Technical Appendix 15.4

Carbon Calculator

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Table 15.1.1: Carbon Calculator Input

Input data	Expected value	Minimum value	Maximum value	Source of data
Windfarm Characteristics				
Dimensions				
No. of turbines	13	13	13	**Chapter 1: Introduction**
Duration of consent (years)	40	40	40	**Chapter 3: Proposed Development**
Performance				
Power rating of 1 turbine (MW)	5.8	5.8	5.8	**Chapter 1: Introduction**
Capacity factor	35	30	40	Department for Business, Energy and Industrial Strategy (2020) Renewable electricity in Scotland, Wales, Northern Ireland and the regions of England in 2020.
Backup				
Fraction of output to backup (%)	5	5	5	Per Nayak et al (2008)
Additional emissions due to reduced thermal efficiency of the reserve generation (%)	10	10	10	Fixed
Total CO_2 emission from turbine life (tCO_2 MW^{-1}) (eg. manufacture, construction, decommissioning)	Calculate wrt installed capacity	Calculate wrt installed capacity	Calculate wrt installed capacity	Scottish Government Carbon Calculator
Characteristics of peatland before windfarm development				
Type of peatland	Acid bog	Acid bog	Acid bog	The calculator offers two options for this item: Fen or Acid Bog. Peatland present on this site is consistent with the Acid Bog option.
Average annual air temperature at site (°C)	9.4	6.4	12.4	Met Office (2020).
Average depth of peat at site (m)	0.93	0	6.2	**Chapter 10: Hydrology, hydrogeology, geology and soils**

Input data	Expected value	Minimum value	Maximum value	Source of data
Content of dry peat (% by weight)	50.45	46.3	54.7	**Chapter 10: Hydrology, hydrogeology, geology and soils**
Average extent of drainage around drainage features at site (m)	0.75	0.5	1	**Chapter 10: Hydrology, hydrogeology, geology and soils**
Average water table depth at site (m)	0.2	0	0.4	**Chapter 10: Hydrology, hydrogeology, geology and soils**
Dry soil bulk density (g cm^{-3})	0.2	0.11	0.26	**Chapter 10: Hydrology, hydrogeology, geology and soils**
Characteristics of bog plants				
Time required for regeneration of bog plants after restoration (years)	3	3	3	**Chapter 8: Ecology and Biodiversity**
Carbon accumulation due to C fixation by bog plants in undrained peats (tC ha^{-1} yr^{-1})	0.38	0.35	0.4	**Chapter 8: Ecology and Biodiversity**
Forestry Plantation Characteristics				
Area of forestry plantation to be felled (ha)	110.9	103.2	125.1	**Technical Appendix 15.1: Forestry**
Average rate of carbon sequestration in timber (tC ha^{-1} yr^{-1})	3.6	2.4	4.4	Default values for Sitka Spruce (highly conservative)
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	3	3	6	**Chapter 3: Proposed Development**
Average length of pits (m)	96.3	80	115	**Technical Appendix 10:3: Borrow Pit Assessment**
Average width of pits (m)	127.7	88	195	**Technical Appendix 10:3: Borrow Pit Assessment**

Input data	Expected value	Minimum value	Maximum value	Source of data
Average depth of peat removed from pit (m)	0.38	0.1	0.8	**Technical Appendix 10:3: Borrow Pit Assessment**
Foundations and Hard-Standing Area Associated with Each Turbine				
Depth of hole dug when constructing foundations (m)	0.66	0.2	1.4	**Technical Appendix 10:2: Outline Peat Management Plan**
Approximate geometric shape of hole dug when constructing foundations	Circular	Circular	Circular	**Chapter 3: Proposed Development**
Diameter at bottom	26	23.4	28.6	Metrics Spreadsheet
Diameter at surface	26	23.4	28.6	Metrics Spreadsheet
Depth of whole dug when constructing hardstanding (m)	0.7	0.2	1.9	**Technical Appendix 10:2: Outline Peat Management Plan**
Approximate geometric shape of hole dug when constructing hardstanding	Rectangular with vertical walls	Rectangular with vertical walls	Rectangular with vertical walls	**Chapter 3: Proposed Development**
Length at surface	112.3	100.8	123.2	Metrics Spreadsheet
Width at surface	60	54	66	Metrics Spreadsheet
Length at bottom	112.3	100.8	123.2	Metrics Spreadsheet
Width at bottom	60	54	66	Metrics Spreadsheet
Is pilling used?	No	No	No	**Chapter 3: Proposed Development**
Volume of concrete	12000	10800	13200	**Chapter 3: Proposed Development**
Access Track				
Total length of access track (m)	23,361	21,025	25,697	Metrics Spreadsheet
Existing track length (m)	12,941	11,647	14,235	Metrics Spreadsheet
Length of access track that is floating road (m)	1,470	1,323	1,617	Metrics Spreadsheet
Floating road width (m)	5.5	5	6	**Chapter 3: Proposed Development**
Floating road depth (m)	0.7	0.6	0.8	Metrics Spreadsheet
Length of floating road that is drained (m)	88	79	96.6	**Chapter 3: Proposed Development**

