



RWE Renewables UK Onshore Wind Limited

EREDINE WIND FARM FURTHER ENVIRONMENTAL INFORMATION

Technical Appendix 7B: Carbon Payback Data
Tables





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Technical Appendix 7B: Carbon Payback Data Tables

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QUALITY CONTROL

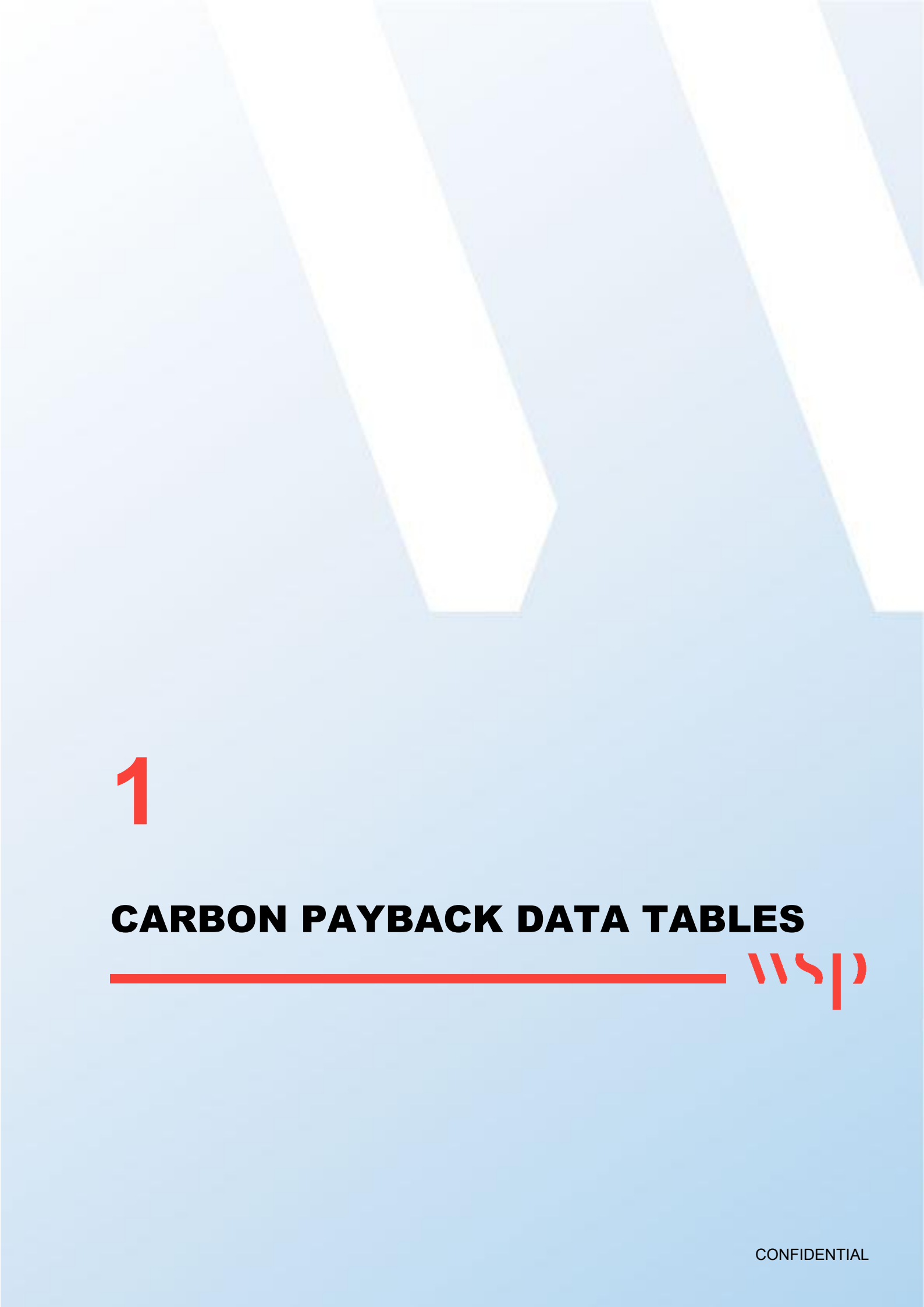
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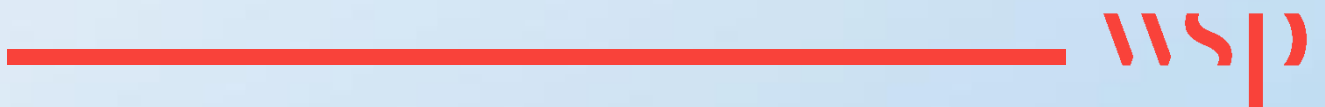
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CARBON PAYBACK DATA TABLES



