Craig Watch Wind Farm

Technical Appendix 2.3: Peat Landslide Hazard and Risk Assessment

November 2024

Contents

1. Introduction

1.1.1 This Peat Landslide Hazard and Risk Assessment (PLHRA) provides an update from that presented in Technical Appendix 2.5 of the 2022 EIA Report.

2. Consultation

2.1.1 The Applicant received a consultation response from the Scottish Government Energy Consents Unit (ECU) in October 2022 prepared by Ironside Farrar in relation to the Peat Landslide Hazard and Risk Assessment (PLHRA) submitted with the 222 EIA Report. **Table 2.1** has been prepared to respond to the ECU on their post-submission consultation response.

Table 2.1 – Scottish Government ECU Response

Ironside Farrar Stage 1 Checking Report Comments	Applicant's Response
The PLHRA requires minor revisions: although much of the PLHRA is sound, key elements are considered to be insufficiently robust to support the PLHRA conclusions and revisions are required; areas for attention will be advised in the review findings and may be progressed by the developer through either an appendix to the original submission or by clarification letter. Whilst the report provides a generally robust desk study, survey methodology and figures, the PLHRA document does not fully satisfy the ECU Best Practice Guidance at all points and a number of queries are raised. 1. Competencies, qualifications and experience of the team should be included in the PLHRA reporting in order to establish the robustness of the assessment.	The Peat surveys and landslide hazard and risk assessment was undertaken by Stephen Holmes (BSc, MICE), a geotechnical Engineer with over 16 years' experience of earthworks and geotechnical design and over 8 years' experience of wind farm and electricity transmission peat surveying and peat survey design to support EIA submissions.
2. While the desk study is generally considered consistent with a level required to satisfy the guidance, some sources of information have potentially been overlooked. These include but are not limited to; local knowledge from landowners / land managers, historical mapping, newspaper articles, etc. A key piece of desk study information for this site would be any issues identified during construction/operational phases of existing adjacent windfarms. Please provide comment on whether these resources have been considered and update the desk study to reflect their findings where necessary.	The desk study included an overview of the following elements to inform the baseline design: • Bedrock and superficial geology from BGS Mapping[1]; • Peatland and peat characteristic information from The Scottish Natural Heritage (NatureScot) carbon rich soils, deep peat and priority habitat[2]; • Habitat survey information from Chapter 5: Biodiversity of the 2022 EIA Report); • Hydrogeological and Hydrology information from Chapter 7: Hydrology, Hydrogeology and Geology and Soils of the 2022 EIA Report; • Topographical information taken from published Digital Terrain Model (DTM) LIDAR data; • Records for potential instability were also researched from nearby operational windfarm and electrical transmission sites; • Media articles, historic maps and local landowner accounts of historic land movements; and • Meteorological rainfall data[3].
3. The probing densities described (TA 2.3 of the 2022 EIA Report, Section 1.3.5) provide ample coverage around all turbine locations and proposed track routes. However further ancillary infrastructure such as crane pads, borrow pits construction compounds etc should also be probed on an appropriate grid. Although Figure 2.5.5, 2022 EIA Report shows ancillary infrastructure locations have been probed, the supporting text does not mention the probing density. Please confirm the density and sampling strategy of probing	Two peat depth probing surveys were undertaken at the Site, with a combined total of 1,889 peat probes taken. This comprised 843 peat depth probes during the Phase 1 survey, as part of a low resolution 100 m grid survey across the developable area of the Site, and a further 1,046 probes during Phase 2 survey based on a more mature development layout. The scope of the Stage 2 Peat Survey included: • Turbine locations – Centre point and 10 m intervals along cardinal points for a total of 50 m from centre; • Access tracks – 50 m centre line spaced points with 10 m perpendicular offsets; and

[1] British Geological Society https://mapapps.bgs.ac.uk/geologyofbritain/home.html
[2] Based on SNH Landscape Character Assessment 2019, available at https://data.gov.uk/dataset/cce069c5-8a2b-4932-9fae-4f9023cd9d5b/snh-landscape-character-assessment-2019M
[3] SEPA rainfall data for Cabrach https://www2.sepa.org.uk/rainfall/data/index/234176

