

Appendix 6.A

Carbon Calculator - Justification for Values Used

Input data	Enoch Hill Wind Farm (Proposed Development)			Comments/Assumptions
	Expected	Minimum	Maximum	
Wind Farm Characteristics				
Dimensions				
No. of turbines	16	16	16	Number of turbines included in Proposed Development.
Lifetime of wind farm	30	30	30	Expected turbines lifetime
Power rating of turbines	5 MW	5 MW	5 MW	5MW is the nominal candidate turbine as outlined in Chapter 4 of the EIA report.
Capacity factor	37.6%	36.7%	38.5%	EIA Report - Chapter 6. Renewable energy and peat management. Minimum and maximum figures are based on 2.5% movement down or up.
Extra capacity required for back up	5	0	5	Following the guidance provided by Nayak et al, UK Energy in brief 2013 confirms that wind energy accounts for less than 20% of total national electricity generation therefore 0% could be used however 5% has been used to reflect a worst case scenario 0% is entered as a minimum value.
Additional emissions due to thermal inefficiency of back up generation (%)	10%	10%	10%	Default used by Nayak et al 2011.
Carbon dioxide emissions from turbines' life	Calculate w.r.t installed capacity			
Peatland Characteristics before wind development				
Average annual air temperature at site (°C)	7.5	3.9	11.2	Average annual temperature taken for Eskdalemuir Met Office station 1981-2010. Expected value calculated using average of minimum and maximum average temperatures. Maximum and minimum chosen as a range.
Average peat depth at site	0.65	0.5	1	Expected value calculated as average value of all 1,752 peat depth measurements taken at site. Minimum and maximum values chosen as a range. See Peat Management Plan (PMP) 2017 FEI Appendix 6.A for calculations.
Content of dry peat % by weight	55	49	62	Calculated using typical values provided in carbon calculator tool
Average extent of drainage around drainage features at site (m)	7.5	5	10	No site specific measurements available, precautionary values used
Average water table depth at site (m)	0.3	0.2	0.4	Expected value is average across all 1,752 measurements taken at site where water table depth is estimated to be equivalent to catotelm

Input data	Enoch Hill Wind Farm (Proposed Development)			Comments/Assumptions
	Expected	Minimum	Maximum	
				thickness. Detailed water table depth measurements were not taken.
Dry soil bulk density (gcm ⁻³)	0.25	0.20	0.45	Due to lack of site specific information, indicative figures from National Soil Inventory of Scotland have been used.
Characteristics of bog plants				
Time required for regeneration of bog plants after restoration (years)	3	2	5	Estimated values, based on condition of the current vegetation.
Carbon accumulation due to C fixation by bog plants in undrained peat (tC ha ⁻¹ yr ⁻¹)	0.25	0.12	0.31	Default values provided by Turunen et al., 2001; Botch et al., 1995
Forestry Plantation Characteristics				
Enter simple data				
Area of forestry plantation to be felled (ha)	0	0	0	No forestry felling is expected.
Average rate of carbon sequestration in timber	3.6	3.4	3.8	Figures from Cannell, 1999. min and max entered as a range.
Counterfactual emission factors				
Coal-fired plant emission factor tCO ₂ MWh ⁻¹	0.92	0.92	0.92	Values provided automatically by online calculator, updated annually based on DUKes.
Grid mix emission factor tCO ₂ MWh ⁻¹	0.25358	0.25358	0.25358	Values provided automatically by online calculator, updated annually based on DUKes.
Fossil fuel mix emission factor tCO ₂ MWh ⁻¹	0.45	0.45	0.45	Values provided automatically by online calculator, updated annually based on DUKes.
Borrow Pits				
Number of Areas	2	2	2	EIA Report - Chapter 3. Project description
Average length of area (m)	200	150	250	EIA Report - Chapter 3. Project description
Average width of areas (m)	100	75	125	EIA Report - Chapter 3. Project description
Average depth of peat removed from area (m)	0	0	0	No peat will be extracted from borrow pits.
Access tracks				
Total length of access tracks (m)	12070	11670	12470	EIA Report - Chapter 3. Project description
Existing tracks length (m)	0	0	0	No upgrading of existing track on this site.
<u>Length of access tracks that is floating road (m)</u>	1700	1600	1800	EIA Report - Chapter 3. Project description. Minimum and maximum entered as a range to allow for variations following detailed site investigation.
Floating road width (m)	6	6	6	EIA Report - Chapter 3. Project description
Floating road depth (m)	0	0	0	0 as no sinking expected.

