peat Management Plan
Average annual air temperature at site (°C)	8.8	8.36	9.24	Met Office. Stornoway Airport Weather Station (1990-2020) ¹

¹ <https://www.metoffice.gov.uk/research/climate/maps-and-data/uk-climate-averages/gf7e0jd30> (Accessed 04/03/2024)

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Input data	Expected value	Minimum value	Maximum value	Source of data
Average depth of peat at site (m)	0.5	0.475	0.525	Raw Data from Peat Probing. Appendix 7.1 – Outline Peat Management Plan
C Content of dry peat (% by weight)	44.1	38.9	49.4	Scottish Soil's mapping by SEPA
Average extent of drainage around drainage features at site (m)	10	5	15	Smith et al (2011) Worst case Scenario
Average water table depth at site (m)	0.3	0.1	0.5	Exact value unknown as this stage so used guidance from 'Calculating Potential Carbon Losses & Savings from Wind Farms on Scottish Peatlands'
Dry soil bulk density (g cm ⁻³)	0.132	0.072	0.293	Assumed decomposed peat value, National Soil Inventory of Scotland
Characteristics of bog plants				
Time required for regeneration of bog plants after restoration (years)	4	3	5	Raw Data, already well covered site.
Carbon accumulation due to C fixation by bog plants in undrained peats (tC ha ⁻¹ yr ⁻¹)	0.25	0.12	0.31	NatureScot recommended value, Calculating carbon savings from wind farms on Scottish peat lands: a new approach
Forestry Plantation Characteristics				
Area of forestry plantation to be felled (ha)	0	0	0	EIA Report Chapter 5: Carbon Balance, Section 5.7.3
Average rate of carbon sequestration in timber (tC ha ⁻¹ yr ⁻¹)	0	0	0	N/A
Counterfactual emission factors				
Coal-fired plant emission factor (t CO ₂ MWh ⁻¹)	0.945	0.945	0.945	Fixed
Grid-mix emission factor (t CO ₂ MWh ⁻¹)	0.207	0.207	0.207	Fixed
Fossil fuel-mix emission factor (t CO ₂ MWh ⁻¹)	0.424	0.424	0.424	Fixed
Borrow pits				
Number of borrow pits	0	0	0	EIA Report Chapter 2: Proposed Development

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Input data	Expected value	Minimum value	Maximum value	Source of data
Average length of pits (m)	0	0	0	EIA Report Chapter 2: Proposed Development
Average width of pits (m)	0	0	0	EIA Report Chapter 2: Proposed Development
Average depth of peat removed from pit (m)	0	0	0	EIA Report Chapter 2: Proposed Development
Access tracks				
Total length of access track (m)	1300	1235	1365	EIA Report Chapter 2: Proposed Development
Existing track length (m)	930	883.5	976.5	EIA Report Chapter 2: Proposed Development
Length of access track that is floating road (m)	80	76	84	EIA Report Chapter 2: Proposed Development
Floating road width (m)	5.5	5.225	5.775	EIA Report Chapter 2: Proposed Development. Average of 4m on straight sections and 7m on bends.
Floating road depth (m)	0.5	0.475	0.525	EIA Report Chapter 2: Proposed Development
Length of floating road that is drained (m)	80	76	84	EIA Report Chapter 2: Proposed Development
Average depth of drains associated with floating roads (m)	0.42	0.399	0.441	EIA Report Chapter 2: Proposed Development
Length of access track that is excavated road (m)	290	275.5	304.5	EIA Report Chapter 2: Proposed Development
Excavated road width (m)	5.5	5.225	5.775	EIA Report Chapter 2: Proposed Development. Average of 4m on straight sections and 7m on bends.
Average depth of peat excavated for road (m)	0.2	0.19	0.21	Estimate based on Peat Probing raw data.
Length of access track that is rock filled road (m)	0	0	0	N/A

