Arecleoch Windfarm Extension

EIA Report Technical Appendix 15.1: Carbon Calculator

June 2019

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Carbon Calculator v1.5.1
Arecleoch Windfarm Extension Location: 55.089324 -4.820641
SPR Renewables

Core input data

Input data	Expected value	Minimum value	Maximum value	Source of data
Windfarm characteristics				
Dimensions				
No. of turbines	13	13	13	ES Chapter 2
Duration of consent (years)	40	40	40	ES Chapter 2
Performance				
Power rating of 1 turbine (MW)	5.6	5.6	5.6	ES Chapter 2
Capacity factor	33	31	36	ES Chapter 2
Backup				
Fraction of output to backup (%)	5	5	5	Es Chapter 2
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 8
Average annual air temperature at site (°C)	5	4	6	ES Chapter 8
Average depth of peat at site (m)	1.2	1.19	1.21	ES Chapter 8
C Content of dry peat (% by weight)	55	49	62	ES Chapter 8
Average extent of drainage around drainage features at site (m)	5	4	6	ES Chapter 8
Average water table depth at site (m)	0.2	0.1	0.3	ES Chapter 8
Dry soil bulk density (g cm^{-3})	0.2	0.18	0.22	ES Chapter 8
Characteristics of bog plants				
Time required for regeneration of bog plants after restoration (years)	2	2	2	ES Chapter 8
Carbon accumulation due to C fixation by bog plants in undrained peats (tC ha^{-1} yr^{-1})	0.25	0.24	0.26	ES Chapter 8
Forestry Plantation Characteristics				
Area of forestry plantation to be felled (ha)	135	134	136	Chpater 3 TA 3.2
Average rate of carbon sequestration in timber (tC ha^{-1} yr^{-1})	3.6	3.5	3.7	Chapter 3 TA 3.2
Counterfactual emission factors				
Coal-fired plant emission factor (t CO2 MWh^{-1})	0.918	0.918	0.918	
Grid-mix emission factor (t CO2 MWh^{-1})	0.28088	0.28088	0.28088	
Fossil fuel-mix emission factor (t CO2 MWh^{-1})	0.46	0.46	0.46	
Borrow pits				
Number of borrow pits	6	6	6	ES Chapter 10
Average length of pits (m)	100	100	100	ES Chapter 10
Average width of pits (m)	50	50	50	ES Chapter 10
Average depth of peat removed from pit (m)	0.24	0.24	0.24	ES Chapter 10
Access tracks				
Total length of access track (m)	25505	25503	25507	ES Chapter 3
Existing track length (m)	20500	20500	20500	ES Chapter 3
Length of access track that is floating road (m)	1500	1499	1501	ES Chapter 3
Floating road width (m)	7	7	7	ES Chapter 3
Floating road depth (m)	0	0	0	ES Chapter 3
Length of floating road that is drained (m)	1500	1499	1501	ES Chapter 3
Average depth of drains associated with floating roads (m)	0.3	0.3	0.3	ES Chapter 3
Length of access track that is excavated road (m)	3505	3504	3506	ES Chapter 3

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Average depth of drains associated with floating roads (m)	0.3	0.3	0.3	ES Chapter 3
Length of access track that is excavated road (m)	3505	3504	3506	ES Chapter 3
Excavated road width (m)	5	5	5	ES Chapter 3
Average depth of peat excavated for road (m)	1.2	1.2	1.2	ES Chapter 3
Length of access track that is rock filled road (m)	0	0	0	ES CHapter 3
Rock filled road width (m)	5	5	5	ES Chapter 3
Rock filled road depth (m)	0	0	0	ES Chapter 3
Length of rock filled road that is drained (m)	0	0	0	ES Chapter 3
Average depth of drains associated with rock filled roads (m)	0	0	0	ES Chapter 3
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 Chapter 3
Average depth of peat cut for cable trenches (m)	0	0	0	ES Chapter 3
Additional peat excavated (not already accounted for above)				
Volume of additional peat excavated (m^3)	0	0	0	ES Chapter 3
Area of additional peat excavated (m^2)	0	0	0	ES Chapter 3
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	NA
Water table depth in degraded bog before improvement (m)	0	0	0	NA
Water table depth in degraded bog after improvement (m)	0	0	0	ES Chapter 8
Time required for hydrology and habitat of bog to return to its previous state on improvement (years)	2	2	2	ES Chapter 8
Period of time when effectiveness of the improvement in degraded bog can be guaranteed (years)	2	2	2	ES Chapter 8
Improvement of felled plantation land				
Area of felled plantation to be improved (ha)	44.3	44.3	44.3	ES Chapter 3 TA3.2
Water table depth in felled area before improvement (m)	0.2	0.19	0.21	ES Chapter 3 TA 3.2
Water table depth in felled area after improvement (m)	0.19	0.18	0.2	ES Chapter 3 TA 3.2
Time required for hydrology and habitat of felled plantation to return to its previous state on improvement (years)	2	2	2	ES Chapter 3 TA 3.2
Period of time when effectiveness of the improvement in felled plantation can be guaranteed (years)	2	2	2	ES Chapter 3
Restoration of peat removed from borrow pits				
Area of borrow pits to be restored (ha)	15	15	15	ES Chapter 10
Depth of water table in borrow pit before restoration with respect to the restored surface (m)	2	1.9	2.1	ES Chapter 10
Depth of water table in borrow pit after restoration with respect to the restored surface (m)	0.3	0.29	0.31	ES Chapter 10
Time required for hydrology and habitat of borrow pit to return to its previous state on restoration (years)	2	2	2	ES Chapter 8
Period of time when effectiveness of the restoration of peat removed from borrow pits can be guaranteed (years)	2	2	2	ES Chapter 8
Early removal of drainage from foundations and hardstanding				
Water table depth around foundations and hardstanding before restoration (m)	0.3	0.29	0.31	ES Chapter 10
Water table depth around foundations and hardstanding after restoration (m)	0.2	0.19	0.21	ES Chapter 10
Time to completion of backfilling, removal of any surface drains, and full restoration of the hydrology (years)	2	2	2	Es Chapter 10
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 Chapter 8
Will you attempt to block all artificial ditches and facilitate rewetting?	Yes	Yes	Yes	ES Chapoter 8
Will the habitat of the site be restored on decommissioning?	No	No	No	
Will you control grazing on degraded areas?	No	No	No	ES Chapter 8
Will you manage areas to favour reintroduction of species	Yes	Yes	Yes	ES Chapter 8
Methodology				
Choice of methodology for calculating emission factors	Site specific (required for planning applications)			