Ironside Farrar Stage 1 Checking Report Comments	Applicant's Response
across ancillary infrastructure locations on the site.	• Site compounds, borrow pits and areas of proposed hardstanding, 25 m grid points with reduced 10m spacing where peat depth of >0.5 m was encountered.
4. Loads can significantly impact on the factor of safety results, for example under areas of floating roads or peat storage. Please clarify whether loads have been considered in the FoS assessment/calculations.	The Proposed Development site is considered to be Low or Very Low risk with regards to peat slide risk. Where adjacent areas of moderate likelihood or potentially unstable ground have been identified within the FoS and Combined factors assessment it is considered that adopting general good practice mitigation will be sufficient to mitigate instability within these areas. Following completion of vertical design and detailed ground investigation, further slope stability assessment should be undertaken to confirm the finding of this assessment and reassess potential peat slide risk once imposed loads have been determined.
5. The inclusion of two methods provides a comprehensive assessment of likelihood and does provide a useful sense check. However, there isn't any significant discussion in the report comparing the two sets of results and as the FoS approach isn't taken forward, it's not made particularly clear what the relevance of this check is and how it is used in the assessment. Please could this be expanded upon.	The results broadly agree with the results of the Factor of Safety Assessment which also indicated that areas of the Proposed Development are classified as "stable" or "low" likelihood.
6. Please confirm whether existing infrastructure and settlements have been considered in the consequence assessment.	See **Section 3: Assessment of Consequence and Risk** below.
7. In the consequence assessment, it is clear from the mapping where watercourses and infrastructure receptors are located. However, there is no mapping presented showing the locations of habitat receptors. Please expand on how habitat receptors have been considered.	
8. A Low-risk outcome has been scored for each of the three receptors considered. Please provide supporting discussion for each area where an area of Moderate Likelihood is nearby to high value infrastructure (Receptor) as it is possible that these could generate Higher Risks than those presented. Specific areas include, but are not limited to: • Turbine 3 - Moderate Likelihood area adjacent, • Turbine 4 - Moderate Likelihood area adjacent, • Turbine 7 - Moderate Likelihood area adjacent, • Turbine 11 - Moderate Likelihood area adjacent, • Track south of T8 - Moderate Likelihood area adjacent	Areas of "moderate" likelihood are located adjacent to areas of Proposed Development infrastructure. However, whilst vertical design of the windfarm infrastructure has not been undertaken, we consider that adopting mitigation measures as detailed in Technical Appendix 2.5 of the 2022 EIA Report, during construction will be sufficient to mitigate the level of risk to the identified adjacent areas. Also see **Section 3: Update Assessment of Consequence and Risk** below.
9. Please also provide supporting discussion on areas classified as Unstable or Marginally Unstable in the FoS assessment, with respect to nearby receptors: • 100m north of T3; downslope of turbine • 100m north of T5; downslope of turbine. Although relatively small in scale compared to the overall development, an assessment of these areas is still required to satisfy ECUBPG requirements.	
10. It is not clear how the scoring for the risk assessment has been undertaken in Table	Based on the combined Qualitative likelihood vs Consequence and the findings within the FoS assessment outlined in

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Ironside Farrar Stage 1 Checking Report Comments	Applicant's Response
2.6.12. If a risk table has been used, please can this be confirmed (i.e as per example provided in ECUBPG Table 5.3).	Technical Appenidx 2.3 of the 2022 EIA Report, it is considered that the combined risk level of peat landslide in association with the construction of the Proposed Development is assessed as being Low risk. This assessment of Risk level is based on Low likelihood vs High or Very High consequence as outlined in Table 5.3 of SEPA best practice guidance[4].

3. Updated Assessment of Consequence and Risk

3.1.1 Based on the assessment of consequence of risk methodology, as defined by best practice guidance, four receptors have been identified at the Site, and are assessed for consequence in **Table 3.1**:

- watercourses;
- non-riverine habitats;
- Residential properties and public buildings; and
- Proposed Development infrastructure.

Table 3.1 – Assessment of Consequence and Risk

Receptor	Consequence	Score	Justification for Score	Consequence Scale
Watercourses	Increased turbidity and acidification, fish kill, blockage of drainage, effects on private water supplies	3	Flood risk assessment has been scoped out of the EIAR. Private water supplies have been assessed.	High
Non-riverine Habitats	Medium term loss of vegetation cover, disruption of peat hydrology, carbon release	3	Effects on peatland habitats, though the effects of peat landslides are generally short in duration	High
Residential properties and public buildings	Medium term loss of residency for local occupants. Significant cost to restore property and temporary accommodation. Possible injury, loss of life to occupants	5	Loss of life, though unlikely, is a severe consequence; financial implications of damage and repair to residents property are less significant	Extremely high
Proposed Development Infrastructure	Damage to infrastructure, possible injury, loss of life	5	Loss of life, though unlikely, is a severe consequence; financial implications of damage and repair to the Proposed Development are less significant	Extremely high

3.1.2 **Table 3.2** shows how the Risk Level is defined for each of the defined consequences when applied to the likelihood classification.

