Appendix 6.D
Enoch Hill Wind Farm FEI - Justification for Values Used in Carbon Calculator

Input data	Enoch Hill Wind Farm FEI			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	25	25	25	Standard lifetime used by Nayak *et al.*
Power rating of turbines	3.4MW	3.4MW	3.4MW	3.4MW is the candidate turbine in the FEI as outlined in **Chapter 4.**
Capacity factor	32.92%	30.42%	35.42%	Average capacity factor measured at the site is 32.92%. 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[1] 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.*
Carbon dioxide emissions from turbines life	Calculate w.r.t installed capacity			Total CO_2 emission calculated using installed capacity (default equation provided in spreadsheet).
Peatland Characteristics before wind development				
Average annual air temperature at site (ºC)	7.5	3.9	11.2	Average annual temperature taken for Eskadalemuir Met Office station 1981-2010[2]. 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	1.0	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) FEI **Appendix 6.A** for calculations.

[1] https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/224130/uk_energy_in_brief_2013.PDF Last accessed 26/09/2016.

[2] http://www.metoffice.gov.uk/public/weather/climate/gcvdxj13y Last accessed 26/09/2016.

Input data	Enoch Hill Wind Farm FEI			Comments/Assumptions
	Expected	Minimum	Maximum	
Content of dry peat % by weight	55	49	62	Calculated using typical values provided in carbon balance spreadsheet.
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 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 Nayak *et al.*
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	n/a	n/a	n/a	
Counterfactual emission factors				
Coal-fired plant emission factor tCO_2MWh^{-1}	0.907	0.907	0.907	Values for 2014 published in Chapter 5 of DUKES 2016[3].
Grid mix emission factor tCO_2MWh^{-1}	0.400	0.400	0.400	Values for 2014 published in Chapter 5 of DUKES 2016.
Fossil fuel mix emission factor tCO_2MWh^{-1}	0.652	0.652	0.652	Values for 2014 published in Chapter 5 of DUKES 2016.
Borrow Pits				
Number of Areas	2	2	2	Two potential borrow pit search areas have been identified as described in **Chapter 4** of the FEI. However neither is in an area where peat is present.
Average length of area (m)	200	150	250	
Average width of areas (m)	100	75	125	
Average depth of peat removed from area (m)	0	0	0	No peat will be extracted from borrow pits.
Foundations and hard-standing area associated with each turbine				
Average length of turbine foundations (m)	27.5	25	27.5	An excavation area of 27.5m square is expected (and worst case).

[3] https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/552059/Chapter_5_web.pdf Last accessed 26/09/2016

Input data	Enoch Hill Wind Farm FEI			Comments/Assumptions
	Expected	**Minimum**	**Maximum**	
Average width of turbine foundations (m)	27.5	25	27.5	As above.
Average depth of peat removed from turbine foundations (m)	0.73	0.5	1.0	Average peat depth values taken from peat excavation calculations across all 16 turbine locations. See PMP, FEI **Appendix 6.A** for calculations. Minimum and maximum entered as a range.
Average length of hard standing	50	50	50	Hardstandings are 50 x 25m. Additional area not required for excavation as not deep.
Average width of hard standing	25	25	25	As above.
Average depth of peat removed from hardstanding (m)	0.68	0.5	1.0	Average peat depth values taken from peat excavation calculations done for the PMP for hardstanding locations. See PMP, FEI **Appendix 6.A** for calculations. Minimum and maximum entered as a range.
Access tracks				
Total length of access tracks (m)	12,070	12,070	12,070	As outlined in FEI **Chapter 4**, the total value Includes new cut and floating track length.
Existing tracks length (m)	n/a	n/a	n/a	No upgrading of existing track on this site.
Length of access tracks that is floating road (m)	1,700	1,600	1,800	Expected value is taken from PMP (FEI **Appendix 6.A**). Minimum and maximum entered as a range to allow for variations following detailed site investigation.
Floating road width (m)	6	6	6	As per **Figure 4.2** in FEI.
Floating road depth (m)	0	0	0	0 as no sinking expected.
Length of floating road that is drained (m)	1,700	1,600	1,900	Assume the full length of floating road is drained, will be confirmed following detailed ground investigation.
Average depth of drains associated with floating roads (m)	0.5	0.5	0.5	Assume drain depth of 0.5m.
Length of access track that is excavated road (m)	10,370	10,000	11,000	Total new track length as outlined in FEI **Chapter 4** allowing for 1.7km of floating road. Minimum and maximum entered as a range to allow for variations following detailed site investigation.
Excavated road width (m)	6	6	6	As per **Figure 4.2** in FEI.
Average depth of peat excavated from road (m)	0.7	0.50	0.9	Average peat depth value calculated from peat depth measurements along new track used. See PMP, FEI **Appendix 6.A** for calculations. Minimum and maximum entered as a range.

Input data	Enoch Hill Wind Farm FEI			Comments/Assumptions
	Expected	**Minimum**	**Maximum**	
Length of access track that is rock filled road (m)	5600	5500	5700	Assumed that road on organic matter <0.5m is rock filled and hence no peat excavated.
Rock filled road width (m)	6	6	6	As per **Figure 4.2** in FEI.
Rock filled road depth (m)	0	0	0	No peat excavated for these tracks.
Length of rock filled road that is drained (m)	5600	5500	5700	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 drain depth of 0.5m.
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	0	0	
Additional peat excavated (not accounted for above)				
Volume of additional peat excavated (m3)	20,048	19,500	21,000	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 FEI **Chapter 4** (minimum and maximum figures are a range to allow for minor adjustments to compound sizes). See PMP, FEI **Appendix 6.A** for calculations.
Peat Landslide hazard				
Peat landslide hazard risk assessment				Measures have been taken to limit risk. See Peatslide Hazard and Risk Assessment (FEI **Appendix 6.B**).
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	n/a
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

