

TECHNICAL APPENDIX 12.3 - CARBON CALCULATOR

Table 12.3-A: Carbon Calculator Input

CARBON CALCULATOR TOOL v1.7.0				Ref: M21A-KV42-OAS0 (v6)
Input data	Expected value	Minimum value	Maximum value	Source of data
Windfarm Characteristics				
Dimensions				
No. of turbines	6	5	6	Chapter 1: Introduction
Duration of consent (years)	35	35	35	Chapter 1: Introduction
Performance				
Power rating of 1 turbine (MW)	5.7	5.7	5.7	Chapter 1: Introduction
Capacity factor	36.7	33.03	40.37	Chapter 1: Introduction
Backup				
Fraction of output to backup (%)	5	4.5	5.5	Standard value recommended by the carbon calculator (Assumes more than 20% of national electricity is generated by wind energy)
Additional emissions due to reduced thermal efficiency of the reserve generation (%)	10	10	10	Default
Total CO ₂ emission from turbine life (tCO ₂ MW ⁻¹) (eg. manufacture, construction, decommissioning)	Calculated from installed capacity			
Characteristics of peatland before windfarm development				
Type of peatland	Acid bog			
Average annual air temperature at site (°C)	9.25	5.76	12.73	Met office climate station - Tredegar: https://www.metoffice.gov.uk/research/climate/maps-and-data/uk-climate-averages/gcjww0udy
Average depth of peat at site (m)	0.41	0.0	5.2	Site peat depth data
Content of dry peat (% by weight)	31.6	19.4	47.1	Envirolab analysis of soil samples
Average extent of drainage around drainage features at site (m)	0.75	0.5	1.0	Estimates based on observations of drainage around excavated ditches
Average water table depth at site (m)	0.3	0.2	0.5	Estimate based on observed/measured ground conditions
Dry soil bulk density (g cm ⁻³)	0.3	0.25	0.3	Envirolab analysis of soil samples
Characteristics of bog plants				
Time required for regeneration of bog	3.0	3.0	10.0	Chapter 6: Geology, Hydrology, Hydrogeology and Peat

CARBON CALCULATOR TOOL v1.7.0				Ref: M21A-KV42-OAS0 (v6)
Input data	Expected value	Minimum value	Maximum value	Source of data
plants after restoration (years)				
Carbon accumulation due to C fixation by bog plants in undrained peats (tC ha ⁻¹ yr ⁻¹)	0.25	0.225	0.275	Default value
Forestry Plantation Characteristics				
Area of forestry plantation to be felled (ha)	0.0	0.0	0.0	No forestry on site
Average rate of carbon sequestration in timber (tC ha ⁻¹ yr ⁻¹)	0.0	0.0	0.0	No forestry on site
Counterfactual emission factors				
Coal-fired plant emission factor (t CO ₂ MWh ⁻¹)	0.92	0.92	0.92	Scottish Government Carbon Calculator
Grid-mix emission factor (t CO ₂ MWh ⁻¹)	0.25358	0.25358	0.25358	Scottish Government Carbon Calculator
Fossil fuel-mix emission factor (t CO ₂ MWh ⁻¹)	0.45	0.45	0.45	Scottish Government Carbon Calculator
Borrow pits				
Number of borrow pits	0.0	0.0	0.0	No borrow pits on site
Average length of pits (m)	0.0	0.0	0.0	No borrow pits on site
Average width of pits (m)	0.0	0.0	0.0	No borrow pits on site
Average depth of peat removed from pit (m)	0.0	0.0	0.0	No borrow pits on site
Foundations and hard-standing area associated with each turbine				
Average length of turbine foundations (m)	22.0	19.8	24.2	Infrastructure design and aggregate estimates
Average width of turbine foundations (m)	22.0	19.8	24.2	Infrastructure design and aggregate estimates
Average depth of peat removed from turbine foundations (m)	0.38	0.2	0.6	Site peat depth data
Average length of hard-standing (m)	177.5	162	193	Infrastructure design and aggregate estimates
Average width of hard-standing (m)	60.5	58	63	Infrastructure design and aggregate estimates
Average depth of peat removed from hard-standing (m)	0.4	0.05	1.1	Infrastructure design and aggregate estimates
Volume of concrete (m ³)	7,982.8	7,184.5	8,781.08	Infrastructure design and aggregate estimates

