Document history

Author	Sarah Lister	20/10/2021
Checked	Ruth Paterson	01/11/2021
Approved	Ffion Edwards	25/10/2021

Client Details	
Contact	Julie Aitken
Client Name	Fred Olsen Renewables Limited
Address	Ochil House Springkerse Business Park Stirling FK7 7XE

Issue	Date	Revision Details
A	10/11/2021	First draft issued to client for review
B	23/11/2021	Legal review.
C	25/03/2022	Third draft for legal review
D	01/11/2022	Released

Appendix 9.1

Carbon Balance Assessment

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Glossary

Term	Definition
Environmental Impact Assessment	Environmental Impact Assessment (EIA) is a means of drawing together by the developer, in a systematic way, a description of the development and information relating to the likely significant environmental effects arising from a Proposed Development.
Environmental Impact Assessment Report	A document reporting the findings of the EIA and produced in accordance with the Electricity Works (Environmental Impact Assessment) (Scotland) Regulations 2017 Regulation 5
The Applicant	Fred. Olsen Renewables (Ltd)
Th Proposed Development Area/The Site	The development area within the red line site boundary (application area) as shown in Volume 3a Figure 1.2: Site Layout
The Proposed Development	The Proposed Scawd Law Wind Farm development

List of Abbreviations

Abbreviation	Description
CO_2	Carbon Dioxide
DETS	Derwentside Environmental Testing Services Ltd.
DOC	Dissolved Organic Carbon
EIAR	Environmental Impact Assessment
FORL	Fred. Olsen Renewables (Ltd)
ha	Hectare
MW	Mega watt
MWh	Mega watt per hour
MWh yr^{-1}	Mega watt per hour per year
POC	Particulate Organic Carbon
SEPA	Scottish Environment Protection Agency
SNH	Scottish Natural Heritage
tCO_2 yr^{-1}	Tonnes of CO_2 per year

A9.1.1 CARBON BALANCE ASSESSMENT

A9.1.1.1 This report has been prepared by Natural Power Consultants Ltd. and describes the carbon balance assessment undertaken for Scawd Law Wind Farm (hereafter known as the Proposed Development) which consists of 8 turbines and ancillary infrastructure. This report presents the carbon balance findings for the Proposed Development and has been produced to assist consultees and Scottish Ministers with their review of the Proposed Development's impact on peat and to assess the impact in terms of carbon dioxide (CO_2) emissions against the total potential carbon savings attributed to the Proposed Development.

A9.1.1.2 This report should be read in conjunction with the Geology, Hydrology and Hydrogeology (Chapter 9), Ecology (Chapter 7), and Project Description (Chapter 4) chapters and relevant appendices of the Environmental Impact Assessment Report (EIAR) which describe the Proposed Development in more detail and provide important information on the peat resource within the area.

Scope

A9.1.1.3 In the UK, Scotland is at the forefront in terms of providing a guidance framework through which the impact of development upon peatlands can be minimised. The carbon balance assessments make use of the carbon calculator tool[1], which is currently the best method to date to undertake this kind of assessment and is endorsed by the Scottish Environment Protection Agency (SEPA) and the Scottish Government.

[1] Available online from: https://informatics.sepa.org.uk/CarbonCalculator/index.jsp (last accessed 06/10/2021)

A9.1.1.4 The carbon balance assessment has been undertaken in accordance with guidance[2] 'Calculating Carbon Losses & Savings from Wind Farms on Scottish Peatlands – Technical Note 2.10.0'[3]. As well as Technical Note 2.10.0, this report has been produced giving consideration to the following guidance documents:

- D.R. Nayak *et al.* Calculating Carbon Budgets of Wind Farms in Scottish Peatlands (May 2010);
- Calculating carbon savings from wind farms on Scottish peat lands - A New Approach by Nayak *et al.,* 2010;
- Smith *et al.* Carbon Implications of Windfarms Located On Peatlands – Update Of The Scottish Government Carbon Calculator Tool (2011);
- Scottish Natural Heritage (SNH) (now NatureScot): Carbon rich soil, deep peat and priority peatland habitats map (2016);
- CCW Guidance Note: Assessing the impact of windfarm developments on peatlands in Wales (Jan 2010);
- Natural England Commissioned Report: Investigating the impacts of windfarm development on peatlands in England (Jan 2010);
- Guidance on the Assessment of Peat Volumes, Reuse of Excavated Peat and the Minimisation of Waste. Scottish Renewables (2014);
- Lindsay, R. Peatlands and Carbon: a critical synthesis to inform policy development in peatland conservation and restoration in the context of climate change (2010); and
- Scottish Government, SNH and SEPA - Peatland Survey - Guidance on Developments on Peatland – 2017.

A9.1.1.5 In addition, advice from the authors of the carbon calculator tool sought for previous assessments has been used again here, and the completion of the carbon balance assessments for the Proposed Development required input from hydrology, peat, ecology and site investigation specialists.

A9.1.1.6 Version V1.6.1 of the carbon calculator is currently the latest version of the online tool available (as of 18th October 2021). The inputs from the online carbon calculator tool run are presented in Annex B of this report (Reference: 2X0P-76LR-I0SQ v5). As the online tool does not allow any amendments to functionality and cannot be changed, the carbon balance assessment was undertaken subject to the specifications that the tool dictates. The tool does not currently allow users to describe the sources of the input data or the detailed information that is inserted to conduct the analysis. Therefore, Table A9.1.1 below presents this source information for the assessment. The data and infrastructure dimensions used have been based on the best data available at the time and, in cases where infrastructure design or construction methods were not yet clear, the worse-case values were used to ensure that the assessment presented a worse-case scenario in any areas of uncertainty. This carbon balance assessment is based on the data and infrastructure dimensions that reflect the final design of the Proposed Development, as far as is possible, as provided by Fred. Olsen Renewables Ltd (FORL, the Applicant). Some of the infrastructure dimensions may vary slightly to those presented in Chapter 4: Project Description as dimensions also include working and disturbance areas.

A9.1.1.7 It is important to highlight that the assessment used a robust and comprehensive peat depth dataset that was collected throughout all stages of the design work and which provides a fair representation of peat depths across the site as well as the final layout, as described in Chapter 9: Hydrology, Geology and Hydrogeology.

Table A9.1.1: Record of Data Sources

Input	Source of Information
Turbine capacity and lifespan	**FORL:** Vestas V150 (indicative): 8 turbines each with a rated output of up to 6 MW. Fixed life-span is expected to be up to 35 years.
Capacity factor	BEIS Scottish onshore wind average of 2016-2020 data with minimum and maximum average annual values across this period (Energy Trends, Table 6.1 Renewable electricity capacity and generation, Scotland Qtr dataset). Load factor statistics obtained from https://www.gov.uk/government/statistics/energy-trends-section-6-renewables (accessed on 18/10/2021). **It is important to note that the capacity factors used here will not typically reflect the final capacity factor of the Proposed Development and are much lower than energy yield assessments for this Proposed Development and candidate turbines indicate; the capacity factor would be anticipated to be greater, as modern turbines are more efficient and taller than many of the older turbines on operational wind farms where the BEIS data is derived from.**
Fraction of output to backup	The extra capacity that would be needed for back-up power generation is currently estimated at 5% of the rated capacity of wind plant as UK wind power regularly contributes more than 20% to the National grid.
Type of peatland	**Ecology Dept., Natural Power Consultants Ltd.** In the tool, the choice of peatland habitats is limited to acid bog or fen. In this case, acid bog was selected as no other relevant option is available. The ecological surveys (Chapter 7: Ecology) identified that the Proposed Development Area is located within an upland landscape context comprised of mosaics of blanket bog, modified blanket bog and heath in the more level areas on the hill tops in the north-west section and along the north boundary. However, these habitats are only represented in smaller patches within the site boundary as the hill tops are largely acid grassland. On the steeper slopes of the hillsides dry heath and continuous bracken are more widespread. As described in Chapter 9: Hydrology, Geology and Hydrogeology, the generalised soil type according to the National Soil Map of Scotland[4] (shown in Figure 9.2 found in Volume 3a) within the Site Boundary includes podzols and brown soils (predominantly), with smaller patches of peat and mineral gleys. Within the Proposed Development Area, the Scotland's Carbon and Peatland Map (2016)[5] shows that the majority of the site is of Class 0 mineral soil classification, with smaller pockets of Class 1 and 2 (nationally important) soils to the north and east of the site, intermixed with other larger pockets of a mix of Class 3, 4 and 5 soils (Figure 9.3).
Average air temp. at site	Site specific temperature based on 29 years (1981-2010) data collected from the closest **Met Office** weather station to the Proposed Development. The Galashiels Climate Station is positioned approximately 12 km south-east of the Proposed Development. The expected value is the average annual temperature over the data collection period. The minimum value is the minimum average annual temperature and maximum value is the maximum average annual temperature. https://www.metoffice.gov.uk/research/climate/maps-and-data/uk-climate-averages/gcvurvzxs (accessed 13/10/2021).