Input data	Enoch Hill Wind Farm FEI			Comments/Assumptions
	Expected	**Minimum**	**Maximum**	
Improvement of felled plantation				
Area of felled plantation to be improved (ha)	0	0	0	There will be no felled plantation within the Development Site.
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 restoration (years)	0	0	0	
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)	3	2	3	As outlined in the PMP provided in 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.
Depth of water table in borrow pit after restoration with respect to the restored surface (m)	0.3	0.2	0.4	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)	22	23	21	The restoration measures are expected to last the lifetime of the wind farm (i.e. following restoration to previous state).
Removal of drainage from foundations and hardstanding				Assume no removal of drainage.
Water table depth around foundations and hardstanding before restoration	0	0	0	
Water table depth around foundations and hardstanding after restoration	0	0	0	
Time to completion of backfilling, removal of any surface drains and full restoration of the hydrology (years)	0	0	0	
Restoration of site after decommissioning				

Input data	Enoch Hill Wind Farm FEI			Comments/Assumptions
	Expected	**Minimum**	**Maximum**	
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	
Will the habitat of the site be restored on decommissioning				
Will you control grazing on degraded areas?	Yes	Yes	No	If required.
Will you manage areas to favour reintroduction of species	No	No	No	

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.
Turbine foundations				
Depth of hole dug when constructing foundations	0	0	0	Based on **Figure 4.12** in the FEI and peat probes for these turbine locations.
Approximate geometric shape of hole dug when constructing foundations	Rectangular	Rectangular	Rectangular	Circular or square geometry not available as an option.
Length at surface (m)	27.5	25	27.5	Based on **Figure 4.12** in the FEI, adjusted dimensions for a rectangular geometry.
Width at surface (m)	27.5	25	27.5	Based on **Figure 4.12** in the FEI, adjusted dimensions for a rectangular geometry.
Length at bottom (m)	25	25	25	Based on **Figure 4.12** in the FEI, adjusted dimensions for a rectangular geometry.
Width at bottom (m)	25	25	25	Based on **Figure 4.12** in the FEI, adjusted dimensions for a rectangular geometry.
Hardstanding				
Depth of hole dug when constructing hardstanding	0	0	0	Based on **Figure 4.3** in the FEI and details in Chapter 4.
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 FEI.
Width at surface (m)	25	25	25	Based on **Figure 4.3** in the FEI.
Length at bottom (m)	50	50	50	Based on **Figure 4.3** in the FEI.
Width at bottom (m)	25	25	25	Based on **Figure 4.3** in the FEI.
Is piling used?	No	No	No	Based on **Figure 4.3** in the 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 750m^3 being the largest.

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 proposed development.
Turbine foundations				
Depth of hole dug when constructing foundations	0.9	0.8	1.0	Based on **Figure 4.12** in the FEI and peat probes for these turbine locations.
Approximate geometric shape of hole dug when constructing foundations	Rectangular	Rectangular	Rectangular	Circular or square geometry not available as an option.
Length at surface (m)	27.5	25	27.5	Based on **Figure 4.12** in the FEI, adjusted dimensions for a rectangular geometry.
Width at surface (m)	27.5	25	27.5	Based on **Figure 4.12** in the FEI, adjusted dimensions for a rectangular geometry.
Length at bottom (m)	25	25	25	Based on **Figure 4.12** in the FEI, adjusted dimensions for a rectangular geometry.
Width at bottom (m)	25	25	25	Based on **Figure 4.12** in the FEI, adjusted dimensions for a rectangular geometry.
Hardstanding				
Depth of hole dug when constructing hardstanding	0.7	0.5	0.9	Based on **Figure 4.3** in the FEI and details in Chapter 4.
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 FEI.
Width at surface (m)	25	25	25	Based on **Figure 4.3** in the FEI.
Length at bottom (m)	50	50	50	Based on **Figure 4.3** in the FEI.
Width at bottom (m)	25	25	25	Based on **Figure 4.3** in the FEI.
Is piling used?	No	No	No	Based on **Figure 4.3** in the 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 750m^3 being the largest.

Construction Input Data – turbines in peat > 1m deep				
Number of turbines in this area	2	2	2	Number of turbines included in proposed development.
Turbine foundations				
Depth of hole dug when constructing foundations	1.9	1.7	2.1	Based on **Figure 4.12** in the FEI and peat probes for these turbine locations.
Approximate geometric shape of hole dug when constructing foundations	Rectangular	Rectangular	Rectangular	Circular or square geometry not available as an option.
Length at surface (m)	27.5	25	27.5	Based on **Figure 4.12** in the FEI, adjusted dimensions for a rectangular geometry.
Width at surface (m)	27.5	25	27.5	Based on **Figure 4.12** in the FEI, adjusted dimensions for a rectangular geometry.
Length at bottom (m)	25	25	25	Based on **Figure 4.12** in the FEI, adjusted dimensions for a rectangular geometry.
Width at bottom (m)	25	25	25	Based on **Figure 4.12** in the FEI, adjusted dimensions for a rectangular geometry.
Hardstanding				
Depth of hole dug when constructing hardstanding	1.2	1.1	1.3	Based on **Figure 4.3** in the FEI and details in Chapter 4.
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 FEI.
Width at surface (m)	25	25	25	Based on **Figure 4.3** in the FEI.
Length at bottom (m)	50	50	50	Based on **Figure 4.3** in the FEI.
Width at bottom (m)	25	25	25	Based on **Figure 4.3** in the FEI.
Is piling used?	No	No	No	Based on **Figure 4.3** in the 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 750m^3 being the largest.