Input data	Enoch Hill Wind Farm (Proposed Development)			Comments/Assumptions
	Expected	Minimum	Maximum	
Length of floating road that is drained (m)	1700	1600	1800	Assume full length of road will be drained for simplicity, will be confirmed during detailed ground investigations
Average depth of drains associated with floating roads (m)	0.5	0.5	0.5	EIA Report - Chapter 3. Project description
<u>Length of access track that is excavated road (m)</u>	5600	5500	5700	EIA Report - Chapter 3. Project description. Minimum and maximum entered as a range to allow for variations following detailed site investigation.
Excavated road width (m)	6	6	6	EIA Report - Chapter 3. Project description
Average depth of peat excavated from road (m)	0.7	0.5	0.9	EIA Report - Chapter 3. Project description
<u>Length of access track that is rock filled road (m)</u>	4770	4570	4970	EIA Report - Chapter 3. Project description. Assumed that road on organic matter <0.5m is rock filled and hence no peat excavated./ Minimum and maximum entered as a range to allow for variations following detailed site investigation.
Rock filled road width (m)	6	6	6	EIA Report - Chapter 3. Project description
Rock filled road depth (m)	0	0	0	No peat excavated for these tracks.
Length of rock filled road that is drained (m)	4770	4570	4970	Assume full length of road will be drained for simplicity, will be confirmed during detailed ground investigations
Average depth of drains associated with rock filled roads (m)	0.5	0.5	0.5	Assume no drains required alongside floating roads. Maximum drain depth of 0.5m required for worst case scenario.
Cable Trenches				
Length of any cable trench on peat that does not follow access track and is lined with a permeable material (m)	0	0	0	Assume full length of cable route to follow access track.
Depth of cable trench	0.00	0.00	0.00	N/A
Additional peat excavated (not accounted for above)				
Volume of additional peat excavated (m ³)	20,048	18,500	20,500	Total volume of excavated peat for primary and secondary compound, control building, met masts and passing places along access tracks
Area of additional peat excavated (m ²)	30,225	30,000	30,500	Area of infrastructure as per site layout and described in 2017 FEI Chapter 4 (minimum and maximum figures are a range to allow for minor adjustments to compound sizes). See PMP, 2017 FEI Appendix 6.A for calculations.

Input data	Enoch Hill Wind Farm (Proposed Development)			Comments/Assumptions
	Expected	Minimum	Maximum	
Peat Landslide hazard				
Peat landslide hazard risk assessment	Negligible	Negligible	Negligible	Fixed value.
Improvement of C sequestration at site by blocking drains, restoration of habitat etc.				
<u>Improvement of degraded bog</u>				
Area of degraded bog to be improved (ha)	0	0	0	No bog restoration works proposed other than those in the borrow pit – see below.
Water table depth in degraded bog before improvement (m)	n/a	n/a	n/a	n/a
Water table depth in degraded bog after improvement (m)	n/a	n/a	n/a	n/a
Time required for hydrology and habitat of bog to return to its previous state on restoration (years)	n/a	n/a	n/a	n/a
Period of time when effectiveness of the improvement in degraded bog can be guaranteed (years)	n/a	n/a	n/a	n/a
<u>Improvement of felled plantation</u>				
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 restoration (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
<u>Restoration of peat removed from borrow pits</u>				
Area of borrow pits to be restored (ha)	2	2	2	As outlined in the PMP provided in 2017 FEI Appendix 6.A. Minimum and maximum entered as a range.
Depth of water table in borrow pit before restoration with respect to the restored surface (m)	0.3	0.2	0.4	Estimated water table depth in borrow pit before restoration. Using average water table depth.

Input data	Enoch Hill Wind Farm (Proposed Development)			Comments/Assumptions
	Expected	Minimum	Maximum	
Depth of water table in borrow pit after restoration with respect to the restored surface (m)	0.2	0.1	0.3	Restored water table depth expected (estimated to be restored to previous value).
Time required for hydrology and habitat of borrow pit to return to its previous state on restoration (years)	3	2	4	Estimated time input for the expected case, minimum and maximum entered as a range.
Period of time when effectiveness of the restoration of peat removed from borrow pits can be guaranteed (years)	21	20	23	The restoration measures are expected to last the lifetime of the wind farm (i.e. following restoration to previous state).
<u>Removal of drainage from foundations and hardstanding</u>				
Water table depth around foundations and hardstanding before restoration	0	0	0	Assume no removal of drainage.
Water table depth around foundations and hardstanding after restoration	0	0	0	N/A
Time to completion of backfilling, removal of any surface drains and full restoration of the hydrology (years)	0	0	0	N/A
Restoration of site after decommissioning				
Will you attempt to block any gullies that have formed due to the wind farm?	Yes	Yes	No	Assumes that any gullies caused by construction of the wind farm would be blocked to maintain habitats except worst case scenario (maximum column).
Will you attempt to block all artificial ditches and facilitate rewetting?	No	No	No	No
Will the habitat of the site be restored on decommissioning				
Will you control grazing on degraded areas?	Yes	Yes	Yes	If required. Details to be provided in Habitat Management Plan which is expected to be conditioned in any consent.
Will you manage areas to favour reintroduction of species	No	No	No	No
Construction Input Data				
Area 1. Construction Input Data for turbines in organic matter <0.5m deep				
Number of turbines in this area	7	7	7	Number of turbines included in proposed development.