[2] Available online from: http://www.gov.scot/Topics/Business-Industry/Energy/Energy-sources/19185/17852-1/CSavings/CCguidance2-10-0 (accessed 20/10/2021)

[3] Available online from: https://www.gov.scot/publications/calculating-carbon-savings-wind-farms-scottish-peat-lands-new-approach/pages/13/ (accessed 14/10/2021)

[4] National Soil Map of Scotland, available online: http://map.environment.gov.scot/Soil_maps/?layer=1 (accessed 13/10/2021)

[5] Available online from: https://map.environment.gov.scot/Soil_maps/?layer=10 (accessed 13/10/2021)

Input	Source of Information
Average depth of peat on site	**Hydrology Department, Natural Power Consultants Ltd.** Informed by peat probe data collection. The average of all the peat probe data collected across the site during August 2019 and May 2021, total number of probes was 1,211 illustrated in the interpolated peat depth map in Figure 9.4 (found in Volume 3a). As advised by the authors of the original Excel tool, the arithmetic mean was calculated from this data to represent the 'expected' value, and the minimum and maximum values provided represent the lower and upper bound values of the 95% confidence intervals of the sample data collected.
C content of dry peat	**Derwentside Environmental Testing Services (DETS) Ltd**. results June 2021 – see Annex A. Three peat cores were collected at track locations between T3 and T6 and from T6 location where the deepest peat depths were found during surveys. Collection of cores was limited as depths experienced at other turbine locations (where cores would typically be collected) were too shallow. Accordingly, these results present a worst-case scenario as the tool will assume these peat characteristics across the whole site.
Extent of drainage	**Hydrology Department, Natural Power Consultants Ltd.** Based on site observation, literature review and previous experience on similar, unforested sites.
Average water table depth	**Hydrology Department, Natural Power Consultants Ltd.** Based on water table depth observations across the site during site visits., literature review and previous experience on similar, unforested sites.
Dry soil bulk density	**MAT Test Ltd.** results June 2021 – see Annex A. Three peat cores were collected at track locations between T3 and T6 and from T6 location where the deepest peat depths were found during peat surveys. Collection of cores was limited as depths experienced at other turbine locations (where cores would typically be collected) were too shallow. Accordingly, these results present a worst-case scenario as the tool will assume these peat characteristics across the whole site.
Time for regeneration of bog plants	**Ecology Dept., Natural Power Consultants Ltd.** This has been estimated to be 7 years (5 years minimum and 10 years maximum). The time period for successful regeneration of bog plant species is dependent on numerous factors including relevant seed source, successional rate, the level of herbivore disturbance and the successful stabilisation of the water table in a restoration area. As little peat exists under any infrastructure of the Proposed Development, the values provided are based on the professional experience of project ecologists and the quality of the existing vegetation. Opportunities for habitat management and potential peat restoration have been investigated and are reported in the Outline Habitat Management Plan presented in Chapter 7: Ecology of the EIAR. To present a worst-case scenario for this assessment however, it is assumed that no peat restoration will take place.
Carbon accumulation due to	Values have been inserted from the online tool notes that quote published primary literature and NatureScot guidance values.

