Cloud Hill Wind Farm

Technical Appendix 15.1 Carbon Calculations

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CONTENTS

1. WIND FARM CHARACTERISTICS

	Expected Values	Minimum	Maximum	Source of Data
Dimensions				
No. of Turbines	11	11	11	Chapter 1: Introduction
Duration of consent (years)	35	35	35	Chapter 1: Introduction
Peformance				
Power rating of 1 turbine (MW)	5.6	5.6	5.6	Candidate turbine is Vestas V150 5.6MW.
Capacity Factor	38.6	38.5	38.7	Client based estimate based on a site specific yield assessment carried out by specialist consultant Brightwind. Also informed by available information from nearby sites.
Fraction of output to backup (%)	5	0	5	Calculating Potential Carbon Losses & Savings from Wind Farms on Scottish Peatlands, Technical Note, Version 2.10.0, Para 19.
Additional emissions due to reduced thermal efficiency of the reserve generation (%)	10	10	10	Fixed.
CO2 emissions from turbine life (tCO2/MW)				
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	N/A.

2. CHARACTERISTICS OF PEATLAND

	Expected Values	Minimum	Maximum	Source of data
Type of Peatland	Acid bog	Acid bog	Acid bog	Estimation from ERM based on typical type of Scottish Peatland.
Average annual air temperature at site °C	13.04	13	13.2	Met Office Reference, nearest climate station: Glenlee.
Average depth of peat at site (m)	0.48	0.47	0.49	Technical Appendix A10.2: Outline Peat Management Plan (oPMP)
C Content of dry peat (% by weight)	53.23	19.57	64.28	Site specific values are not available. Standard values are from "Windfarm Carbon Calculator Web Tool, User Guidance". Values for 'C Content of dry peat' have been used, Section 7.2.
Average extent of drainage around drainage features at site (m)	10	5	50	Site specific values are not available. Standard values are from "Windfarm Carbon Calculator Web Tool, User Guidance". Values for 'average drainage extent' have been used, Section 7.2.
Average water table depth at site (m)	0.1	0.05	0.3	Site specific values are not available. Standard values are from "Windfarm Carbon Calculator Web Tool, User Guidance". Values for 'average water table depth' have been used, Section 7.2.
Dry soil bulk density (g cm-3)	0.132	0.072	0.293	Site specific values are not available. Standard values are from "Windfarm Carbon Calculator Web Tool, User Guidance". Values for 'dry soil bulk density' have been used, Section 7.2.

3. CHARACTERISTICS OF BOG PLANTS

	Expected Values	Minimum	Maximum	Source of data
Time required for regeneration of bog plants after restoration (years)	5	2	10	McArthur Green technical estimation. From experience of monitoring bog plant restoration, this can vary widely depending on the location of the site and the target bog plants for restoration, and whether the ground was previously afforested or open moorland. The speed of regeneration will also depend on species present and their colonising ability and traits, as well as the methods of restoration and maintenance of hydrology. Typical bog plants may take longer to establish where suitable conditions exist. The values stated take this into account considering available literature and anectodical observations of wind farms in Scotland. Five years assumed a reasonable precautionary estimate for regeneration of most bog plants, some taking hold sooner (min value) and some requiring longer to establish (max value). A min and max of 2 and 10 years assumed. References: Whitelee Phase 3 Technical Appendix 9.1 Appendix B Restoring blanket bog from commercial forestry: summary of monitoring and management interventions at two large windfarm sites 2004 - 2011. Other online sources, academic literature (e.g. Anderson & Peace, 2017) and observations from other wind farms during surveys.
Carbon accumulation due to C fixation by bog plants in undrained peats (tC ha-1yr-1)	0.25	0.12	0.31	Calculating Potential Carbon Losses & Savings from Wind Farms on Scottish Peatlands, Technical Note, Version 2.10.0, para 25.

4. FORESTRY PLANTATION CHARACTERISTICS

	Expected Values	Minimum	Maximum	Source of Data
Method used to calculate Co2 loss from forest felling	0	0	0	N/A.

	Expected Values	Minimum	Maximum	Source of Data
Area of forestry plantation to be felled (ha)	0	0	0	No felling will take place as a direct result of the Proposed Developoment.
Average rate of carbon sequestration in timber	0	0	0	No felling will take place as a direct result of the Proposed Developoment.

