Appendix 15.1 Carbon Calculator Input Values

Carbon Calculator v1.6.1
Kintradwell Wind Farm Location: 58.076294 -3.840489
Renewable Energy Systems Ltd (RES)

Core input data

Input data	Expected value	Minimum value	Maximum value	Source of data
Windfarm characteristics				
Dimensions				
No. of turbines	15	15	15	EIAR Chapter 2
Duration of consent (years)	40	40	40	In perpetuity - 40 years used for calculation
Performance				
Power rating of 1 turbine (MW)	4.2	4.2	4.2	EIAR Chapter 2
Capacity factor	46	41.4	50.6	Site specific predicted capacity factor
Backup				
Fraction of output to backup (%)	5	5	5	standard
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	EIAR Chapter 8
Average annual air temperature at site (°C)	8.4	7.56	9.24	From annual met data (Tain weather station)
Average depth of peat at site (m)	0.87	0.783	0.957	EIAR Chapter 10 - PLHRA
C Content of dry peat (% by weight)	55.5	49	62	protocol values suggested used.
Average extent of drainage around drainage features at site (m)	10	9	11	EIAR Chapter 8
Average water table depth at site (m)	0.3	0.2	0.4	observed during surveys
Dry soil bulk density (g cm^{-3})	0.25	0.2	0.3	protocol suggested values used
Characteristics of bog plants				
Time required for regeneration of bog plants after restoration (years)	10	5	15	standard
Carbon accumulation due to C fixation by bog plants in undrained peats (tC ha^{-1} yr^{-1})	0.25	0.12	0.31	SNH guidance
Forestry Plantation Characteristics				
Area of forestry plantation to be felled (ha)	0	0	0	no felling required
Average rate of carbon sequestration in timber (tC ha^{-1} yr^{-1})	0	0	0	no felling required
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	
Fossil fuel-mix emission factor (t CO2 MWh^{-1})	0.45	0.45	0.45	
Borrow pits				
Number of borrow pits	1	1	1	EIAR Chapter 2
Average length of pits (m)	131.24	118.12	144.36	EIA Chapter 2 - based on total borrow pit search area and assumption max 32% excavated
Average width of pits (m)	131.24	118.12	144.36	EIA Chapter 2 - based on total borrow pit search area and assumption max 32% excavated

Input data	Expected value	Minimum value	Maximum value	Source of data
Average depth of peat removed from pit (m)	0.58	0.52	0.64	EIAR Chapter 10 - PLHRA
Access tracks				
Total length of access track (m)	13418	12076	14760	EIAR Chapter 2
Existing track length (m)	0	0	0	EIAR Chapter 2
Length of access track that is floating road (m)	2150	1935	2365	EIAR Chapter 2 and engineering data
Floating road width (m)	5	5	5	EIAR Chapter 2
Floating road depth (m)	0	0	0	EIAR Chapter 2
Length of floating road that is drained (m)	0	0	0	no drains
Average depth of drains associated with floating roads (m)	0	0	0	no drains
Length of access track that is excavated road (m)	11268	10141	12395	EIAR Chapter 2
Excavated road width (m)	5	5	5	EIAR Chapter 2
Average depth of peat excavated for road (m)	0.77	0.69	0.85	EIAR Chapter 10 - PLHRA
Length of access track that is rock filled road (m)	0	0	0	
Rock filled road width (m)	0	0	0	
Rock filled road depth (m)	0	0	0	
Length of rock filled road that is drained (m)	0	0	0	
Average depth of drains associated with rock filled roads (m)	0	0	0	
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	EIAR Chapter 2
Average depth of peat cut for cable trenches (m)	0	0	0	EIAR Chapter 2
Additional peat excavated (not already accounted for above)				
Volume of additional peat excavated (m^3)	664.33	597.9	730.76	EIAR Chapter 2 and 10
Area of additional peat excavated (m^2)	4313	3881.7	4744.3	EIAR Chapter 10
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)	47	42.3	51.7	EIAR Appendix 8.6 HMP
Water table depth in degraded bog before improvement (m)	0.3	0.2	0.4	survey observations
Water table depth in degraded bog after improvement (m)	0.29	0.19	0.39	assumptions based on survey observations
Time required for hydrology and habitat of bog to return to its previous state on improvement (years)	10	5	15	standard
Period of time when effectiveness of the improvement in degraded bog can be guaranteed (years)	40	40	40	lifetime of wind farm
Improvement of felled plantation land				
Area of felled plantation to be improved (ha)	0	0	0	no felling required
Water table depth in felled area before improvement (m)	0	0	0	
Water table depth in felled area after improvement (m)	0	0	0	
Time required for hydrology and habitat of felled plantation to return to its previous state on improvement (years)	0	0	0	