Table 3.2 – Risk Levels Derived from Likelihood vs Consequence

Receptor	Qualitative Likelihood Worst Case	Consequence Scale/ Score	Risk Level	Minimum Distance to Receptor	Level of Mitigation Required	Level of Risk post Mitigation
Watercourses	Low (2)	High (3)	Low	50 m	General Good Pactice Refer Section 1.6	Low
Non-riverine Habitats	Low (2)	High (3)	Low	50 m	General Good Pactice Refer Section 1.6	Low
Residential properties and public buildings	Low (2)	Extremely High (5)	Low	100 m (Rinturk Farm)	General Good Pactice Refer Section 1.6	Low
Proposed Development Infrastructure	Low (2)	Extremely High (5)	Low	50m Various	General Good Pactice Refer Section 1.6	Low

[4] Scottish Government. (2017) Peat Landslide Hazard and Risk Assessments: Best Practice Guide for Proposed Electricity Generation Developments

3.1.3 The risk levels identified above for each potential receptor are based on the worst case likelihood and closest proximity to the receptor. Where proposed infrastructure locations have been identified as being in proximity to areas of unstable or potentially unstable ground, the risk level for these areas is considered to be Low, based on:

- On completion of vertical design of proposed track and turbine hardstanding areas, further detailed analysis will be required to assess potential instability from imposed loads or undermining from excavations;
- proximity of potential unstable ground from proposed infrastructure and using good practice recommendations as detailed in Technical Appendix 2.5 of the 2022 EIA Report;
- level and slope angle both up and down slope; and
- run out distances to potential receptors.

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Technical Appendix 2.4: Outline Peat Management Plan

November 2024

Contents

1. Introduction

1.1.1 This Outline Peat Management Plan (PMP) provides an update from that presented in Technical Appendix 2.4 of the 2022 EIA Report.

1.1.2 The Outline PMP has been prepared in accordance with appropriate guidance and best practice[1,2] and should be read in conjunction with the Technical Appendix 2.1: Outline Construction Environmental Management Plan (CEMP) of the 2022 EIA Report and the various other reports that contribute to it, including the Peat Depth Survey Report (**Technical Appendix 2.2**) and Peat Landslide Hazard Risk Assessment (PLHRA) (**Technical Appendix 2.3**).

1.1.3 The Outline PMP describes principles and methods to be used by the Applicant when excavating, moving and reinstating peat. It includes a volumetric peat balance and contains requirements for the final PMP, that will be developed by the contractor post consent, prior to construction. A final PMP will be produced by the Applicant's infrastructure Contractor.

1.1.4 The overarching aim of the PMP is to provide guidance and a framework for the contractor to effectively re-use peat excavated during construction in order to maintain and improve peatland habitats, minimise the risks to water quality and volumes, and retaining and using peat as close as possible to the point of extraction. The main requirement for the contractor is to plan peat management in detail and incorporate its progressive reinstatement and restoration of adjacent peatland areas into the construction programme so that they take place concurrently, minimising time the peat is in temporary storage and avoiding double-handling of peat.

2. Summary of Peat Depth

2.1.1 There is no change to the peat baseline at the Site, with most of the developable area of the Site having either no peat present or has a shallow depth of peat soil present (~88% <0.5 m in depth). Whilst the majority of the coverage is relatively shallow, the maximum depth of peat recorded at the Site was 5.2 m, located in the central part of the Site, south of Craig Watch and west of Brown Hill. The mean peat depth recorded was 0.31 m. The design of the Proposed Development has taken into consideration peat depths, along with other technical and environmental constraints, and the Proposed Development's infrastructure has been sited away from these areas, where possible.

3. Limitations

3.1.1 Peat probing and mapping have been used to inform the design process, at strategic points in the design evolution of the Proposed Development. However, there are some differences between the final design and the extent of the peat survey results based on design changes made through this process, as a result of micrositing etc.

3.1.2 However, the peat survey probing points do provide high resolution coverage of the Site, and these revealed the peatland to be typically shallow (<1.0 m) but with pockets of deeper peat, particularly in the central part of the Site, along the western boundary. It is considered that the peat depths collected, and interpolations derived from these data, are representative of the Site and have adequately informed the layout of the Proposed Development.

3.1.3 The peat excavation and reuse volumes included in this outline PMP are intended as an initial indication. The total peat volumes are based on a series of design assumptions and estimates for the Proposed Development layout and peat depth sample data interpolated across discrete areas of the Site. Such parameters can still vary over a small scale and therefore local topographic changes in the geological profile may impact the total accuracy of the volume calculations.

