Appendix 6B
Carbon Calculator - Justification for Values Used

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Carbon Calculator - Justification for Values Used

Carbon Calculator v1.7.0

Enoch Hill 2 (Location 55.333671: -4.236197)

RWE Renewables UK Ltd

Core input data

Input data	Expected	Minimum	Maximum	Comments/Assumptions
Dimensions				
Number of turbines	2	2	2	Source - Project Description
Duration of consent (years)	35	35	35	Source - Project Description chapter 3.7
Power rating of 1 turbine (MW)	5	5	5	Source - Project Description
Capacity factor	43%	34.4%	51.6%	Source – Provided by client and within Project Description (site-specific) / BEIS DUKES E.g. Scottish average onshore capacity factor for the last 5 years is 26.4%. (BEIS 2022). Minimum capacity factor estimated as approximately - 20%. Confirm any onsite monitoring for capacity factor. The site specific capacity factor is 43%, the wind turbines capacity factor is 43%, based on the installed capacity of 10MW.
Fraction of output to backup (%)	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.

Input data	Expected	Minimum	Maximum	Comments/Assumptions
Additional emissions due to reduced thermal efficiency of the reserve generation (%)	10%	10%	10%	Extra emissions due to reduced thermal efficiency of the reserve power generation ≈ 10% (Dale et al 2004).
CO2 emissions from turbine life (tCO2/MW)	Calculate w.r.t installed capacity			Total CO2 emission calculated using installed capacity (default equation provided in spreadsheet).
Peatland characteristics before wind development				
Type of peatland	Acid bog	Acid bog	Acid bog	Source - Peat Topic Lead (see definitions --->)
Average annual air temperature at site (oC)	9.60	7.68	11.52	Source - Project Description (Prestwick, Gannet) / MetOffice
Average peat depth at site (m)	0.23	0.18	0.28	Source - Peat Topic Lead Figure 9 Interpolated Peat Map Average of all infrastructure locations. Minimum and maximum entered as approximately 20% range to allow for variations
Content of dry peat % by weight	55	49	62	Calculated using typical values provided in carbon calculator tool.

Input data	Expected	Minimum	Maximum	Comments/Assumptions
Average extent of drainage around drainage features at site (m)	5	3	7	Source - Peat Topic Lead / Examples E.g. No site specific measurements available, precautionary values used.
Average water table depth at site (m)	0.3	0.2	0.4	Source - Peat Topic Lead / Examples E.g. No site specific values available. Values taken from a similar upland site with underlying peat.
Dry soil bulk density (gcm-3)	0.25	0.2	0.3	Due to lack of site specific information, indicative figures from National Soil Inventory of Scotland have been used.
Time required for regeneration of bog plants after restoration (years)	3	2	5	Source - Peat Topic Lead / Examples E.g. Estimated values.
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				
Area of forestry plantation to be felled (ha)	12.68	10.14	15.22	Source - Forestry Topic Lead and felling notes Minimum and maximum entered as a 20% range to allow for variations.
Average rate of carbon sequestration in timber (tC ha ha-1 yr-1)	3.6	3.4	3.8	Source - Cannell, 1999 E.g. Figures from Cannell, 1999. min and max entered as a range.
Counterfactual emission factors				
Coal-fired plant emission factor tCO_2MWh^{-1}	1.002	1.002	1.002	Figure provided in carbon payback calculator.
Grid mix emission factor tCO_2MWh^{-1}	0.19338	0.19338	0.19338	Figure provided in carbon payback calculator.
Fossil fuel mix emission factor tCO_2MWh^{-1}	0.432	0.432	0.432	Figure provided in carbon payback calculator.
Borrow pits (if any)				
Number of borrow pits	0	0	0	Source - Project Description (see 'calculations' sheet)
Average length of pits (m)	0	0	0	Source - Project Description Minimum and maximum entered as a 20% range to allow for variations.

