Technical Appendix 15.1

Carbon Calculator

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SCOTTISHPOWER RENEWABLES

Carbon Calculator v1.6.1
Euchanhead Location: 55.326231 -4.078168
ScottishPowerRenewables

Core input data

Input data	Expected value	Minimum value	Maximum value	Source of data
Windfarm characteristics				
Dimensions				
No. of turbines	21	21	21	ES Chapter 3
Duration of consent (years)	40	40	40	ES Chapter 3
Performance				
Power rating of 1 turbine (MW)	6	6	6	ES Chapter 3
Capacity factor	35	34.9	35.1	ES Chapter 3
Backup				
Fraction of output to backup (%)	5	5	5	ES Chapter 3
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	
Characteristics of peatland before windfarm development				
Type of peatland	Acid bog	Acid bog	Acid bog	ES Chapter 9
Average annual air temperature at site (°C)	6.75	6	7.5	ES Chapter 10
Average depth of peat at site (m)	0.52	0.51	0.53	ES Chapter 10 TA 10.1
C Content of dry peat (% by weight)	48	38	56	ES Ch 10 TA 10.1
Average extent of drainage around drainage features at site (m)	10	5	25	ES Ch 10
Average water table depth at site (m)	0.1	0.05	0.3	ES Ch 10
Dry soil bulk density (g cm^{-3})	0.2	0.18	0.22	ES Chapter 10 TA 10.1
Characteristics of bog plants				
Time required for regeneration of bog plants after restoration (years)	6	4	8	ES Ch 9
Carbon accumulation due to C fixation by bog plants in undrained peats (tC ha^{-1} yr^{-1})	0.25	0.12	0.31	Es Ch 9
Forestry Plantation Characteristics				
Area of forestry plantation to be felled (ha)	217.8	217.7	217.9	ES TA3.2
Average rate of carbon sequestration in timber (tC ha^{-1} yr^{-1})	0.36	0.35	0.37	ES TA 3.2
Counterfactual emission factors				
Coal-fired plant emission factor (t CO2 MWh^{-1})	0.92	0.92	0.92	
Grid-mix emission factor (t CO2 MWh^{-1})	0.25358	0.25358	0.25358	

Input data	Expected value	Minimum value	Maximum value	Source of data
Fossil fuel-mix emission factor (t CO2 MWh^{-1})	0.45	0.45	0.45	
Borrow pits				
Number of borrow pits	7	7	7	ES Ch 10 TA 10.6
Average length of pits (m)	123	123	123	ES Ch 10 TA 10.6
Average width of pits (m)	63	63	63	ES Ch 10 TA 10.6
Average depth of peat removed from pit (m)	0.38	0.38	0.38	ES Ch 10 TA 10.6
Foundations and hard-standing area associated with each turbine				
Average length of turbine foundations (m)	38	38	38	ES Ch3
Average width of turbine foundations (m)	38	38	38	ES Ch3
Average depth of peat removed from turbine foundations(m)	0.48	0.48	0.48	ES Ch3
Average length of hard-standing (m)	100	100	100	ES Ch3
Average width of hard-standing (m)	30	30	30	ES Ch3
Average depth of peat removed from hard-standing (m)	0.5	0.5	0.5	ES Ch3
Volume of concrete used in construction of the ENTIRE windfarm				
Volume of concrete (m^3)	16464	16464	16464	ES Ch3
Access tracks				
Total length of access track (m)	52389	52387	52391	ES Ch3
Existing track length (m)	19757	19757	19757	ES Ch3
Length of access track that is floating road (m)	3558	3557	3559	ES Ch3
Floating road width (m)	7	7	7	ES Ch3
Floating road depth (m)	0	0	0	ES Ch3
Length of floating road that is drained (m)	3558	3557	3559	ES Ch3
Average depth of drains associated with floating roads (m)	0.5	0.5	0.5	ES Ch3
Length of access track that is excavated road (m)	29074	29073	29075	ES Ch3
Excavated road width (m)	7	7	7	ES Ch3
Average depth of peat excavated for road (m)	0.48	0.48	0.48	ES Ch10 TA10.1
Length of access track that is rock filled road (m)	0	0	0	ES Ch3
Rock filled road width (m)	7	7	7	ES Ch3
Rock filled road depth (m)	0	0	0	ES Ch3
Length of rock filled road that is drained (m)	0	0	0	ES Ch3
Average depth of drains associated with rock filled roads (m)	0	0	0	ES Ch3
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	ES Ch3
Average depth of peat cut for cable trenches (m)	0.5	0.5	0.5	ES Ch3
Additional peat excavated (not already accounted for above)				
Volume of additional peat excavated (m^3)	12021	12021	12021	ES Ch2 TA 10.2
Area of additional peat excavated (m^2)	26700	26700	26700	ES Ch2 TA 10.2
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)	23	23	23	ES Ch 9
Water table depth in degraded bog before improvement (m)	0.3	0.29	0.31	ES Ch 9
Water table depth in degraded bog after improvement (m)	0.1	0.09	0.11	ES Ch 9