3.1.4 The PMP is a 'live' document and would be developed into a final PMP post-consent and in advance of construction commencing, when the contractor has been appointed. As part of this process it is proposed that further peat depth probing and coring would be undertaken at infrastructure locations, particularly wind turbine locations, post-consent and during pre-construction ground investigation surveys. This additional data would be used to aid micrositing of wind turbines away from any pockets of deeper peat into the shallowest areas, thereby minimising impacts on peatland within the micrositing tolerances, and to gather further information on the characteristics of the peat deposits present. A finalised post-consent layout would be completed once detailed ground investigations have been undertaken and before

[1] Scottish Renewables and SEPA, (2012). *Guidance on the Assessment of Peat Volumes, Reuse of Excavated Peat and the Minimisation of Waste.*
[2] SEPA, (2011).*Restoration Techniques Using Peat Spoil from Construction Works.*

construction works commence. This would demonstrate how any newly collected information has been used to inform the proposed layout and minimise impacts on features such as deep peat.

3.1.5 No additional peat survey has been undertaken to inform the SEI and therefore changes in locations of infrastructure may be based on high level peat data only.

4. Estimated Peat Balance

4.1.1 The estimated peat volume to be excavated based on the changes to the Proposed Development are shown in **Table 4.1**. These volumes would be subject to review and updated following ground investigation, detailed design and micrositing as part of the post-consent process, prior to construction.

Table 4.1 - Estimated Peat Volume to be Excavated

Element	**Estimated Peat Volume to be Excavated (m3)**
Turbine 1 – foundation and excavation area	512
Turbine 2 – foundation and excavation area	512
Turbine 3 – foundation and excavation area	512
Turbine 4 – foundation and excavation area	512
Turbine 5 – foundation and excavation area	512
Turbine 6 – foundation and excavation area	512
Turbine 7 – foundation and excavation area	1,024
Turbine 8 – foundation and excavation area	512
Turbine 10 – foundation and excavation area	512
Turbine 11 – foundation and excavation area	512
New cut tracks, emergency access tracks, turbine hardstandings and met mast	21,069.3
New floating tracks	0
Permanent substation compound	8,268.75
Borrow pit search area (1no)	900
TOTAL	**35,870.05**

4.1.2 **Table 4.2** provides an estimate of the potential reinstatement opportunities for the Proposed Development.

Table 4.2 - Estimated Peat Volume to be Reinstated

Element	**Area to be Restored (m^2)**	**Average Depth of Restoration Area (m)**	**Total Reinstatement (m^3)**
Turbine foundations - surface	6,500	0.5	3,250
Turbine foundations - backfill	5,400	2.0	10,800
Crane and met mast hardstanding verges	1,350	0.5	675
Permanent substation compound verges	1,335	0.5	667.5
Access track verges	38,150	0.5	19,075
Borrow pit restoration	4,500	0.6	2,700
Ditch backfilling/ habitat management and restoration	0	1.0	0
TOTAL	–		**37,167.5**

5. Summary

5.1.1 On this basis, there is potential that the peat excavated as part of the Proposed Development can be reused on-Site. In addition, there is potential that some of the peat excavated could be used for habitat and peatland restoration at the Site, rather than reused for backfilling excavation and borrow pit restoration if required.

5.1.2 Reference should be made to the proposed peat and mineral soil handling methods, storage and other requirements detailed in Technical Appendix 2.4 of the 2022 EIA Report .

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Technical Appendix 2.5: Carbon Balance Assessment

November 2024

Contents

1. Introduction and Methodology

1.1.1 This carbon assessment report provides an update from that presented in Technical Appendix 15.1 and Chapter 15 in the 2022 EIA Report.

1.1.2 The carbon assessment has been undertaken using the Scottish Government's online calculation tool[1] which has been developed to assess the carbon impact of wind farm development. The carbon assessment tool calculates the CO_2 emissions from the Proposed Development and compares them against the CO_2 emissions estimated from other electricity generation sources.

1.1.3 This Technical Appendix is supported by the following:

- **Annex 1.1: Carbon Calculator Inputs**; and
- **Annex 1.2: Carbon Calculator Results and Charts**.

1.1.4 The online carbon calculator tool uses the methodology and approach developed by Nayak et al[2].

2. Input Parameters

2.1 Characteristics of the Proposed Development

2.1.1 The carbon calculator has been updated to reflect the changes to the Proposed Development, specifically:

- Ten turbines with an operational life of 33 years and total installed capacity of 72 MW;
- Relocated substation with increased area of 1.65; and
- Revised new track length (now 7.4 km).

