CLASHINDARROCH II

WIND FARM

Carbon Calculator Summary Results
Reference No. UIX6-MDEN-B4YX v6
Prepared for: Vattenfall Wind Power Ltd

Technical Appendix 12.1

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SLR Ref: 405.03640.00011
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Input Tables

12/12/2019 Reference: UIX6-MDEN-B4YX v6

Carbon Calculator v1.6.0
Clashindarroch II Wind Farm Location: 57.378639 -2.876517
Vattenfall

Core input data

Input data	Expected value	Minimum value	Maximum value	Source of data
Windfarm characteristics				
Dimensions				
No. of turbines	14	14	14	ES Chapter 2
Duration of consent (years)	30	30	30	ES Chapter 2
Performance				
Power rating of 1 turbine (MW)	5.5	5.5	5.5	ES Chapter 2
Capacity factor	37.5	35	40	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 9
Average annual air temperature at site (°C)	5	4	6	ES Chapter 11
Average depth of peat at site (m)	0.14	0.13	0.15	ES Chapter 11 TA11.1
C Content of dry peat (% by weight)	55	49	62	ES Chapter 11 TA 11.1
Average extent of drainage around drainage features at site (m)	5	4	6	ES Chapter 11
Average water table depth at site (m)	0.2	0.1	0.3	ES Chapter 11
Dry soil bulk density (g cm^{-3})	0.2	0.18	0.22	ES Chapter 11 TA 11.1
Characteristics of bog plants				
Time required for regeneration of bog plants after restoration (years)	2	2	2	ES Chapter 9
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 9
Forestry Plantation Characteristics				
Area of forestry plantation to be felled (ha)	87.1	87	87.2	ES Chapter 17
Average rate of carbon sequestration in timber (tC ha^{-1} yr^{-1})	3.6	3.59	3.61	ES Chapter 17
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	

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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	1	1	1	ES Chapter 11 TA 11.2
Average length of pits (m)	150	150	150	ES Chapter 11 TA 11.2
Average width of pits (m)	100	100	100	ES Chapter 11 TA 11.2
Average depth of peat removed from pit (m)	0	0	0	ES Chapter 11 TA 11.2
Access tracks				
Total length of access track (m)	33800	33798	33802	ES Chapter 3
Existing track length (m)	22900	22899	22901	ES Chapter 3
Length of access track that is floating road (m)	0	0	0	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)	0	0	0	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)	10900	10899	10901	ES Chapter 3
Excavated road width (m)	5	5	5	ES Chapter 3
Average depth of peat excavated for road (m)	0.14	0.14	0.14	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)	1	1	1	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)	1	1	1	ES Chapter 3
Additional peat excavated (not already accounted for above)				
Volume of additional peat excavated (m^3)	0	0	0	ES Chapter 11
Area of additional peat excavated (m^2)	0	0	0	ES Chapter 11
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	ES Chapter 9