Input data	Expected value	Minimum value	Maximum value	Source of data
Time required for hydrology and habitat of bog to return to its previous state on improvement (years)	6	4	8	ES Ch 9
Period of time when effectiveness of the improvement in degraded bog can be guaranteed (years)	15	10	20	ES Ch 9
Improvement of felled plantation land				
Area of felled plantation to be improved (ha)	209.4	209.4	209.4	ES Ch 9
Water table depth in felled area before improvement (m)	0.3	0.1	0.5	ES Ch 9
Water table depth in felled area after improvement (m)	0.1	0.05	0.3	ES Ch 9
Time required for hydrology and habitat of felled plantation to return to its previous state on improvement (years)	6	4	8	ES Ch 9
Period of time when effectiveness of the improvement in felled plantation can be guaranteed (years)	15	10	20	ES Ch 9
Restoration of peat removed from borrow pits				
Area of borrow pits to be restored (ha)	5.57	5.57	5.57	ES Ch 9
Depth of water table in borrow pit before restoration with respect to the restored surface (m)	0.3	0.1	0.5	ES Ch 9
Depth of water table in borrow pit after restoration with respect to the restored surface (m)	0.1	0.05	0.3	ES Ch 9
Time required for hydrology and habitat of borrow pit to return to its previous state on restoration (years)	6	4	8	ES Ch 9
Period of time when effectiveness of the restoration of peat removed from borrow pits can be guaranteed (years)	5	5	5	ES Ch 9
Early removal of drainage from foundations and hardstanding				
Water table depth around foundations and hardstanding before restoration (m)	0.3	0.1	0.5	ES Ch 9
Water table depth around foundations and hardstanding after restoration (m)	0.1	0.05	0.3	ES Ch 9
Time to completion of backfilling, removal of any surface drains, and full restoration of the hydrology (years)	1.5	1	3	ES Ch 9
Restoration of site after decomissioning				
Will the hydrology of the site be restored on decommissioning?	Yes	Yes	Yes	
Will you attempt to block any gullies that have formed due to the windfarm?	Yes	Yes	Yes	ES Ch10
Will you attempt to block all artificial ditches and facilitate rewetting?	Yes	Yes	Yes	ES Ch 10
Will the habitat of the site be restored on decommissioning?	No	No	No	
Will you control grazing on degraded areas?	No	No	No	ES Ch 9
Will you manage areas to favour reintroduction of species	Yes	Yes	Yes	ES Ch 9
Methodology				
Choice of methodology for calculating emission factors	Site specific (required for planning applications)			

Forestry input data

N/A

Construction input data

N/A

Payback Time and CO_2 emissions • ZDQB-U0UU-1UX2 v5

1. Windfarm CO2 emission saving over...	Exp.	Min.	Max.
...coal-fired electricity generation (t CO2 / yr)	355,411	354,395	356,426
...grid-mix of electricity generation (t CO2 / yr)	97,962	97,682	98,242
...fossil fuel-mix of electricity generation (t CO2 / yr)	173,842	173,346	174,339
Energy output from windfarm over lifetime (MWh)	15,452,640	15,408,490	15,496,790

Total CO2 losses due to wind farm (tCO2 eq.)	Exp.	Min.	Max.
2. Losses due to turbine life (eg. manufacture, construction, decomissioning)	113,112	113,112	113,112
3. Losses due to backup	99,338	99,338	99,338
4. Lossess due to reduced carbon fixing potential	5,103	1,580	13,243
5. Losses from soil organic matter	57,765	25,140	62,763
6. Losses due to DOC & POC leaching	149	1	805
7. Losses due to felling forestry	11,500	11,175	11,825
Total losses of carbon dioxide	286,967	250,346	301,086

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	-1,590	-334	-2,967
8b. Change in emissions due to improvement of felled forestry	-14,479	0	-45,913
8c. Change in emissions due to restoration of peat from borrow pits	0	0	-55
8d. Change in emissions due to removal of drainage from foundations & hardstanding	-2,808	0	-14,366
Total change in emissions due to improvements	-18,878	-334	-63,301

RESULTS	Exp.	Min.	Max.
Net emissions of carbon dioxide (t CO2 eq.)	268,089	187,045	300,752
Carbon Payback Time			
...coal-fired electricity generation (years)	0.8	0.5	0.8
...grid-mix of electricity generation (years)	2.7	1.9	3.1
...fossil fuel-mix of electricity generation (years)	1.5	1.1	1.7
Ratio of soil carbon loss to gain by restoration (not used in Scottish applications)	3.07	0.40	190.51
Ratio of CO2 eq. emissions to power generation (g/kWh) (for info. only)	17.35	12.07	19.52

ScottishPower Renewables
9th Floor
320 St Vincent Street
Glasgow
G2 5AD

T +44 (0)141 614 0451

euchanheadrenewables@scottishpower.com

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