2.1.2 The net capacity factor for the Proposed Development is estimated to be approximately at 45%, which has been estimated based on wind data analysis.

2.2 Peatland and Environmental Characteristics of the Site

2.2.1 The baseline peatland information to that provided in the 2022 EIA Report remains unchanged and no additional survey has been undertaken.

2.2.2 The mean annual temperature has been updated to include five year data to 2023, derived based on the mean annual air temperature for Dufftown[3]. The mean annual air temperature for Dufftown was found to be 8.8°C, with minimum and maximum values of -4°C and 19°C respectively. However, 0°C and 15°C have been used as the minimum and maximum values in the carbon calculator as these are the maximum and minimum values allowed.

2.3 Counterfactual Emission Factors

2.3.1 The most recent counterfactual emission factors for three methods of energy generation have been used as provided in the online carbon calculator, which have been updated from those used in the 2022 EIA Report. These are 0.207 tCO_2 MWh^{-1} CO_2 emissions for grid mix, 0.945 tCO_2 MWh^{-1} for coal and 0.424 tCO_2 MWh^{-1} for fossil fuel mix.

3. Results

3.1.1 The estimated total carbon losses as calculated by the online carbon calculator are shown in **Table 1.1**.

[1] https://informatics.sepa.org.uk/CarbonCalculator/index.jsp
[2] 2 Nayak D.R., Miller D., Nolan A., Smith P., Smith J.U. (2011). *Calculating Carbon Savings from Windfarms on Scottish Peat Lands: A New Approach.*
[3] Dufftown, Moray, GB Historical Weather Almanac (worldweatheronline.com)

Table 1.1 - Total Carbon Losses

Source	Expected CO_2 Losses (tCO_2)	Minimum Value CO_2 Losses (tCO_2)	Maximum Value CO_2 Losses (tCO_2)
Losses due to turbine life	67,654	67,654	67,654
Losses due to backup	44,125	0	44,125
Losses due to reduced carbon fixing potential	948	282	5,228
Losses from soil organic matter	3,716	-4,640	104,916
Losses from Dissolved Organic Carbon and Particulate Organic Carbon Leaching	8	0	20,205
Losses due to forestry felling	124,396	112,531	125,115
Total losses of carbon dioxide	240,847	175,827	367,243

3.1.2 The carbon losses calculated are independent of the generation mix used to calculate the overall carbon balance. It is assumed that back-up capacity is derived from conventional fossil fuel generation.

3.1.3 The predicted payback time for the Proposed Development, as determined from the online carbon calculator, is shown in **Table 1.2**.

Table 1.2: Carbon Payback Period

Source	Counterfactual Emission Factors (t CO_2 MWh^{-1})	Carbon Payback Period (years)		
		Expected Value	Minimum Value 0% Balancing Capacity	Maximum Value 5% Balancing Capacity
Coal fired generation	0.945	0.9	0.6	1.4
Grid mix generation	0.207	4.1	2.6	6.4
Fossil fuel mix generation	0.424	2.0	1.3	3.1

3.2 Summary

3.2.1 The carbon assessment indicates that the carbon emission payback time for the Proposed Development would be between 1.3 and 3.1 years, with an expected value of 2 years. This is when compared against a fossil fuel mix generation.

ANNEX 1.1: CARBON CALCULATOR INPUTS

Carbon Calculator v1.8.1
Craig Watch Wind Farm   Location: 57.392302 -3.0413
Craig Watch Wind Farm Limited