Input data	Expected value	Minimum value	Maximum value	Source of data
Average depth of drains associated with floating roads (m)	0.5	0.45	0.55	**Chapter 3: Proposed Development**
Length of access track that is excavated road (m)	0	0	0	**Chapter 3: Proposed Development**
Length of access track that is rock filled road (m)	8,950	8,055	9,845	**Chapter 3: Proposed Development**
Rock filled road width (m)	5.5	5	6	**Chapter 3: Proposed Development**
Rock filled road depth (m)	0.8	0.6	1	**Chapter 3: Proposed Development**
Length of rock filled road that is drained (m)	5944	5349.6	6538.4	**Chapter 3: Proposed Development**
Average depth of drains associated with rock filled roads (m)	0.5	0.5	0.5	**Chapter 3: Proposed Development**
Cable trenches				
Length of any cable trench on peat that does not follow access tracks and is lined with a permeable medium (e.g., sand) (m)	0	0	0	All cable routes follow access tracks
Average depth of peat cut for cable trenches (m)	0	0	0	All cable routes follow access tracks
Additional peat excavated (not already accounted for above)				
Volume of additional peat excavated (m^3)	8946	8946	8946	**Technical Appendix 10.2: Peat Management Plan**
Area of additional peat excavated (m^2)	10928	10928	10928	**Technical Appendix 10.2: 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				

Input data	Expected value	Minimum value	Maximum value	Source of data
Area of degraded bog to be improved (ha)	0	0	0	**Chapter 8: Ecology and Biodiversity**
Water table depth in degraded bog before improvement (m)	0.3	0.3	0.3	**Chapter 10: Hydrology, hydrogeology, geology and soils**
Water table depth in degraded bog after improvement (m)	0.1	0	0.2	**Chapter 10: Hydrology, hydrogeology, geology and soils**
Time required for hydrology and habitat of bog to return to its previous state on improvement (years)	3	3	3	**Chapter 8: Ecology and Biodiversity**
Period of time when effectiveness of the improvement in degraded bog can be guaranteed (years)	40	40	40	Duration of consent
Improvement of felled plantation land				
Area of felled plantation to be improved (ha)	91.72	0	91.72	**Technical Appendix 15.1: Forestry**
Water table depth in felled area before improvement (m)	0.5	0.5	0.5	**Chapter 10: Hydrology, hydrogeology, geology and soils**
Water table depth in felled area after improvement (m)	0.1	0	0.2	**Chapter 10: Hydrology, hydrogeology, geology and soils**
Time required for hydrology and habitat of felled plantation to return to its previous state on improvement (years)	4	4	4	**Chapter 8: Ecology and Biodiversity**
Period of time when effectiveness of the improvement in felled plantation can be guaranteed (years)	40	40	40	Duration of consent
Restoration of peat removed from borrow pits				
Area of borrow pits to be restored (ha)	1.5	0.5	2	Metrics Spreadsheet
Depth of water table in borrow pit before restoration with respect to the restored surface (m)	2	2	2	**Chapter 10: Hydrology, hydrogeology, geology and soils**

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)	1	0.8	1	**Chapter 10: Hydrology, hydrogeology, geology and soils**
Time required for hydrology and habitat of borrow pit to return to its previous state on restoration (years)	10	5	15	**Chapter 10: Hydrology, hydrogeology, geology and soils**
Period of time when effectiveness of the restoration of peat removed from borrow pits can be guaranteed (years)	20	15	25	**Chapter 10: Hydrology, hydrogeology, geology and soils**
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 10: Hydrology, hydrogeology, geology and soils**
Water table depth around foundation and hard standing after restoration (m)	0.2	0.1	0.5	**Chapter 10: Hydrology, hydrogeology, geology and soils**
Time to completion of backfilling, removal of any surface drains, and full restoration of hydrology (years)	5	2	5	**Chapter 10: Hydrology, hydrogeology, geology and soils**
Early removal of drainage from foundations and hardstanding				
Will the hydrology of the site be restored on decommissioning?	Yes	Yes	Yes	**Chapter 8: Ecology and Biodiversity**
Will you attempt to block any gullies that have formed due to the windfarm?	Yes	Yes	Yes	**Chapter 8: Ecology and Biodiversity**
Will you attempt to block all artificial ditches and facilitate rewetting?	Yes	Yes	Yes	**Chapter 8: Ecology and Biodiversity**
Will the habitat of the site be restored on decommissioning?	No	No	No	**Chapter 8: Ecology and Biodiversity**
Will you control grazing on degraded areas?	No	No	No	**Chapter 8: Ecology and Biodiversity**

Input data	Expected value	Minimum value	Maximum value	Source of data
Will you manage areas to favour reintroduction of species	No	No	No	**Chapter 8: Ecology and Biodiversity**
Methodology				
Choice of methodology for calculating emission factors	Site specific (required for planning applications)			

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