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Input data	Expected value	Minimum value	Maximum value	Source of data
Water table depth in degraded bog before improvement (m)	0	0	0	ES Chapter 9
Water table depth in degraded bog after improvement (m)	0	0	0	ES Chapter 9
Time required for hydrology and habitat of bog to return to its previous state on improvement (years)	2	2	2	ES Chapter 9
Period of time when effectiveness of the improvement in degraded bog can be guaranteed (years)	2	2	2	ES Chapter 9
Improvement of felled plantation land				
Area of felled plantation to be improved (ha)	0	0	0	ES Chapter 17
Water table depth in felled area before improvement (m)	0.2	0.19	0.21	ES Chapter 17
Water table depth in felled area after improvement (m)	0.19	0.18	0.2	ES Chapter 17
Time required for hydrology and habitat of felled plantation to return to its previous state on improvement (years)	2	2	2	ES Chapter 17
Period of time when effectiveness of the improvement in felled plantation can be guaranteed (years)	2	2	2	ES Chapter 17
Restoration of peat removed from borrow pits				
Area of borrow pits to be restored (ha)	15	15	15	ES Chapter 11 TA 11.2
Depth of water table in borrow pit before restoration with respect to the restored surface (m)	2	1.9	2.1	ES Chapter 11 TA 11.2
Depth of water table in borrow pit after restoration with respect to the restored surface (m)	0.3	0.29	0.31	ES Chapter 11 TA 11.2
Time required for hydrology and habitat of borrow pit to return to its previous state on restoration (years)	2	2	2	ES Chapter 1 TA 11.2
Period of time when effectiveness of the restoration of peat removed from borrow pits can be guaranteed (years)	2	2	2	ES Chapter 11 TA 11.2
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 11
Water table depth around foundations and hardstanding after restoration (m)	0.2	0.19	0.21	ES Chapter 11
Time to completion of backfilling, removal of any surface drains, and full restoration of the hydrology (years)	2	2	2	ES Chapter 11
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 9
Will you attempt to block all artificial ditches and facilitate rewetting?	Yes	Yes	Yes	Es Chapter 9
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 9
Will you manage areas to favour reintroduction of species	Yes	Yes	Yes	ES Chapter 9
Methodology				
Choice of methodology for calculating emission factors	Site specific (required for planning applications)			

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Forestry input data

N/A

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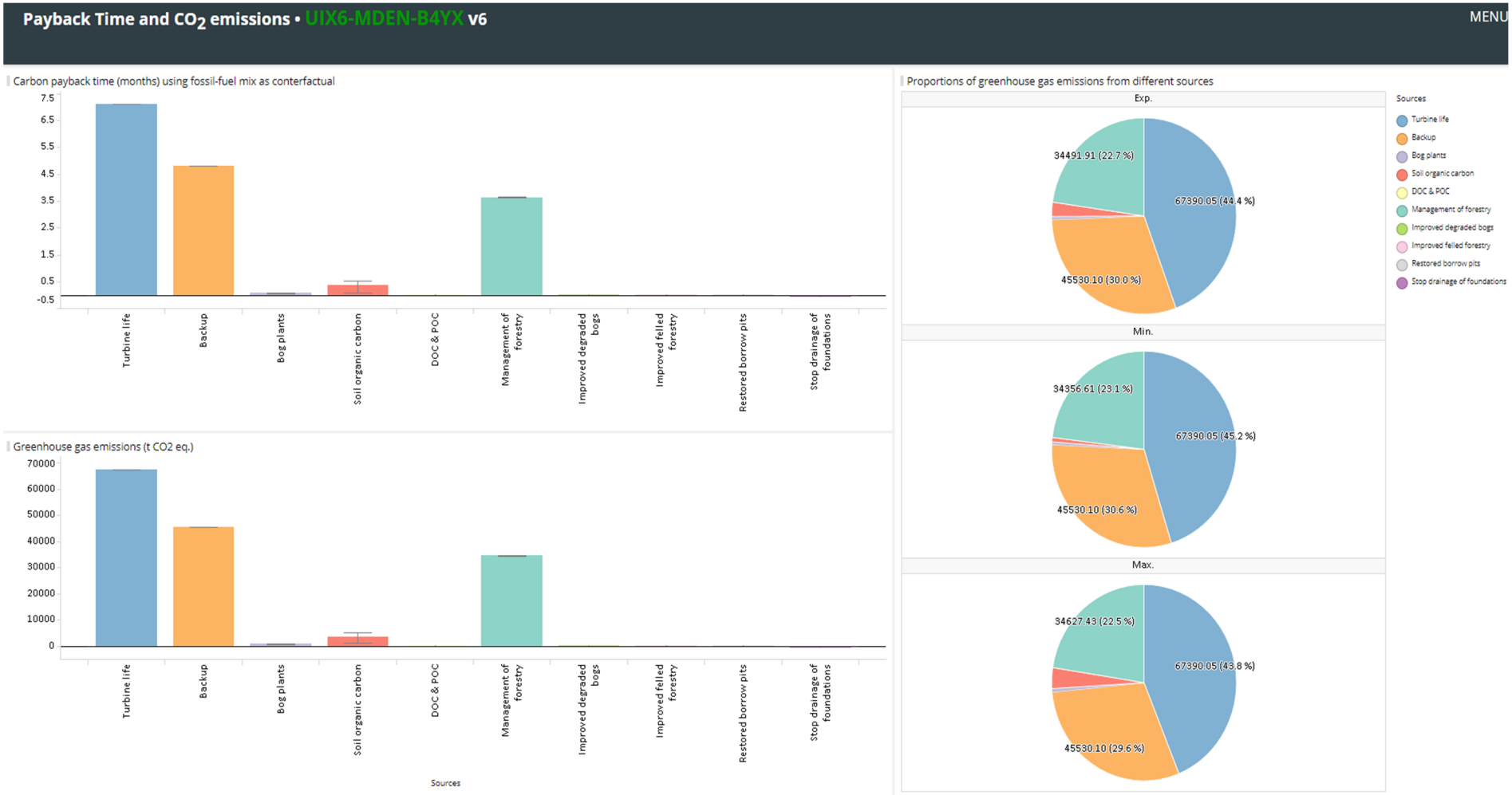
Construction input data