Core input data

Input data	Expected value	Minimum value	Maximum value	Source of data
Windfarm characteristics				
Dimensions				
No. of turbines	10	10	10	EIAR Chapter 2 Development Description
Duration of consent (years)	33	33	33	EIAR Chapter 2 Development Description
Performance				
Power rating of 1 turbine (MW)	7.2	7.2	7.2	EIAR Chapter 2 Development Description
Capacity factor	45	44	46	Generated from the Applicant's internal wind analysis for the Proposed Developement
Backup				
Fraction of output to backup (%)	5	0	5	Calculating Potential Carbon Losses and Savings from Wind Farm Analysis from Wind Farms on Scottish Peatlands Technical Note
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	EIAR Volume 4 Ecological Technical Appendices
Average annual air temperature at site (°C)	8.8	0	15	Data derived based on local weather station at Dufftown, Moray for period 2017 to 2021 (https://www.worldweatheronline.com/dufftown-weather-averages/moray/gb.aspx). Maximum and minimum temperatures of 0 and 15 degrees used as per tool limitations
Average depth of peat at site (m)	0.31	0	5.2	EIAR Volume 4 Technical Appendix 2.3 Peat Depth Survey Report
C Content of dry peat (% by weight)	65	19	65	EIAR Volume 4 Technical Appendix 2.3 Peat Depth Survey Report. Maximum and minimum values of 65% and 19% used as per tool limitations.
Average extent of drainage around drainage features at site (m)	10	5	50	Wind Farm Carbon Calculator Web Tool, User Guidance
Average water table depth at site (m)	0.3	0.1	0.5	Wind Farm Carbon Calculator Web Tool, User Guidance
Dry soil bulk density (g cm^{-3})	0.105	0.05	0.3	Maximum vlaue of 0.3g cm-3 used as per tool limitations.
Characteristics of bog plants				
Time required for regeneration of bog plants after restoration (years)	5	2	10	Five years used as a precautionary approach based on location and elevation of the site.
Carbon accumulation due to C fixation by bog plants in undrained peats (tC ha^{-1} yr^{-1})	0.25	0.12	0.31	Wind Farm Carbon Calculator Web Tool, User Guidance
Forestry Plantation Characteristics				
Area of forestry plantation to be felled (ha)	93.46	93	94	EIAR Volume 4 Technical Appendix 16 Forestry
Average rate of carbon sequestration in timber (tC ha^{-1} yr^{-1})	11	10	11	Wind Farm Carbon Calculator Web Tool, User Guidance
Counterfactual emission factors				
Coal-fired plant emission factor (t CO2 MWh^{-1})	0.945	0.945	0.945	
Grid-mix emission factor (t CO2 MWh^{-1})	0.207	0.207	0.207	
Fossil fuel-mix emission factor (t CO2 MWh^{-1})	0.424	0.424	0.424	
Borrow pits				
Number of borrow pits	1	1	1	EIAR Volume 4 Technical Appendix 2.2 Borrow Pit Assessment
Average length of pits (m)	160	160	160	EIAR Volume 4 Technical Appendix 2.2 Borrow Pit Assessment
Average width of pits (m)	30	30	30	EIAR Volume 4 Technical Appendix 2.2 Borrow Pit Assessment
Average depth of peat removed from pit (m)	0.3	0	0.3	EIAR Volume 4 Technical Appendix 2.2 Borrow Pit Assessment
Foundations and hard-standing area associated with each turbine				
Average length of turbine foundations (m)	22	22	22	EIAR Chapter 2 Development Description
Average width of turbine foundations (m)	22	22	22	EIAR Chapter 2 Development Description
Average depth of peat removed from turbine foundations(m)	0.31	0.1	1.5	EIAR Volume 4 Technical Appendix 2.3. Peat Depth Survey
Average length of hard-standing (m)	60	60	60	EIAR Chapter 2 Development Description
Average width of hard-standing (m)	40	40	40	EIAR Chapter 2 Development Description
Average depth of peat removed from hard-standing (m)	0.31	0.1	1.5	EIAR Volume 4 Technical Appendix 2.3. Peat Depth Survey