1 Carbon Payback Data Tables

Table 1 Potential Electricity Generation and CO₂ Savings

Input Data	Expected Value (Proposed Development)	Expected Value (Revised Development)	Source of Data
<u>Dimensions</u>			
No. of turbines	22	17	FEI Report Chapter 2: Project Design.
Duration of consent (years)	35	35	Lifetime is 35 years – stated in EIA Report Chapter 4 Description of the Proposed Development.
<u>Performance</u>			
Power rating of 1 turbine (MW)	4.5	4.8	4.8 MW is the nominal candidate turbine used for this assessment.
Capacity factor	35%	40%	Site capacity factor of approximately 40% provided by RWE.
<u>Backup</u>			
Fraction of output to backup (%)	5%	5%	Following the guidance provided by Nayak et al (2013) ¹ and the carbon calculator a 5% back up is required.
Additional emissions due to reduced thermal efficiency of the reserve generation (%)	10%	10%	Extra emissions due to reduced thermal efficiency of the reserve power generation = 10% (Dale et al 2004) ² .
Total CO ₂ emission from turbine life (tCO ₂)	Calculate w.r.t installed capacity		Total CO ₂ emission calculated using installed capacity (default

¹ Nayak, D.R., Miller, D., Nolan, A., Smith, P., Smith, J. 2008 (corrected in 2010) Calculating Carbon Savings from Wind Farms on Scottish Peat Lands – a New Approach, available at: <http://www.gov.scot/Resource/Doc/917/0117390.pdf>

² Royal Academy of Engineering 2014 Wind Energy, implications of large-scale deployment on the GB electricity system, available at: <http://www.raeng.org.uk/publications/reports/wind-energy-implications-of-large-scale-deployment>

Input Data	Expected Value (Proposed Development)	Expected Value (Revised Development)	Source of Data
MW ⁻¹) (e.g. manufacture, construction, decommissioning)			equation provided by carbon calculator).
<u>Peatland characteristics before wind development</u>			
Type of peatland	Acid Bog	Acid Bog	An 'acid bog' is fed primarily by rainwater and often inhabited by sphagnum moss, thus making it acidic. See Stoneman & Brooks (1997)
Average annual air temperature at site (°C)	9.4	9.4	Average annual temperature taken for Lephinmore Met Office station, 1981-2010 (16 Kilometres away from Eredine).
Average depth of peat at site (m)	0.63	0.63	Expected value calculated using data from peat depth probing surveys.
Carbon content of dry peat (% by weight)	55%	55%	Typical values provided in carbon calculator tool.
Average extent of drainage around drainage features at site (m)	7.5	7.5	Site-specific data not available. Value based on professional judgement.
Average water table depth at site (m)	0.3	0.3	Site-specific data not available. Value based on professional judgement.
Dry soil bulk density (g cm ⁻³)	0.25	0.25	Typical values provided in carbon calculator tool.
<u>Characteristics of Bog Plants</u>			
Time required for regeneration of bog plants after restoration (years)	3	3	Estimated values based on professional judgement.

Input Data	Expected Value (Proposed Development)	Expected Value (Revised Development)	Source of Data
Carbon accumulation due to carbon fixation by bog plants in undrained peats (tC ha ⁻¹ yr ⁻¹)	0.25	0.25	Default values from Turunen et al., 2001 ³ ; Botch et al., 1995 ⁴ .
<u>Forestry Plantation Characteristics</u>			
Area of forestry plantation to be felled (ha)	264	192.3	EIA Chapter 4: Description of the Proposed Development. Assumed unchanged for the Revised Development.
Average rate of carbon sequestration in timber (tC ha ⁻¹ yr ⁻¹)	3.6	3.6	From Cannell, 1999 ⁵ .
<u>Counterfactual Emission Factors</u>			
Coal-fired plant emission factor (t CO ₂ MWh ⁻¹)	0.945	0.919	Values provided automatically by online calculator, updated annually based on DUKES ⁶
Grid-mix emission factor (t CO ₂ MWh ⁻¹)	0.207	0.154	Values provided automatically by online calculator, updated annually based on DUKES ⁶
Fossil fuel-mix emission factor (t CO ₂ MWh ⁻¹)	0.424	0.448	Values provided automatically by online calculator, updated annually based on DUKES ⁶
<u>Borrow Pits</u>			

³ Turunen J., Tahvanainen T., Tolonen K. and Pitkänen A. 2001 Carbon accumulation in West Siberian mires, Russia. Global Biogeochemical Cycles 15: 285-296.