Input	Source of Information
C fixation by bog plants	
Coal-fired emission factor	Fixed value of the carbon calculator tool.
Grid mix emission factor	Fixed value of the carbon calculator tool.
Fossil fuel mix emission factor	Fixed value of the carbon calculator tool.
No. of borrow pits and dimensions	**FORL:** Most stone on site will be won from road cuttings, however, one borrow pit is proposed for additional stone for use in construction of turbines and hardstandings, as required. This borrow pit is located on an area of acid grassland but dimensions have been included to represent a worst-case scenario.
Average depths of peat removed from infrastructure	**Hydrology Department, Natural Power Consultants Ltd.** Informed by August 2019 and May 2021 survey data. A total of 1,211 probes were collected within the Proposed Development Area. These values are derived from interrogation of the peat depth data collected underlying each type of infrastructure including a 75 m micrositing allowance for turbines. As advised by the authors of the original Excel tool, the arithmetic mean was calculated from this data to represent the 'expected' value, and the minimum and maximum values provided represent the lower and upper bound values of the 95% confidence intervals of the sample data collected.
No. of foundations/ hardstandings and dimensions	**FORL:** The foundations will be made from reinforced concrete, delivered to the site. Expected dimension of the actual foundations is 25 m x 25 m as a worst case, which includes a 5 m working area. Dimensions for hardstandings consider the permanent crane hardstanding area including the temporary hardstandings/laydown areas around the turbines, a 5 m working area and a 20% tolerance for additional excavation areas.
Volume of concrete	**FORL:** Based on approximately 800 m^3 for each turbine base, plus some allowance for substation and transformer elements if they are external to the turbine on the turbine foundation.
Total length of track	**FORL:** 6,864 m of excavated road expected. This value comprises the proposed new tracks minus the sections of track through the crane hardstanding areas so as to avoid double counting. No existing tracks on site. Minimum and maximum scenarios are -/+ 10% of the expected value to accommodate any changes to design through micrositing.
Length of floating roads	**FORL:** No floating roads are proposed.
Excavated road length	**FORL:** This value covers 6,864 m of excavated roads.
Excavated road width	**FORL:** The expected scenario value of 14.5 m is based on 5 m running width, 2.5.m drainage/cable trench on one side (1 m drainage + 1.5 m cable trench) and then 7 m allowance for cut/fill working areas. In some areas, cut/fill working areas may be narrower or wider therefore, the minimum and maximum values of 12.5 m and 16.5 m have been provided respectively.