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Rock filled road width (m)	0	0	0	N/A
Rock filled road depth (m)	0	0	0	N/A
Length of rock filled road that is drained (m)	0	0	0	N/A
Average depth of drains associated with rock filled roads (m)	0	0	0	N/A
Cable trenches				
Length of any cable trench on peat that does not follow access tracks and is lined with a permeable medium (eg. sand) (m)	0	0	0	N/A
Average depth of peat cut for cable trenches (m)	0	0	0	N/A
Additional peat excavated (not already accounted for above)				
Volume of additional peat excavated (m ³)	30.7	29.2	32.2	Peat Probing Survey Data of Storage Containers. Appendix 7.1 – Outline Peat Management Plan
Area of additional peat excavated (m ²)	321.1	305.04	337.2	Peat Probing Survey Data of Storage Containers. Appendix 7.1 – Outline Peat Management Plan
Peat Landslide Hazard				
Peat Landslide Hazard and Risk Assessments: Best Practice Guide for Proposed Electricity Generation Developments	negligible	negligible	negligible	Fixed
Improvement of C sequestration at site by blocking drains, restoration of habitat etc				
Improvement of degraded bog				
Area of degraded bog to be improved (ha)	0	0	0	Data not currently available, will be incorporated into Appendix 8.1 - Outline Habitat Biodiversity Enhancement Management Plan.
Water table depth in degraded bog before improvement (m)	0	0	0	
Water table depth in degraded bog after improvement (m)	0	0	0	
Time required for hydrology and habitat of bog to return to its previous state on improvement (years)	0	0	0	

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Input data	Expected value	Minimum value	Maximum value	Source of data
Period of time when effectiveness of the improvement in degraded bog can be guaranteed (years)	0	0	0	
Improvement of felled plantation land				
Area of felled plantation to be improved (ha)	0	0	0	N/A - no felled plantation.
Water table depth in felled area before improvement (m)	0	0	0	
Water table depth in felled area after improvement (m)	0	0	0	
Time required for hydrology and habitat of felled plantation to return to its previous state on improvement (years)	0	0	0	
Period of time when effectiveness of the improvement in felled plantation can be guaranteed (years)	0	0	0	
Restoration of peat removed from borrow pits				
Area of borrow pits to be restored (ha)	0	0	0	N/A - No borrow pits.
Depth of water table in borrow pit before restoration with respect to the restored surface (m)	0	0	0	
Depth of water table in borrow pit after restoration with respect to the restored surface (m)	0	0	0	
Time required for hydrology and habitat of borrow pit to return to its previous state on restoration (years)	0	0	0	
Period of time when effectiveness of the restoration of peat removed from borrow pits can be guaranteed (years)	0	0	0	
Early removal of drainage from foundations and hardstanding				
Water table depth around foundations and hardstanding before restoration (m)	0	0	0	Data not available.
Water table depth around foundations and hardstanding after restoration (m)	0	0	0	
Time to completion of backfilling, removal of any surface drains, and full restoration of the hydrology (years)	0	0	0	
Restoration of site after decommissioning				

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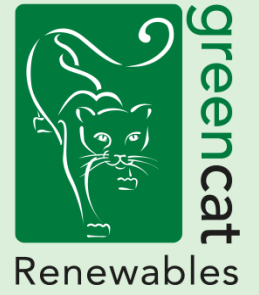
Input data	Expected value	Minimum value	Maximum value	Source of data
Will the hydrology of the site be restored on decommissioning?	No	No	No	
Will you attempt to block any gullies that have formed due to the windfarm?	Yes	Yes	Yes	EIA Report Chapter 7 -Hydrology and Appendix 8.1 - Outline Habitat Biodiversity Enhancement Management Plan.
Will you attempt to block all artificial ditches and facilitate rewetting?	No	No	No	Intend to facilitate rewetting but details unknown at this stage.
Will the habitat of the site be restored on decommissioning?	Yes	Yes	Yes	
Will you control grazing on degraded areas?	n/a	n/a	n/a	To be confirmed
Will you manage areas to favour reintroduction of species	n/a	n/a	n/a	To be confirmed

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Table 2 - Construction Input Data

Construction Input Data	Expected Value	Maximum	Minimum	Source of Data
Development Infrastructure				
Number of turbines in this area	3	3	3	EIA Report Chapter 2: Proposed Development
Turbine foundations				
Depth of hole dug when constructing foundations (m)	0.1	0.095	0.11	Peat probing Raw Data
Approximate geometric shape of whole dug when constructing foundations	Circular	Circular	Circular	EIA Report Chapter 2: Proposed Development and Drawing C5507-GCR-WF-DT-DR-P-0002
Diameter at bottom	15	15	15	
Diameter at surface	7	7	7	
Hardstanding				
Depth of hole dug when constructing hardstanding (m)	0.13	0.12	0.14	Peat probing Raw Data
Approximate geometric shape of whole dug when constructing hardstanding	Rectangular	Rectangular	Rectangular	EIA Report Chapter 2: Proposed Development
Length at surface	40	40	40	
Width at surface	34	34	34	
Length at bottom	40	40	40	
Width at bottom	34	34	34	
Piling				
Is piling used?	No	No	No	Post-consent decision
Volume of Concrete				
Volume of concrete used (m ³) in the entire area	1800	1710	1890	Raw Data



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