⁴ Botch M.S., Kobak K.I. Vinson T.S. and Kolchugina T.P. 1995 carbon pools and accumulation in peatlands of the former Soviet Union. Global Biogeochemical Cycles 9: 37-46

⁵ Cannell, M.G.R. (1999) Growing trees to sequester carbon in the UK: answers to some common questions. Forestry, 72, 238–247

⁶ Department for Energy Security and Net Zero (2023). Digest of UK Energy Statistics. Available at: <https://www.gov.uk/government/collections/digest-of-uk-energy-statistics-dukes>

Input Data	Expected Value (Proposed Development)	Expected Value (Revised Development)	Source of Data
Number of borrow pits	9	9	FEI Report Chapter 2: Project Design.
Average length of pits (m)	158	162	FEI Report Appendix 7A: Outline Peat Management Plan Addendum (NB these are search areas, so likely over-estimate the volume of peat that will need to be excavated).
Average width of pits (m)	100	100	
Average depth of peat removed from pit (m)	0.27	0.26	
<u>Access Tracks</u>			
Total length of access track (m)	41,000	36,130	FEI Report Appendix 7A: Outline Peat Management Plan Addendum
Existing track length (m)	0	0	All existing tracks will need to be upgraded and are therefore excluded.
Length of access track that is floating road (m)	5,300	4,482	FEI Report Appendix 7A: Outline Peat Management Plan Addendum
Floating road width (m)	8	8	The running width will generally be 5m, but it is assumed that the total excavated width will be an average of 8m.
Floating road depth (m)	0	0	Zero as no sinking is expected.
Length of floating road that is drained (m)	0	0	Assumption is that no drains will be required alongside floating roads.
Average depth of drains associated with floating roads (m)	0	0	Assumption is that no drains will be required alongside floating roads.
Length of access track that is excavated road (m)	36,000	31,648	FEI Report Appendix 7A: Outline Peat Management Plan Addendum. Includes all new and upgraded cut tracks.

Input Data	Expected Value (Proposed Development)	Expected Value (Revised Development)	Source of Data
Excavated road width (m)	8	8	The running width will generally be 5m, but it is assumed that the total excavated width will be an average of 8m to allow for drainage. This has been adjusted to account for 14,895m of new tracks (where it is assumed that 8m will need to be excavated) and 16,753m of upgraded tracks (where it is assumed that 5m will need to be excavated).
Average depth of peat excavated for road (m)	0.48	0.45	FEI Report Appendix 7A: Outline Peat Management Plan Addendum.
Length of access track that is rock filled road (m)	0	0	N/A
Rock filled road width (m)	0	0	N/A
Rock filled road depth (m)	0	0	N/A
Length of rock filled road that is drained (m)	N/A	N/A	N/A
Average depth of drains associated with rock filled roads (m)	N/A	N/A	N/A
<u>Cable Trenches</u>			
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	FEI Report Appendix 7A: Outline Peat Management Plan Addendum. It is assumed that the cable trench will run alongside access tracks but will be dug and immediately restored separately.

Input Data	Expected Value (Proposed Development)	Expected Value (Revised Development)	Source of Data
Average depth of peat cut for cable trenches (m)	0.61	0.61	FEI Report Appendix 7A: Outline Peat Management Plan Addendum.
<u>Additional peat excavated (not accounted for above)</u>			
Volume of additional peat excavated (m ³)	19,500	18,934	FEI Appendix 7A: Outline Peat Management Plan Addendum (construction compounds including battery storage area, substation and turning heads).
Area of additional peat excavated (m ²)	61,500	35,800	FEI Appendix 7A: Outline Peat Management Plan Addendum (as above).
Peat Landslide Hazard and Risk Assessments: Best Practice Guide for Proposed Electricity Generation Developments	Dominated by Negligible to low. However, parts of T1, T3, T7, T8, T9, T11, T19, T21, BP2, BP6 and Temporary Construction Compound 1 are within areas of Moderate risk	Dominated by Negligible to low. However, parts of T1, T8, T9, T19, T21, BP2, BP6 and Temporary Construction Compound 1 are within areas of Moderate risk	EIA Appendix 6B: Peat Landslide Risk Assessment.
<u>Improvement of degraded bog</u>			
Area of degraded bog to be improved (ha)	0	0	FEI Appendix 6D: Outline Habitat Management Plan. Peatland restoration measures are proposed across 6.3ha. However, methods are currently not fully prescribed. A precautionary view has therefore been adopted, and peatland restoration is therefore omitted from the carbon payback calculation at this stage.
Water table depth in degraded bog before improvement (m)	N/A	N/A	
Water table depth in degraded bog after improvement (m)	N/A	N/A	