Input data	Expected	Minimum	Maximum	Comments/Assumptions
Average width of pits (m)	0	0	0	Source - Project Description Minimum and maximum entered as a 20% range to allow for variations.
Average depth of peat removed from pit (m)				Source - Peat Topic Lead
Access tracks				
Total length of access tracks (m)	7870	6296	9444	Source - Project Description Table 3.1 (see 'calculations' sheet) Minimum and maximum entered as a 20% range to allow for variations.
Existing tracks length (m)	5511	4409	6613	Source - Project Description and Peat Topic Lead Minimum and maximum entered as a 20% range to allow for variations.
Length of access tracks that is floating road (m)	418	334	502	Source - Project Description and Peat Topic Lead Access roads in mean peat depths >1 m assumed to be floating roads. Minimum and maximum entered as a 20% range to allow for variations.
Floating road width (m)	6	5	7	Source - Project Description and Peat Topic Lead Minimum 5 m and maximum entered as a 20% range to allow for variations.
Floating road depth (m)	0.56	0.45	0.6	Source - Project Description para, 3.5.9 and Peat Topic Lead E.g. 0 as no sinking expected, worst case allows for some sinkage.
Length of floating road that is drained (m)	0	0	0	Source - Project Description and Peat Topic Lead E.g. Assume no drains required alongside floating roads.
Average depth of drains associated with floating roads (m)	0	0	0	Source - Project Description and Peat Topic LeadE.g. Assume no drains required alongside floating roads. Maximum drain depth of 0.5m required for worst case scenario.
Length of access track that is excavated road (m)	1,941	1553	2329	Source - Project Description and Peat Topic Lead Minimum and maximum entered as a 20% range to allow for variations.
Excavated road width (m)	6	3	6	Source - Project Description and Peat Topic Lead Minimum 5 m and maximum entered as a 20% range to allow for variations.
Average depth of peat excavated from road (m)	0.38	0.30	0.46	Source - Peat Topic Lead, figure 9 Interpolated Peat Depth, mean peat depths sheet. Minimum and maximum entered as approximately 20% range to allow for variations.

Input data	Expected	Minimum	Maximum	Comments/Assumptions
Length of access track that is rock filled road (m)	0	0	0	Source - Project Description and Peat Topic Lead E.g. Assumed that road on peat depth <1m is peat excavated and hence there is no rock filled road. Below inputs N/A.
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	0.00	0	
Cable trenches				
Length of any cable trench on peat that does not follow access tracks and is lined with a permeable medium (e.g. sand) (m)	0	0	0	Source - Project Description Table 3.1 and Peat Topic Lead E.g. Assume full length of cable route to follow access track.
Average depth of peat cut for cable trenches (m)	0.29	0.23	0.35	Source - Project description table 3.1 Peat Topic Lead
Additional peat excavated (not already accounted for above)				
Volume of additional peat excavated (m3)	2034	1627	2441	Source - Peat Topic Lead (ensure peat totals align to PMP), mean peat depth spread sheet, peat management plan.
Area of additional peat excavated (m2)	14800	11840	17760	Source - Project Description and Peat Topic Lead Minimum and maximum entered as a 20% range to allow for variations. The peat displaced to accommodate the Temporary Construction Compound has been included within the assessment.
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.				
Improvement of degraded bog				
Area of degraded bog to be improved (ha)	1.1	0.88	1.32	Source - Project Description and Ecology Topic Lead Requires improvement of water table depth.

Input data	Expected	Minimum	Maximum	Comments/Assumptions
Water table depth in degraded bog before improvement (m)	0.3	0.25	0.35	Same as above. Estimated water table depth before restoration, using average water table depth.
Water table depth in degraded bog after improvement (m)	0.25	0.2	0.3	Source - Peat Topic Lead
Time required for hydrology and habitat of bog to return to its previous state on improvement (years)	5	3	7	Source - Peat Topic Lead E.g. Expected case based upon professional judgement. Maximum and minimum values plus/ minus 20%.
Period of time when effectiveness of the improvement in degraded bog can be guaranteed (years)	25	23	27	
<u>Improvement of felled plantation</u>				
Area of felled plantation to be improved (ha)	0.52	0.42	0.64	Source - Forestry Topic Lead Requires improvement of water table depth.
Water table depth in felled area before improvement (m)	0.3	0.35	0.35	Same as above. Estimated water table depth before restoration, using average water table depth.
Water table depth in felled area after improvement (m)	0.25	0.2	0.3	Source - Peat Topic Lead
Time required for hydrology and habitat of felled plantation to return to its previous state on improvement (years)	5	3	7	Source - Peat Topic Lead E.g. Expected case based upon professional judgement. Maximum and minimum values plus/ minus 20%.
Period of time when effectiveness of the improvement in felled plantation can be guaranteed (years)	25	23	27	
<u>Restoration of peat removed from borrow pits</u>				