Input	Source of Information
Length of rock filled roads	**FORL:** There will be no rock filled roads.
Length of cable trenches	**FORL:** It is assumed that all cables will follow tracks and an allowance for cable trenches has been made when calculating excavated road widths.
Additional peat excavated	**FORL:** An expected volume of 6,361 m^3 of additional peat will be excavated. This input accounts for the substation, construction compounds and permanent met mast areas. Not all infrastructure is located on deep peat however, as pockets of peat exist on site, all infrastructure has been included in the tool to represent a worst-case scenario. Construction compounds will also provide areas for potential storage and additional lay down areas. Substation dimensions include area for control building. Calculations are shown in Table A9.2 of this document.
Area of improvement of felled plantation land	**Natural Power Consultants Ltd.** The site is unforested, so no felling of plantation proposed. No improvement of felled plantation is proposed.
Area of degraded bog to be improved	**Ecology Dept., Natural Power Consultants Ltd.** Opportunities for habitat management and potential peat restoration have been investigated and are reported in the Outline Habitat Management Plan presented in Chapter 7 Ecology of the EIAR. To present a worse-case scenario for this assessment however, it is assumed that no peat restoration/improvement of degraded bog will take place.
Area of borrow pits to be restored	**Natural Power Consultants Ltd.** Borrow pit will be reinstated. The final reinstatement of the borrow pit would be agreed with the local authority in consultation with NatureScot prior to reinstatement works commencing. However, as the borrow pit is not located on peat habitats, inputs for peat restoration have not been included to represent the worst-case scenario.
Water table depth around foundations and hardstandings before and after restoration	**Hydrology Department., Natural Power Consultants Ltd.** The 'before restoration' water table depth is based on the scenario whereby drainage is not removed but left in situ. It assumes that the drainage left in place would cause some draw down on the existing water table. The 'after restoration' water depths are based on backfilling of the drainage which would bring the water table depth up to, and likely higher, than previous levels before construction.
Time to completion of backfilling, removal of any surface drains, and full restoration of the hydrology (years)	**Hydrology Department., Natural Power Consultants Ltd.** Values of 3, 2 and 5 years used. Based on professional judgement.
Will the hydrology of the site be restored on decommissioning?	**Hydrology Department. Natural Power Consultants Ltd.** Yes. During the construction and commissioning of the wind farm, drainage ditches will be blocked and therefore the water table will increase. Upon the decommissioning of the wind farm, best practice principles will be adopted.
Will the habitat of the site be restored on decommissioning?	**Ecology Department. Natural Power Consultants Ltd.** No. At the moment it is assumed that upon decommissioning, restoration of habitats will not be undertaken. There are no plans to control grazing or to reintroduce species using nurse crops or fertilisation, therefore a worst-case scenario of "no restoration" has been inputted into the carbon calculator tool.

A9.1.1.8 The following paragraphs report on the results of the carbon calculator calculations that are present within the online tool. For clarification of the calculations, the reader will need to view the online submission (Reference: 2X0P-76LR-I0SQ v5).

Wind Farm CO_2 Emission Savings

A9.1.1.9 The amount of CO_2 emissions produced during energy production varies with the type of fuel used; therefore, the potential CO_2 savings from the Proposed Development depends on the type of fuel it replaces. The wind farm CO_2 emission savings over other types of generation (i.e. coal-fired, grid-mix, fossil fuel-mix) is calculated by multiplying the energy output of the Proposed Development by the emissions factor of the other type of generation.

A9.1.1.10 Based on an averaged 6 MW turbine model scenario, the expected potential annual energy output of the Proposed Development is 109,745 MWh yr^{-1} (3,841,085 MWh over 35 years), with minimum and maximum potential outputs at 99,233 MWh yr^{-1} and 113,530 MWh yr^{-1}.

A9.1.1.11 Based on the expected annual energy output of the Proposed Development (109,745 MWh yr^{-1}), the potential expected emissions saved over coal-fired electricity generation is 100,966 tonnes of CO_2 per year (tCO_2 yr^{-1}); and over grid-mix generation is 27,829 tCO_2 yr^{-1} and over fossil fuel-mix generation is 49,385 tCO_2 yr^{-1}.

Emissions due to Turbine Life

A9.1.1.12 Energy is consumed and associated CO_2 emissions are released during manufacture of turbine components, site construction (including site tracks and turbine foundations etc.), and during decommissioning of a development.

A9.1.1.13 The carbon calculator includes a module for assessing the carbon emissions due to turbine life. Nayak *et al*. (2010) explain that the turbine life calculation within the carbon calculator is based on generic data as it does not accommodate a site-specific full life-cycle analysis. Therefore, the turbine life emissions for the Proposed Development are estimated utilising an equation for ≥1 MW turbines that has been derived from data from numerous European sites, and which shows a significant relationship across the European sites examined.