Input Data	Expected Value (Proposed Development)	Expected Value (Revised Development)	Source of Data
Time required for hydrology and habitat of bog to return to its previous state on improvement (years)	N/A	N/A	
Period of time when effectiveness of the improvement in degraded bog can be guaranteed (years)	N/A	N/A	
<u>Improvement of felled plantation land</u>			
Area of felled plantation to be improved (ha)	0	0	FEI Appendix 6D: Outline Habitat Management Plan. Peatland restoration measures are proposed across 6.3ha. Some measures could involve forest to bog restoration. However, these are not fully established as yet. A precautionary view has therefore been adopted, and peatland restoration is therefore omitted from the carbon payback calculation at this stage.
Water table depth in felled area before improvement (m)	0.3	0.3	
Water table depth in felled area after improvement (m)	0.2	0.2	
Time required for hydrology and habitat of felled plantation to return to its previous state on improvement (years)	5	5	
Period of time when effectiveness of the improvement in felled plantation can be guaranteed (years)	35	35	
<u>Restoration of peat removed from borrow pits</u>			

Input Data	Expected Value (Proposed Development)	Expected Value (Revised Development)	Source of Data
Area of borrow pits to be restored (ha)	1.58	14.6	FEI Report Appendix 7A: Outline Peat Management Plan Addendum. The increase compared to the Proposed Development is due to a typing error.
Depth of water table in borrow pit before restoration with respect to the restored surface (m)	0.3	0.3	No site-specific values available. Values based on professional judgement.
Depth of water table in borrow pit after restoration with respect to the restored surface (m)	0.2	0.2	No site-specific values available. Values based on professional judgement.
Time required for hydrology and habitat of borrow pit to return to its previous state on restoration (years)	5	5	No site-specific values available. Values based on professional judgement.
Period of time when effectiveness of the restoration of peat removed from borrow pits can be guaranteed (years)	35	30	No site-specific values available. Values based on professional judgement. Revised Development shows correct figure (Proposed Development was incorrect)
<u>Early removal of drainage from foundations and hardstanding</u>			
Water table depth around foundations and hardstanding before restoration (m)	0	0	Assumes no removal of drainage.
Water table depth around foundations and hardstanding after restoration (m)	0	0	Assumes no removal of drainage.
Time to completion of backfilling, removal of any surface drains, and full restoration of the hydrology (years)	0	0	Assumes no removal of drainage.
<u>Restoration of site after decommissioning</u>			

Input Data	Expected Value (Proposed Development)	Expected Value (Revised Development)	Source of Data
Will you attempt to block any gullies that have formed due to the windfarm?	Yes	Yes	Assumes that any gullies caused by construction of the wind farm would be blocked to maintain habitats.
Will you attempt to block all artificial ditches and facilitate rewetting?	No	No	Assumes that no attempts will be made to block all artificial ditches.
<u>Will the habitat of the site be restored on decommissioning?</u>			
Will you control grazing on degraded areas?	Yes	Yes	If required
Will you manage areas to favour reintroduction of species	No	No	Assumes that no attempts will be made to manage areas to favour reintroduction of species.

Table 2 Proposed Development and Revised Development expected values – Construction Input Data

Input Data	Expected Value (Proposed Development)	Expected Value (Revised Development)	Source of Data
<u>Area 1 - Construction Input Data - Organic matter <0.5 m deep</u>			
Number of turbines in area	11	8	FEI Appendix 7A: Outline Peat Management Plan Addendum.
<u>Turbine foundations</u>			
Depth of hole dug when constructing foundations (m)	0.31	0.32	FEI Appendix 7A: Outline Peat Management Plan Addendum.
Approximate geometric shape of whole dug when constructing foundations	Circular	Circular	FEI Appendix 7A: Outline Peat Management Plan Addendum.
Diameter at bottom	25	25	FEI Appendix 7A: Outline Peat Management Plan Addendum.
Diameter at surface	25	25	FEI Appendix 7A: Outline Peat Management Plan Addendum.
Volume of concrete used in entire area (m ³)	10,560	7,672	Total volume of concrete per turbine (foundations) is 960m ³ (EIA Chapter 4: Description of the Proposed Development).
<u>Hardstanding</u>			
Depth of hole dug when constructing hardstanding (m)	0.58	0.53	FEI Appendix 7A: Outline Peat Management Plan Addendum.