Input data	Expected value	Minimum value	Maximum value	Source of data
Volume of concrete used in construction of the ENTIRE windfarm				
Volume of concrete (m^3)	16000	16000	16000	EIAR Chapter 2 Development Description
Access tracks				
Total length of access track (m)	9058	9040	9090	EIAR Chapter 2 Development Description
Existing track length (m)	2180	2170	2200	EIAR Chapter 2 Development Description
Length of access track that is floating road (m)	226	220	230	EIAR Chapter 2 Development Description
Floating road width (m)	6	6	6	EIAR Chapter 2 Development Description
Floating road depth (m)	0.25	0	0.5	EIAR Chapter 2 Development Description
Length of floating road that is drained (m)	0	0	0	EIAR Chapter 2 Development Description
Average depth of drains associated with floating roads (m)	0	0	0	EIAR Chapter 2 Development Description
Length of access track that is excavated road (m)	6652	6650	6660	EIAR Chapter 2 Development Description
Excavated road width (m)	6	6	6	EIAR Chapter 2 Development Description
Average depth of peat excavated for road (m)	0.31	0	1.5	EIAR Chapter 2 Development Description
Length of access track that is rock filled road (m)	0	0	0	
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	0	
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	EIAR Chapter 2 Development Description - all trenches follow access tracks
Average depth of peat cut for cable trenches (m)	0	0	0	EIAR Chapter 2 Development Description - all trenches follow access tracks
Additional peat excavated (not already accounted for above)				
Volume of additional peat excavated (m^3)	8581.25	8580	8590	EIAR Volume 4 Technical Annex 2.4 Outline Peat Management Plan
Area of additional peat excavated (m^2)	21662.5	21660	21670	EIAR Volume 4 Technical Annex 2.4 Outline Peat Management Plan
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	Conservative assumption that no bog improvement required.
Water table depth in degraded bog before improvement (m)	0	0	0	
Water table depth in degraded bog after improvement (m)	0	0	0	
Time required for hydrology and habitat of bog to return to its previous state on improvement (years)	0	0	0	
Period of time when effectiveness of the improvement in degraded bog can be guaranteed (years)	0	0	0	
Improvement of felled plantation land				
Area of felled plantation to be improved (ha)	93.46	93	94	Assumed that area will be improved based on removal of trees
Water table depth in felled area before improvement (m)	0.3	0.1	0.5	Same assumptions as used previously for average water table depth
Water table depth in felled area after improvement (m)	0.2	0	0.4	Assumption based on an improvement to water table following improvement
Time required for hydrology and habitat of felled plantation to return to its previous state on improvement (years)	5	2	10	Assumption based on professional experience
Period of time when effectiveness of the improvement in felled plantation can be guaranteed (years)	5	2	10	Assumption based on professional experience
Restoration of peat removed from borrow pits				
Area of borrow pits to be restored (ha)	0.45	0.4	0.5	Based on EIAR Volume 2 Chapter 2 and TA 2.2
Depth of water table in borrow pit before restoration with respect to the restored surface (m)	0.2	0	0.4	Assumption based on an improvement to water table following improvement
Depth of water table in borrow pit after restoration with respect to the restored surface (m)	0.1	0	0.3	Assumption based on an improvement to water table following improvement
Time required for hydrology and habitat of borrow pit to return to its previous state on restoration (years)	5	2	10	Assumption based on an improvement to water table following improvement
Period of time when effectiveness of the restoration of peat removed from borrow pits can be guaranteed (years)	33	33	33	Assumption based on an improvement to water table following improvement and scheme operating life
Early removal of drainage from foundations and hardstanding				

Input data	Expected value	Minimum value	Maximum value	Source of data
Water table depth around foundations and hardstanding before restoration (m)	0.3	0.1	0.5	Windfarm Carbon Calculator Web Tool, User Guidance
Water table depth around foundations and hardstanding after restoration (m)	0.1	0.05	0.3	Windfarm Carbon Calculator Web Tool, User Guidance
Time to completion of backfilling, removal of any surface drains, and full restoration of the hydrology (years)	0.25	0.1	3	Windfarm Carbon Calculator Web Tool, User Guidance
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	This will form part of a decommissioning and restoration plan for the site in future
Will you attempt to block all artificial ditches and facilitate rewetting?	Yes	Yes	Yes	This will form part of a decommissioning and restoration plan for the site in future
Will the habitat of the site be restored on decommissioning?	Yes	Yes	Yes	
Will you control grazing on degraded areas?	Yes	Yes	Yes	This will form part of a decommissioning and restoration plan for the site in future
Will you manage areas to favour reintroduction of species	Yes	Yes	Yes	This will form part of a decommissioning and restoration plan for the site in future
Methodology				
Choice of methodology for calculating emission factors	Site specific (required for planning applications)			

ANNEX 1.2: CARBON CALCULATOR RESULTS AND CHARTS

Payback Time and CO_2 emissions • Q7LP-N9DC-8AYZ v7

1. Windfarm CO2 emission saving over...	Exp.	Min.	Max.
...coal-fired electricity generation (t CO2 / yr)	268,214	262,253	274,174
...grid-mix of electricity generation (t CO2 / yr)	58,752	57,446	60,057
...fossil fuel-mix of electricity generation (t CO2 / yr)	120,341	117,667	123,016
Energy output from windfarm over lifetime (MWh)	9,366,192	9,158,054	9,574,330