A9.1.1.14 The carbon calculator reveals an expected emissions figure of 43,320 tonnes of CO_2 (tCO_2) equivalent (equiv.) emitted due to the manufacture, construction and decommissioning of the turbines. Based on the calculated emissions savings for fossil fuel-mix generation, the payback time for turbine life is expected to take approximately 11 months.

Capacity Required due to Back Up

A9.1.1.15 In order to maintain security of energy supply, a second-by-second balance between generation and demand must be maintained by the grid operators. It has been noted that the inherent variable nature of wind energy may affect this balance and therefore, a certain proportion of power is required to stabilise the supply to the customer. The electricity system however, is designed and operated in such a way as to cope with large and small fluctuations in supply and demand. No power station is totally reliable, and demand, although predictable to a degree, is also uncertain. Therefore, the system operator establishes reserves that provide a capability to achieve balance, given the statistics of variations expected over different timescales. The variability of wind generation is but one component of the generation and demand variations that are considered when setting reserve levels.

A9.1.1.16 It should also be noted that an individual wind turbine will generally generate electricity for 70-85% of the time, and its electricity output can vary between zero and full output in accordance with the wind speed. However, the combined output of the UK's entire wind power portfolio shows less variability, given the differences in wind speeds over the country as a whole. Whilst the amount of UK wind generation varies, it rarely, if ever, goes completely to zero, nor to full output at the same time throughout the UK.

A9.1.1.17 The extra capacity that would be needed for back-up power generation is currently estimated to be approximately 5% of the rated capacity of the wind plant as UK wind power contributes more than 20% to the National Grid. The carbon calculator assumes that all back-up power generation will be via fossil fuels or grid-mix which does not account for any back-up energy generation from renewable sources directly or from renewable energy that has been stored in batteries. As such, the emissions figure required from back-up power generation for the Proposed Development is considered to be conservative as the calculator assumes a very worst case scenario.

A9.1.1.18 The carbon calculator assumes that backup is provided by a fossil fuel mix of energy generation and reveals an expected emissions figure of 33,113 tCO_2 equiv. due to the back-up. Based on the calculated emissions savings for fossil fuel-mix generation, the payback time for back-up is expected to take approximately 8 months.

Loss of Carbon Fixing Potential

A9.1.1.19 Construction of the Proposed Development will involve the installation of infrastructure such as turbine foundations, access tracks and hardstandings etc. Where vegetation and/or peat is removed or covered, the vegetation will no longer be able to photosynthesise and therefore, its ability to fix carbon will be lost. In addition, changes to drainage can have an effect on the vegetation of peatlands. Accordingly, the carbon calculator assumes that the carbon-fixing potential is lost from both the area occupied by infrastructure as well as working areas used to install the infrastructure and areas affected by drainage. In order to demonstrate a worst-case scenario of the Proposed Development's impact on carbon fixing potential through drainage, the extent of drainage around infrastructure is given as 10 m expected and 5 m and 25 m as minimum and maximum values respectively.

A9.1.1.20 The carbon calculator also assumes that the footprint of the wind farm has 100% coverage of bog plants that are still accumulating carbon for those areas where vegetation is either removed during construction or compromised due to disturbance or drainage. This assumption is considered to be very much a worst-case scenario as 100% bog habitat cover is not an accurate representation of the site's total habitat characteristics.

A9.1.1.21 Habitat loss calculations for the Proposed Development's infrastructure have been calculated and are discussed in Chapter 7 (Table 7.7) of the EIAR. The Phase 1 habitat survey (Figure 7.5 in Volume 3a) reveals that the Proposed Development Area is largely comprised of acid grassland, dry heath and bracken. Other habitats include smaller areas of wet and dry modified bog and marshy grassland.