Forestry input data

N/A

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Time required for hydrology and habitat of felled plantation to return to its previous state on improvement (years)	2	2	2	ES Chapter 3 TA 3.2
Period of time when effectiveness of the improvement in felled plantation can be guaranteed (years)	2	2	2	ES Chapter 3
Restoration of peat removed from borrow pits				
Area of borrow pits to be restored (ha)	15	15	15	ES Chapter 10
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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 Chapter 8
Will you attempt to block all artificial ditches and facilitate rewetting?	Yes	Yes	Yes	ES Chapoter 8
Will the habitat of the site be restored on decommissioning?	No	No	No	
Will you control grazing on degraded areas?	No	No	No	ES Chapter 8
Will you manage areas to favour reintroduction of species	Yes	Yes	Yes	ES Chapter 8
Methodology				
Choice of methodology for calculating emission factors	Site specific (required for planning applications)			

Forestry input data

N/A

Construction input data

Input data	Expected value	Minimum value	Maximum value	Source of data
site				
Number of turbines in this area	13	13	13	ES Chapter 2
Turbine foundations				
Depth of hole dug when constructing foundations (m)	0.55	0.55	0.55	ES Chapter 10
Aproximate geometric shape of whole dug when constructing foundations	Rectangular	Rectangular	Rectangular	CEMP
Length at surface	28	28	28	
Width at surface	28	28	28	
Length at bottom	21	21	21	
Width at bottom	21	21	21	
Hardstanding				
Depth of hole dug when constructing hardstanding (m)	0.81	0.81	0.81	ES Chapter 10
Aproximate geometric shape of whole dug when constructing hardstanding	Rectangular	Rectangular	Rectangular	CEMP
Length at surface	72	72	72	
Width at surface	30	30	30	
Length at bottom	70	70	70	
Width at bottom	28	28	28	
Piling				
Is piling used?	No	No	No	CEMP
Volume of Concrete				
Volume of concrete used (m^3) in the entire area	8450	8450	8450	CEMP

Payback Time and CO_2 emissions • AEIL-03DM-Y1WS v4

1. Windfarm CO2 emission saving over...	Exp.	Min.	Max.
...coal-fired electricity generation (t CO2 / yr)	193,193	181,485	210,756
...grid-mix of electricity generation (t CO2 / yr)	59,111	55,529	64,485
...fossil fuel-mix of electricity generation (t CO2 / yr)	96,807	90,940	105,608
Energy output from windfarm over lifetime (MWh)	8,418,010	7,907,827	9,183,283

Total CO2 losses due to wind farm (tCO2 eq.)	Exp.	Min.	Max.
2. Losses due to turbine life (eg. manufacture, construction, decomissioning)	64,613	64,613	64,613
3. Losses due to backup	58,671	58,671	58,671
4. Lossess due to reduced carbon fixing potential	702	614	795
5. Losses from soil organic matter	21,475	14,180	28,940
6. Losses due to DOC & POC leaching	1	0	2
7. Losses due to felling forestry	71,281	68,787	73,803
Total losses of carbon dioxide	216,742	206,866	226,824

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	-519	-370	-692
Total change in emissions due to improvements	-519	-370	-692

RESULTS	Exp.	Min.	Max.
Net emissions of carbon dioxide (t CO2 eq.)	216,223	206,174	226,454
Carbon Payback Time			
...coal-fired electricity generation (years)	1.1	1.0	1.2
...grid-mix of electricity generation (years)	3.7	3.2	4.1
...fossil fuel-mix of electricity generation (years)	2.2	2.0	2.5
Ratio of soil carbon loss to gain by restoration (not used in Scottish applications)	41.36	20.50	78.27
Ratio of CO2 eq. emissions to power generation (g/kWh) (for info. only)	25.69	22.45	28.64