Input data	Enoch Hill Wind Farm (Proposed Development)			Comments/Assumptions
	Expected	Minimum	Maximum	
Turbine foundations				
Depth of hole dug when constructing foundations	0	0	0	Based on Figure 4.12 in the 2017 FEI and peat probes for these turbine locations.
Approximate geometric shape of hole dug when constructing foundations	Circular	Circular	Circular	
Length at surface (m)	25	25	25	Based on Figure 4.12 in the 2017FEI
Width at surface (m)	25	25	25	Based on Figure 4.12 in the 2017FEI
Length at bottom (m)	25	25	25	Based on Figure 4.12 in the 2017FEI
Width at bottom (m)	25	25	25	Based on Figure 4.12 in the 2017FEI
Volume of concrete used per turbine base (m3)	490	400	750	Calculated from area of turbine foundations and depth of excavation. Range given to allow for a range of candidate turbines, with 750m3 being the largest.
Hardstanding				
Depth of hole dug when constructing hardstanding	0	0	0	Based on Figure 4.3 in the 2017 FEI and details in Chapter 4 of 2017 FEI.
Approximate geometric shape of hole dug when constructing hardstanding	Rectangular	Rectangular	Rectangular	
Length at surface (m)	50	50	50	Based on Figure 4.3 in the 2017 FEI.
Width at surface (m)	25	25	25	Based on Figure 4.3 in the 2017 FEI.
Length at bottom (m)	50	50	50	Based on Figure 4.3 in the 2017 FEI.
Width at bottom (m)	25	25	25	Based on Figure 4.3 in the 2017 FEI.
Is piling used?	No	No	No	Piling not likely to be used.
Area 2 . Construction Input Data – Turbines in peat between 0.5m and 1m				
Number of turbines in this area	7	7	7	Number of turbines included in Development
Turbine foundations				
Depth of hole dug when constructing foundations	0.9	0.8	1	Based on Figure 4.12 in the 2017 FEI and peat probes for these turbine locations.
Approximate geometric shape of hole dug when constructing foundations	Circular	Circular	Circular	

Input data	Enoch Hill Wind Farm (Proposed Development)			Comments/Assumptions
	Expected	Minimum	Maximum	
Length at surface (m)	27.5	25	27.5	Based on Figure 4.12 in the 2017 FEI.
Width at surface (m)	27.5	25	27.5	Based on Figure 4.12 in the 2017 FEI.
Length at bottom (m)	25	25	25	Based on Figure 4.12 in the 2017 FEI.
Width at bottom (m)	25	25	25	Based on Figure 4.12 in the 2017 FEI.
Volume of concrete used per turbine base (m3)	490	400	750	Calculated from area of turbine foundations and depth of excavation. Range given to allow for a range of candidate turbines, with 750m3 being the largest.
Hardstanding				
Depth of hole dug when constructing hardstanding	0.7	0.5	0.9	Based on Figure 4.3 in the 2017 FEI and details in Chapter 4 of 2017 FEI.
Approximate geometric shape of hole dug when constructing hardstanding	Rectangular	Rectangular	Rectangular	
Length at surface (m)	50	50	50	Based on Figure 4.3 in the 2017 FEI.
Width at surface (m)	25	25	25	Based on Figure 4.3 in the 2017 FEI.
Length at bottom (m)	50	50	50	Based on Figure 4.3 in the 2017 FEI.
Width at bottom (m)	25	25	25	Based on Figure 4.3 in the 2017 FEI.
Is piling used?	No	No	No	Piling not likely to be used.
Area 3. Construction Input Data – turbines in peat > 1m deep				
Number of turbines in this area	2	2	2	Number of turbines included in Development.
Turbine foundations				
Depth of hole dug when constructing foundations	2.8	2.7	2.9	Based on Figure 4.12 in the 2017 FEI and peat probes for these turbine locations.
Approximate geometric shape of hole dug when constructing foundations	Circular	Circular	Circular	
Length at surface (m)	27.5	27.5	27.5	Based on Figure 4.12 in the 2017 FEI.
Width at surface (m)	27.5	27.5	27.5	Based on Figure 4.12 in the 2017 FEI.
Length at bottom (m)	25	25	25	Based on Figure 4.12 in the 2017 FEI.

Input data	Enoch Hill Wind Farm (Proposed Development)			Comments/Assumptions
	Expected	Minimum	Maximum	
Width at bottom (m)	25	25	25	Based on Figure 4.12 in the 2017 FEI.
Volume of concrete used per turbine base (m ³)	490	400	750	Calculated from area of turbine foundations and depth of excavation. Range given to allow for a range of candidate turbines, with 750m ³ being the largest.
Hardstanding				
Depth of hole dug when constructing hardstanding	1.2	1.1	1.3	Based on Figure 4.3 in the 2017 FEI and details in Chapter 4 of 2017 FEI.
Approximate geometric shape of hole dug when constructing hardstanding	Rectangular	Rectangular	Rectangular	
Length at surface (m)	50	50	50	Based on Figure 4.3 in the 2017 FEI.
Width at surface (m)	25	25	25	Based on Figure 4.3 in the 2017 FEI.
Length at bottom (m)	50	50	50	Based on Figure 4.3 in the 2017 FEI.
Width at bottom (m)	25	25	25	Based on Figure 4.3 in the 2017 FEI.
Is piling used?	No	No	No	Piling not likely to be used.