Input Data	Expected Value (Proposed Development)	Expected Value (Revised Development)	Source of Data
Approximate geometric shape of whole dug when constructing all hardstandings	Rectangular	Rectangular	FEI Appendix 7A: Outline Peat Management Plan Addendum.
Length at surface	200	200	FEI Appendix 7A: Outline Peat Management Plan Addendum.
Width at surface	30	30	FEI Appendix 7A: Outline Peat Management Plan Addendum.
Length at bottom	200	200	FEI Appendix 7A: Outline Peat Management Plan Addendum.
Width at bottom	30	30	FEI Appendix 7A: Outline Peat Management Plan Addendum.
<u>Piling</u>			
Is piling used?	No	No	Assumes that piling will not be used.

Input Data	Expected Value (Proposed Development)	Expected Value (Revised Development)	Source of Data
<u>Area 2 - Construction Input Data - Turbines in peat between 0.5m and 1m deep</u>			
Number of turbines in area	9	9	FEI Report Appendix 7A: Outline Peat Management Plan Addendum.
<u>Turbine foundations</u>			
Depth of hole dug when constructing foundations (m)	0.69	0.73	FEI Report Appendix 7A: Outline Peat

Input Data	Expected Value (Proposed Development)	Expected Value (Revised Development)	Source of Data
			Management Plan Addendum.
Approximate geometric shape of whole dug when constructing foundations	Circular	Circular	FEI Report Appendix 7A: Outline Peat Management Plan Addendum.
Diameter at bottom	25	25	FEI Report Appendix 7A: Outline Peat Management Plan Addendum.
Diameter at surface	25	25	FEI Report Appendix 7A: Outline Peat Management Plan Addendum.
Volume of concrete used in entire area (m ³)	8,640	8,631	Total volume of concrete per turbine (foundations) is 960m ³ (EIA Report Chapter 4: Description of the Proposed Development).
<u>Hardstanding</u>			
Depth of hole dug when constructing hardstanding (m)	0.68	0.67	FEI Report Appendix 7A: Outline Peat Management Plan Addendum.
Approximate geometric shape of whole dug when constructing all hardstandings	Rectangular	Rectangular	FEI Report Appendix 7A: Outline Peat Management Plan Addendum.
Length at surface	200	200	FEI Report Appendix 7A: Outline Peat Management Plan Addendum.
Width at surface	30	30	FEI Report Appendix 7A: Outline Peat Management Plan Addendum.

Input Data	Expected Value (Proposed Development)	Expected Value (Revised Development)	Source of Data
Length at bottom	200	200	FEI Report Appendix 7A: Outline Peat Management Plan Addendum.
Width at bottom	30	30	FEI Report Appendix 7A: Outline Peat Management Plan Addendum.
<u>Piling</u>			
Is piling used?	No	No	Assumes that piling will not be used.

Input Data	Expected Value (Proposed Development)	Expected Value (Revised Development)	Source of Data
Area 3 - Construction Input Data - Turbines in organic matter >1m deep			
Number of turbines in area	2	0	For FEI, there are no turbines located in peat >1m deep
<u>Turbine foundations</u>			
Depth of hole dug when constructing foundations (m)	1.17	N/A	
Approximate geometric shape of whole dug when constructing foundations	Circular	N/A	
Diameter at bottom	25	N/A	
Diameter at surface	25	N/A	
Volume of concrete used in entire area (m ³)	1,920	N/A	
<u>Hardstanding</u>			

Depth of hole dug when constructing hardstanding (m)	0.84	N/A	
Approximate geometric shape of whole dug when constructing hardstanding	Rectangular	N/A	
Length at surface	200	N/A	
Width at surface	30	N/A	
Length at bottom	200	N/A	
Width at bottom	30	N/A	
<u>Piling</u>			
Is piling used?	No	N/A	



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