Input data	Expected value	Minimum value	Maximum value	Source of data
Period of time when effectiveness of the improvement in felled plantation can be guaranteed (years)	0	0	0	
Restoration of peat removed from borrow pits				
Area of borrow pits to be restored (ha)	2.7	2.43	2.97	EIAR Chapter 2
Depth of water table in borrow pit before restoration with respect to the restored surface (m)	0.3	0.2	0.4	survey observations
Depth of water table in borrow pit after restoration with respect to the restored surface (m)	0.29	0.19	0.39	assumptions based on survey observations
Time required for hydrology and habitat of borrow pit to return to its previous state on restoration (years)	10	5	15	standard
Period of time when effectiveness of the restoration of peat removed from borrow pits can be guaranteed (years)	40	40	40	life of windfarm
Early removal of drainage from foundations and hardstanding				
Water table depth around foundations and hardstanding before restoration (m)	0	0	0	n/a no early removal
Water table depth around foundations and hardstanding after restoration (m)	0	0	0	n/a no early removal
Time to completion of backfilling, removal of any surface drains, and full restoration of the hydrology (years)	2	2	2	n/a
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	EIAR Appendix 8.6 HMP
Will you attempt to block all artificial ditches and facilitate rewetting?	Yes	Yes	Yes	EIAR Appendix 8.6 HMP
Will the habitat of the site be restored on decommissioning?	Yes	Yes	Yes	
Will you control grazing on degraded areas?	Yes	Yes	Yes	EIAR Appendix 8.6 HMP
Will you manage areas to favour reintroduction of species	Yes	Yes	Yes	EIAR Appendix 8.6 HMP
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
Kintradwell Wind Farm				
Number of turbines in this area	15	15	15	EIAR Chapter 2
Turbine foundations				
Depth of hole dug when constructing foundations (m)	0.61	0.55	0.67	EIAR Chapter 10 - PLHRA
Aproximate geometric shape of whole dug when constructing foundations	Circular	Circular	Circular	EIAR Chapter 2
Diameter at bottom	24	24	24	
Diameter at surface	24	24	24	
Hardstanding				
Depth of hole dug when constructing hardstanding (m)	0.52	0.47	0.57	EIAR Chapter 10 - PLHRA
Aproximate geometric shape of whole dug when constructing hardstanding	Rectangular	Rectangular	Rectangular	EIAR Chapter 2
Length at surface	35	35	35	
Width at surface	40	40	40	
Length at bottom	35	35	35	
Width at bottom	40	40	40	
Piling				
Is piling used?	No	No	No	EIAR Chapter 2
Volume of Concrete				
Volume of concrete used (m^3) in the entire area	6300	5670	6930	EIAR Transport Assessment

Appendix 15.2 Carbon Calculator Output Values

Payback Time and CO_2 emissions • 9RZ9-ZG1J-WTAP v3

1. Windfarm CO2 emission saving over...	Exp.	Min.	Max.
...coal-fired electricity generation (t CO2 / yr)	233,556	210,200	256,911
...grid-mix of electricity generation (t CO2 / yr)	64,375	57,938	70,813
...fossil fuel-mix of electricity generation (t CO2 / yr)	114,239	102,815	125,663
Energy output from windfarm over lifetime (MWh)	10,154,592	9,139,133	11,170,051

Total CO2 losses due to wind farm (tCO2 eq.)	Exp.	Min.	Max.
2. Losses due to turbine life (eg. manufacture, construction, decomissioning)	53,842	53,643	54,041
3. Losses due to backup	49,669	49,669	49,669
4. Lossess due to reduced carbon fixing potential	1,794	657	2,850
5. Losses from soil organic matter	29,553	13,231	55,257
6. Losses due to DOC & POC leaching	661	0	3,987
7. Losses due to felling forestry	0	0	0
Total losses of carbon dioxide	135,518	117,200	165,803

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	-7,851	0	-20,850
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	-451	0	-1,198
8d. Change in emissions due to removal of drainage from foundations & hardstanding	0	0	0
Total change in emissions due to improvements	-8,302	0	-22,048

RESULTS	Exp.	Min.	Max.
Net emissions of carbon dioxide (t CO2 eq.)	127,215	95,152	165,803
Carbon Payback Time			
...coal-fired electricity generation (years)	0.5	0.4	0.8
...grid-mix of electricity generation (years)	2.0	1.3	2.9
...fossil fuel-mix of electricity generation (years)	1.1	0.8	1.6
Ratio of soil carbon loss to gain by restoration (not used in Scottish applications)	3.64	0.60	No gains!
Ratio of CO2 eq. emissions to power generation (g/kWh) (for info. only)	12.53	8.52	18.14