CARBON CALCULATOR TOOL v1.7.0				Ref: M21A-KV42-OAS0 (v6)
Input data	Expected value	Minimum value	Maximum value	Source of data
<u>Access tracks</u>				
Total length of access track (m)	5,279	4,751.1	5,806.9	Infrastructure design and aggregate estimates
Existing track length (m)	0.0	0.0	0.0	No existing track
Length of access track that is floating road (m)	0.0	0.0	0.0	N/A
Width of access track that is floating road (m)	0.0	0.0	0.0	N/A
Length of access track that is excavated road (m)	1,254.0	1,128.6	1,379.4	Infrastructure design and aggregate estimates
Excavated road width (m)	5.5	5.5	5.5	Infrastructure design and aggregate estimates
Average depth of peat excavated for road (m)	0.35	0.0	1.1	Chapter 6: Geology, Hydrology, Hydrogeology and Peat
Length of access track that is rock filled road (m)	4,025.0	3,622.5	4,427.5	Infrastructure design and aggregate estimates
Rock filled road width (m)	5.5	5.0	6.05	Infrastructure design and aggregate estimates
Rock filled road depth (m)	0.5	0.45	0.55	Infrastructure design and aggregate estimates
Length of rock filled road that is drained (m)	4,025.0	3,622.5	4,427.5	Infrastructure design and aggregate estimates
Average depth of drains associated with rock filled roads (m)	0.2	0.1	0.3	Infrastructure design and aggregate estimates
<u>Cable trenches</u>				
Length of any cable trench on peat that does not follow access tracks and is lined with a permeable medium (eg. sand) (m)	252.0	95.0	277.2	Infrastructure design and aggregate estimates
Average depth of peat cut for cable trenches (m)	0.4	0.2	0.6	Chapter 6: Geology, Hydrology, Hydrogeology and Peat
<u>Additional peat excavated (not already accounted for above)</u>				
Volume of additional peat excavated (m ³)	1,982	1,487	2,477.5	Chapter 6: Geology, Hydrology, Hydrogeology and Peat
Area of additional peat excavated (m ²)	7,500	6,750	8,250	Chapter 6: Geology, Hydrology, Hydrogeology and Peat
<u>Peat Landslide Hazard</u>				
Peat Landslide Hazard and Risk Assessments: Best Practice Guide for Proposed Electricity	Negligible	Negligible	Negligible	Chapter 6: Geology, Hydrology, Hydrogeology and Peat

CARBON CALCULATOR TOOL v1.7.0				Ref: M21A-KV42-OAS0 (v6)
Input data	Expected value	Minimum value	Maximum value	Source of data
Generation Developments				
Improvement of C sequestration at site by blocking drains, restoration of habitat etc				
<u>Improvement of degraded bog</u>				
Area of degraded bog to be improved (ha)	0.0	0.0	0.0	No options within site for peat restoration
Water table depth in degraded bog before improvement (m)	0.0	0.0	0.0	No options within site for peat restoration
Water table depth in degraded bog after improvement (m)	0.0	0.0	0.0	No options within site for peat restoration
Time required for hydrology and habitat of bog to return to its previous state on improvement (years)	0.0	0.0	0.0	No options within site for peat restoration
Period of time when effectiveness of the improvement in degraded bog can be guaranteed (years)	0.0	0.0	0.0	No options within site for peat restoration
<u>Improvement of felled plantation land</u>				
Area of felled plantation to be improved (ha)	0.0	0.0	0.0	No forestry on site
Water table depth in felled area before improvement (m)	0.0	0.0	0.0	No forestry on site
Water table depth in felled area after improvement (m)	0.0	0.0	0.0	No forestry on site
Time required for hydrology and habitat of felled plantation to return to its previous state on improvement (years)	0.0	0.0	0.0	No forestry on site
Period of time when effectiveness of the improvement in felled plantation can be guaranteed (years)	0.0	0.0	0.0	No forestry on site
<u>Restoration of peat removed from borrow pits</u>				
Area of borrow pits to be restored (ha)	0.0	0.0	0.0	No borrow pits
Depth of water table in borrow pit before restoration with respect to the restored surface (m)	0.0	0.0	0.0	No borrow pits