Input data	Expected	Minimum	Maximum	Comments/Assumptions
Area of borrow pits to be restored (ha)	0.0	0.0	0.0	No borrow pits
Depth of water table in borrow pit before restoration with respect to the restored surface (m)	0.0	0.0	0.0	No borrow pits
Depth of water table in borrow pit after restoration with respect to the restored surface (m)	0.0	0.0	0.0	No borrow pits
Time required for hydrology and habitat of borrow pit to return to its previous state on restoration (years)	0.0	0.0	0.0	No borrow pits
Period of time when effectiveness of the restoration of peat removed from borrow pits can be guaranteed (years)	0.0	0.0	0.0	No borrow pits
Early removal of drainage from foundations and hardstanding				
Water table depth around foundations and hardstanding before restoration (m)	0	0	0	Source - Peat Topic Lead E.g. Assume no removal of drainage.
Water table depth around foundations and hardstanding after restoration (m)	0	0	0	Source - Peat Topic Lead E.g. Assume no removal of drainage.
Time to completion of backfilling, removal of any surface drains and full restoration of the hydrology (years)	2.5	0.21	5	Source - Peat Topic Lead E.g. Assume no removal of drainage.
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).

Input data	Expected	Minimum	Maximum	Comments/Assumptions
Will you attempt to block all artificial ditches and facilitate rewetting?	No	No	No	Assumed no.
Will the habitat of the site be restored on decommissioning				
Will you control grazing on degraded areas?	Yes	Yes	Yes	If required.
Will you manage areas to favour reintroduction of species	No	No	No	Assumed no.
Construction Input Data - Organic matter <0.5m deep				
Number of turbines in this area	1	1	1	Source - Project description Peat Topic Lead, Figure 9 Interpolated Peat Depth
<u>Turbine foundations</u>				
Average peat depth excavated when constructing foundations (m)	0.14	0.01	0.50	Source Project description Table 3.1
Approximate geometric shape of hole dug when constructing foundations		Circular		Source - figure 3-4
Diameter at surface (m)	25	25	25	Source - project description Table 3.1
Diameter at bottom (m)	25	25	25	Source - project description Table 3.2
<u>Hardstanding</u>				
Average peat depth excavated when constructing hardstanding (m)	0.06	0.01	0.50	Source - Project description Peat Topic Lead, Figure 9 Interpolated Peat Depth
Approximate geometric shape of hole dug when constructing hardstanding		Rectangular		Figure 3-1A
Length at surface (m)	50	50	50	Source - Project Description Table 3.1 and Peat Topic Lead
Width at surface (m)	25	25	25	Source - Project Description Table 3.1 and Peat Topic Lead
Length at bottom (m)	50	50	50	Source - Project Description Table 3.1 and Peat Topic Lead
Width at bottom (m)	25	25	25	Source - Project Description Table 3.1 and Peat Topic Lead
Is piling used?	No	No	No	Piling not likely to be used.
Volume of concrete used in the entire area (m3)	855	855	855	Source - Project Description Table 3.7 / Transport Topic Lead
Construction Input Data - Peat between 0.5m and 1m				

Input data	Expected	Minimum	Maximum	Comments/Assumptions
Number of turbines in this area	1	1	1	Source - Project description Peat Topic Lead, Figure 9 Interpolated Peat Depth
Turbine foundations				
Average peat depth excavated when constructing foundations (m)	0.36	0.01	1.00	Source - Project description Peat Topic Lead, Figure 9 Interpolated Peat Depth
Approximate geometric shape of hole dug when constructing foundations		Circular		Source Figure - 3-4
Diameter at surface (m)	25	25	25	Source - project description Table 3.1
Diameter at bottom (m)	25	25	25	Source - project description Table 3.2
Hardstanding				
Average peat depth excavated when constructing hardstanding (m)	0.69	0.01	1.00	Source - Peat Topic Lead, PMP, Mean Peat Depths spreadsheet
Approximate geometric shape of hole dug when constructing hardstanding		Rectangular		Source - Figure 3-1A
Length at surface (m)	50	50	50	Source - Project Description Table 3.1 and Peat Topic Lead
Width at surface (m)	25	25	25	Source - Project Description Table 3.1 and Peat Topic Lead
Length at bottom (m)	50	50	50	Source - Project Description Table 3.1 and Peat Topic Lead
Width at bottom (m)	25	25	25	Source - Project Description Table 3.1 and Peat Topic Lead
Is piling used?	No	No	No	Piling not likely to be used.
Volume of concrete used in the entire area (m3)	855	855	855	The peat displaced to accommodate the Temporary Construction Compound has been included within the assessment. Source - Project Description Table 3.7 / Transport Topic Lead