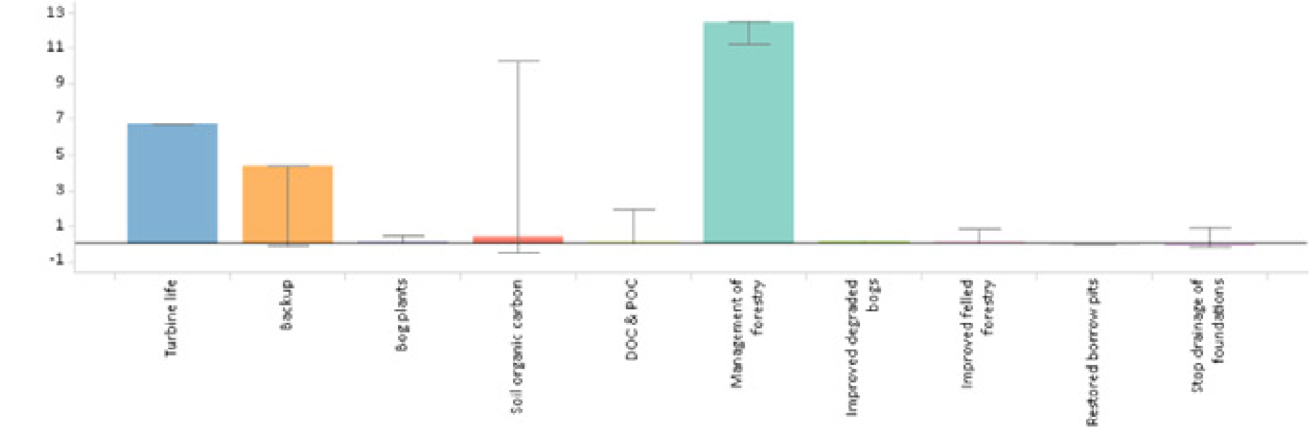
Total CO2 losses due to wind farm (tCO2 eq.)	Exp.	Min.	Max.
2. Losses due to turbine life (eg. manufacture, construction, decomissioning)	67,654	67,654	67,654
3. Losses due to backup	44,125	0	44,125
4. Lossess due to reduced carbon fixing potential	948	282	5,228
5. Losses from soil organic matter	3,716	-4,640	104,916
6. Losses due to DOC & POC leaching	8	0	20,205
7. Losses due to felling forestry	124,396	112,531	125,115
Total losses of carbon dioxide	240,847	175,827	367,243

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	-8,515
8c. Change in emissions due to restoration of peat from borrow pits	-41	0	-66
8d. Change in emissions due to removal of drainage from foundations & hardstanding	-842	0	-11,464
Total change in emissions due to improvements	-883	0	-20,044

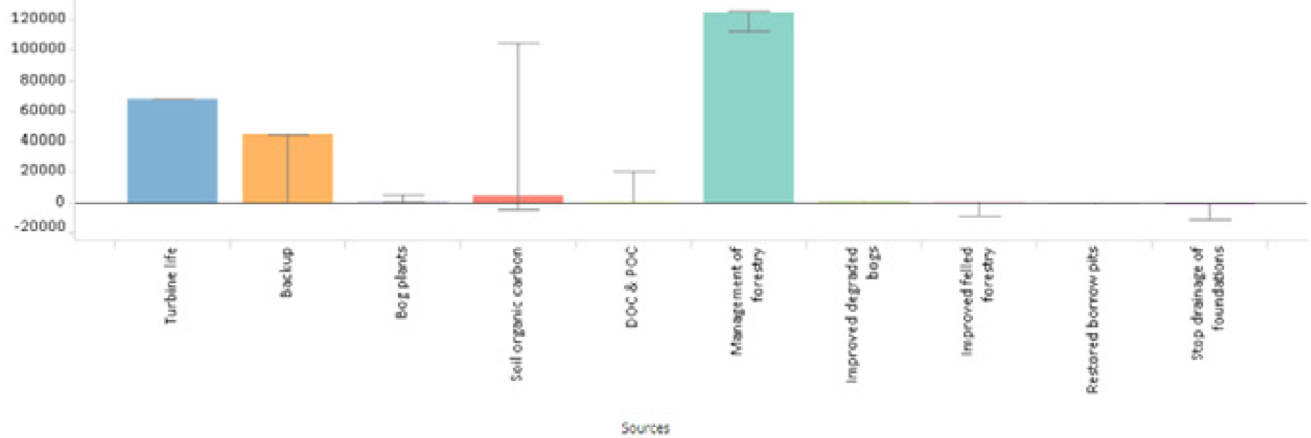
RESULTS	Exp.	Min.	Max.
Net emissions of carbon dioxide (t CO2 eq.)	239,964	155,783	367,243
Carbon Payback Time			
...coal-fired electricity generation (years)	0.9	0.6	1.4
...grid-mix of electricity generation (years)	4.1	2.6	6.4
...fossil fuel-mix of electricity generation (years)	2.0	1.3	3.1
Ratio of soil carbon loss to gain by restoration (not used in Scottish applications)	4.22	-0.23	No gains!
Ratio of CO2 eq. emissions to power generation (g/kWh) (for info. only)	25.62	16.27	40.10

Payback Time and CO_2 emissions • Q7LP-N9DC-8AYZ v7

Carbon payback time (months) using fossil-fuel mix as conterfactual



Greenhouse gas emissions (t CO2 eq.)



Proportions of greenhouse gas emissions from different sources