CARBON CALCULATOR TOOL v1.7.0				Ref: M21A-KV42-OAS0 (v6)
Input data	Expected value	Minimum value	Maximum value	Source of data
Depth of water table in borrow pit after restoration with respect to the restored surface (m)	0.0	0.0	0.0	No borrow pits
Time required for hydrology and habitat of borrow pit to return to its previous state on restoration (years)	0.0	0.0	0.0	No borrow pits
Period of time when effectiveness of the restoration of peat removed from borrow pits can be guaranteed (years)	0.0	0.0	0.0	No borrow pits
Early removal of drainage from foundations and hardstanding				
Water table depth around foundations and hard standing before restoration (m)	0.5	0.3	0.8	Chapter 6: Geology, Hydrology, Hydrogeology and Peat
Water table depth around foundation and hard standing after restoration (m)	0.3	0.2	0.5	Chapter 6: Geology, Hydrology, Hydrogeology and Peat
Time to completion of backfilling, removal of any surface drains, and full restoration of hydrology (years)	5.0	2.0	5.0	Chapter 6: Geology, Hydrology, Hydrogeology and Peat
Early removal of drainage from foundations and hardstanding				
Will you attempt to block any gullies that have formed due to the windfarm?	N/A	N/A	N/A	Not applicable
Will you attempt to block all artificial ditches and facilitate rewetting?	N/A	N/A	N/A	Not applicable
Will you control grazing on degraded areas?	No	No	No	The majority of the site is Common Land, accessed for grazing
Will you manage areas to favour reintroduction of species	No	No	No	
Methodology				
Choice of methodology for calculating emission factors	Site specific (required for planning applications)			

Table 12.3-B: Carbon Calculator Output

CARBON CALCULATOR TOOL v1.7.0		Ref: M21A-KV42-OAS0 (v6)		
Output data	Expected value	Minimum value	Maximum value	
1. Windfarm CO2 emission saving over...				
...coal-fired electricity generation (t CO ₂ / yr)	110,170	82,628	121,187	
...grid-mix of electricity generation (t CO ₂ / yr)	21,262	15,947	23,388	
...fossil fuel-mix of electricity generation (t CO ₂ / yr)	47,499	35,624	52,248	
Energy output from windfarm over lifetime (MWh)	3,848,259	2,886,194	4,233,085	
2. Losses due to turbine life (eg. manufacture, construction, decommissioning)	31,672	26,562	31,924	
3. Losses due to backup	22,649	16,987	24,914	
4. Losses due to reduced carbon fixing potential	400	271	614	
5. Losses from soil organic matter	10,123	-2,989	50,151	
6. Losses due to DOC & POC leaching	0	0	0	
7. Losses due to felling forestry	0	0	0	
Total losses of carbon dioxide	64,845	40,830	107,604	
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	-75	0	-230	
Total change in emissions due to improvements	-75	0	-230	
Net emissions of carbon dioxide (t CO ₂ eq.)	64,770	40,599	107,640	
Carbon Payback Time				
...coal-fired electricity generation (years)	0.6	0.3	1.3	
...grid-mix of electricity generation (years)	3.0	1.7	6.7	
...fossil fuel-mix of electricity generation (years)	1.4	0.8	3.0	
Ratio of soil carbon loss to gain by restoration (not used in Scottish applications)	134.69	-12.98	No gains!	
Ratio of CO ₂ eq. emissions to power generation (g/kWh) (for info. only)	16.83	9.59	37.28	