Input data	Expected value	Minimum value	Maximum value	Source of data
Site				
Number of turbines in this area	14	14	14	ES Chapter 3
Turbine foundations				
Depth of hole dug when constructing foundations (m)	0.14	0.14	0.14	ES Chapter 3
Aproximate geometric shape of whole dug when constructing foundations	Rectangular	Rectangular	Rectangular	ES Chapter 3
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)	0.14	0.14	0.14	ES Chapter 3
Aproximate geometric shape of whole dug when constructing hardstanding	Rectangular	Rectangular	Rectangular	ES Chapter 3
Length at surface	75	75	75	
Width at surface	45	45	45	
Length at bottom	74	74	74	
Width at bottom	42	42	42	
Piling				
Is piling used?	No	No	No	ES Chapter 3
Volume of Concrete				
Volume of concrete used (m^3) in the entire area	6300	6300	6300	ES Chapter 3

Payback Time and CO_2 Emission Data Charts



Payback Time and CO_2 Emission Results

Payback Time and CO_2 emissions • UIX6-MDEN-B4YX v6

1. Windfarm CO2 emission saving over...	Exp.	Min.	Max.
...coal-fired electricity generation (t CO2 / yr)	232,709	217,195	248,223
...grid-mix of electricity generation (t CO2 / yr)	64,142	59,866	68,418
...fossil fuel-mix of electricity generation (t CO2 / yr)	113,825	106,237	121,414
Energy output from windfarm over lifetime (MWh)	7,588,350	7,082,460	8,094,240

Total CO2 losses due to wind farm (tCO2 eq.)	Exp.	Min.	Max.
2. Losses due to turbine life (eg. manufacture, construction, decomissioning)	67,390	67,390	67,390
3. Losses due to backup	45,530	45,530	45,530
4. Lossess due to reduced carbon fixing potential	758	651	872
5. Losses from soil organic matter	3,602	1,086	5,278
6. Losses due to DOC & POC leaching	2	1	3
7. Losses due to felling forestry	34,492	34,357	34,627
Total losses of carbon dioxide	151,774	149,014	153,701

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	-30	0	-70
Total change in emissions due to improvements	-30	0	-70

RESULTS	Exp.	Min.	Max.
Net emissions of carbon dioxide (t CO2 eq.)	151,744	148,944	153,701
Carbon Payback Time			
...coal-fired electricity generation (years)	0.7	0.6	0.7
...grid-mix of electricity generation (years)	2.4	2.2	2.6
...fossil fuel-mix of electricity generation (years)	1.3	1.2	1.4
Ratio of soil carbon loss to gain by restoration (not used in Scottish applications)	121.26	15.43	11938.33
Ratio of CO2 eq. emissions to power generation (g/kWh) (for info. only)	20.00	18.40	21.70

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