5. COUNTERFACTUAL EMISSION FACTORS

	Expected Values	Minimum	Maximum	Source of Data
Coal-fired plant emission factor (tCO2 MWh-1)	0.92	0.92	0.92	Values in this section are fixed.
Grid-mix emission factor (tCO2MWh-1)	0.25358	0.25358	0.25358	Values in this section are fixed.
Fossil fuel-mix emission factor (tCO2MWh-1)	0.45	0.45	0.45	Values in this section are fixed.

6. BORROW PITS

	Expected Values	Minimum	Maximum	Source of Data
No. of borrow pits	3	3	3	Chapter 4: Description of the Proposed Development
Average length of pits (m)	157	87	223	Figure 4.12.1 - Figure 14.12.3.
Average width of pits (m)	123.3	89	191	Figure 4.12.1 - Figure 14.12.3.
Average depth of peat removed from pit (m)	0.47	0.4	0.50	ERM calculation based on site peat volume data (EIA Deisgn Freeze).

7. FOUNDATIONS AND HARDSTANDING AREAS

*associated with each turbine	Expected Values	Minimum	Maximum	Source of data
Method used to calculate CO2 loss from foundations and hard-standing	Rectangular with vertical walls	Rectangular with vertical walls	Rectangular with vertical walls	N/A
Average length of turbine foundation (m)	25	24	26	Chapter 4: Description of the Proposed Development
Average width of turbine foundation (m)	25	24	26	Chapter 4: Description of the Proposed Development
Average depth of peat removed from turbine foundations (m)	0.5002	0.4	0.5	ERM calculation based on site peat volume data (EIA Deisgn Freeze).
Average length of hard-standing (m)	75	74	76	Chapter 4: Description of the Proposed Development
Average width of hardstanding (m)	25	24	26	Chapter 4: Description of the Proposed Development
Average depth of peat removed from hard-standing (m)	0.4551	0.455	0.4552	ERM calculation based on site peat volume data (EIA Deisgn Freeze).
Volume of concrete used in construction of the ENTIRE windfarm (m3)	13,750	13749	13751	ERM calculation based on site peat volume data (EIA Deisgn Freeze).

8. ACCESS TRACK

	Expected Values	Minimum	Maximum	Source of data
Existing track length (m)	3126.4	3121	3131	ERM calculation based on site peat volume data (EIA Deisgn Freeze).
Floating road				
Length of access track (m)	334.17	329	339	ERM calculation based on site peat volume data (EIA Deisgn Freeze).
Floating road width (m)	5	5	5	ERM calculation based on site peat volume data (EIA Deisgn Freeze).
Floating road depth (m)	0.2	0.1	0.3	ERM calculation based on site peat volume data (EIA Deisgn Freeze).
Length og floating road that is drained (m)	334.17	329	339	ERM calculation based on site peat volume data (EIA Deisgn Freeze).
Average depth of drains associated with floating roads (m)	0.5	0.4	0.6	ERM calculation based on site peat volume data (EIA Deisgn Freeze).
Excavated Road				
Length of access track (m)	4493.6	4488	4498	ERM calculation based on site peat volume data (EIA Deisgn Freeze).
Excavated road width (m)	5	5	5	ERM calculation based on site peat volume data (EIA Deisgn Freeze).
Average depth of peat excavated for road (m)	0.489	0.1	5	ERM calculation based on site peat volume data (EIA Deisgn Freeze).
Rock filled road				
Length of access track (m)	5285.7	5280	5290	ERM calculation based on site peat volume data (EIA Deisgn Freeze).
Rock filled road width (m)	5	5	5.5	ERM calculation based on site peat volume data (EIA Deisgn Freeze).
Rock filled road depth (m)	0.2	0.15	0.25	ERM calculation based on site peat volume data (EIA Deisgn Freeze).
Length of rock filled road that is drained (m)	5285.7	5280	5290	ERM calculation based on site peat volume data (EIA Deisgn Freeze).
Average depth of drains associated with rock filled roads (m)	0.5	0.4	0.6	ERM calculation based on site peat volume data (EIA Deisgn Freeze).
Total				
Total length of access track (m)	13239.87	13234	13244	ERM calculation based on site peat volume data (EIA Deisgn Freeze).

9. CABLE TRENCHES

	Expected Values	Minimum	Maximum	Source of Data
Length of any cable tranch on peat that does not follow acces tracks and is lined with a permeable medium (e.g sand) (m)	N/A	N/A	N/A	All cabling is to follow the route of access tracks and be incorporated into the access tracks and associated verges (Chapter 4: Description of The Development).
Average depth of peat cut for cable trenches (m)	0.1	0.05	0.15	ERM calculation based on site peat volume data (EIA Deisgn Freeze).

10. ADDITIONAL PEATLAND EXCAVATED

*not already accounted above	Expected Values	Minimum	Maximum	Source of Data
Volume of additional peat excavated (m3)	4189			Appendix A10.2 Outline Peat Management Plan, Section 3.2.
Area of additional peat excavated (m2)	8,378			ERM calculation based on site peat volume data (EIA Deisgn
Peat Landslide Hazard and Risk Assessments				
Peat Landslide Hazard	Low/negligible	Low/negligible	Low/negligible	Fixed

11. IMPROVEMENT OF CARBON SEQUESTRATION

0	Expected Values	Minimum	Maximum	Source of Data
Improvement of degraded bog				
Area of degraded bog to be improved (ha)	418.2	400	430	Technical Appendix TA7.6: Outline Biodiversity Enhancement Management Plan
Water table depth in degraded bog before improvement (m)	0.05	0.1	0.3	McArthur Green technical estimation.
Water table depth in degraded bog after improvement (m)	0.05	0.1	0.3	McArthur Green technical estimation.
Time required for hydrology and habitat of bog to return to its previous state on improvement (years)	N/A	N/A	N/A	McArthur Green technical estimation.
Period of time when effectiveness of the improvement in degraded bog can be guaranteed (years)	N/A	N/A	N/A	McArthur Green technical estimation.
Improvement of felled plantation land				
Area of felled plantation to be improved (ha)	0	0	0	N/A
Water table depth in felled area before improvement (m)	0	0	0	N/A
Water table depth in felled area after improvement (m)	0	0	0	N/A
Time required for hydrology and habitat of felled plantation to return to its previous state on improvement (years)	0	0	0	N/A
Period of time when effectiveness of the improvement in felled plantation can be guaranteed (years)	0	0	0	N/A
Restoration of peat removed from borrow pits				
Area of borrow pits to be restored (ha)	2.9	2.9	2.9	Technical Appendix TA7.6: Outline Biodiversity Enhancement Management Plan
Depth of water table in borrow pit before restoration with respect to the restored surface (m)	0.1	0.05	0.3	McArthur Green technical estimation.
Depth of water table in borrow pit after restoration with respect to the restored surface (m)	0.1	0.05	0.3	McArthur Green technical estimation.
Time required for hyrdology and habitat of borrow pit to return to its previous state on restoration (years)	3	2	5	McArthur Green technical estimation.
Period of time when effectiveness of the restoration of peat removed from borrow bits can be guranteed (years)	5	2	15	McArthur Green technical estimation.
Early Removal of drainage from foundations and hardstanding				
Water table depth around foundations and hardstanding before restoration (m)	0.05	0.1	0.3	McArthur Green technical estimation.
Water table depth around foundations and hardstanding after restoration (m)	0.05	0.1	0.3	McArthur Green technical estimation.
Time to completion of backfilling, removal of any surface drains, and full restoration of the hydrology (years)				McArthur Green technical estimation.

12. RESTORATION OF SITE AFTER DECOMISSIONING

	Expected Values (yes, no, not applicable)	Minimum	Maximum	Notes
Will the hydrology of the site be restored on decommissioning?				
Will you attempt to block any gullies that have formed due to the windfarm?	N/A	N/A	N/A	N/A
Will you attempt to block all artificial ditches and facilities rewetting?	N/A	N/A	N/A	N/A
Will the habitat of the site be restored on decommissioning?				
Will you control grazing on degraded areas?	N/A	N/A	N/A	N/A
Will you manage areas to favour reintroduction of species?	N/A	N/A	N/A	N/A

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