A9.1.1.22 Of the above habitats, peat habitat types (i.e. modified bog and some potential within marshy grassland) represent approximately 99 hectares (ha) of the *c.*799 ha of habitat types recorded across the area surveyed. However, only a small area of these peat habitats will be directly impacted by preparation and construction activities; with permanent loss confined to only *c.*6.5 ha in total (*c.*6%) in the worst-case scenario. In accordance with the carbon calculator's methodology however, the emissions from loss of CO_2 fixing potential is based on the footprint area of the Proposed Development, plus the expected area affected by drainage which is based on the 10 m expected extent of drainage and assumes 100% bog/mire habitat cover of the footprint and drainage area. As such, Sheet 4 of the online tool assumes that approximately 38 hectares of bog plants will be lost compared to the *c.*6.5 ha habitats (including marshy grassland) identified through site specific survey work.

A9.1.1.23 Therefore, it is considered that the carbon calculator's assumption that 100% of the land lost through construction or drainage of the Proposed Development is covered in bog plants or peatland vegetation is considered to be highly precautionary in this instance as many other types of habitat exist.

A9.1.1.24 The carbon calculator reveals that the expected total emissions attributable to the loss of carbon accumulation by bog plants is equivalent to 1,470 tCO_2 equiv. over the operational period of the wind farm. Based on the calculated emissions savings for fossil fuel-mix generation, the payback time for loss of carbon fixing potential is expected to be less than 1 month. However, as previously described above, it is important to recognise that 100% bog/mire habitat cover is not an accurate description of the site's characteristics.

Loss of Carbon Dioxide from Removed Peat (Direct Loss)

A9.1.1.25 The 2017 Peatland Survey Guidance states that peat is defined as the partially decomposed remains of plants and soil organisms which have accumulated at the surface of the soil profile. Peat accumulates where the rate of input of organic material from the surface exceeds the rate of decomposition and 'turn-over' of this new material. A peat layer does not include a mineral fraction (hence being differentiated from topsoil).

A9.1.1.26 Peat deposits are made up on an organic soil which contains more than 60% of organic matter and exceeds 50 cm in thickness. The peat depth data at the Proposed Development are taken from over 1,200 peat depth measurements collected across the Proposed Development. As advised by the authors of the tool, the arithmetic mean was calculated from this data to represent the 'expected' value, and the minimum and maximum values provided represent the lower and upper bound values of the 95% confidence intervals of the sample data collected. Peat depths of less than 0.5 m are categorised as peat soils with peat deposits being >0.5 m in depth (JNCC, 2011[6]; Scottish Government *et al.,* 2017[7]).

A9.1.1.27 Peat survey methodology was conducted in accordance with the guidance documentation 'Guidance on Developments on Peatland – Peatland Surveys 2017'[7]. The interpolated peat depths are illustrated in Figure 9.4 in Volume 3a of the EIAR. The peat depth results show that the highest proportion of recorded peat depths were ≤0.5 m (93.1%) and only 6.9% were >0.5 m. Infrastructure elements have largely been placed on areas where mean soil depths are noted to be less than 0.5 m (Chapter 9, Table 9.9). The only areas of deep peat (greater than 0.5 m) are found located at T6 and on the track between T3 and T6. Accordingly, the requirement for a standalone peat management plan to be undertaken pre-application has been scoped out with mitigation measures outline in Chapter 9 of the EIAR.

A9.1.1.28 To obtain site-specific information relating to the characteristics of the peat/soil, peat core samples were also collected using a Russian peat core and were retained for laboratory and geochemical analysis. Three peat cores were collected at track locations between T3 and T6 and from T6 location where the deepest peat depths were found during peat surveys. Collection of cores was limited as depths experienced at other turbine locations (where cores would typically be collected) were too shallow.

A9.1.1.29 Carbon content of dry peat (% by weight) and dry soil bulk density (g cm^{-3}) were analysed in a laboratory (see Annex A for results) and the expected, minimum and maximum values have been inserted in the carbon calculator.

A9.1.1.30 The excavated volumes calculated and reported within the assessment accommodate realistic working areas with the assumption built into the model that all peat/habitat in working areas or excavation areas is lost. Within this assessment, in order to represent a worst-case scenario the following working areas and assumptions have been incorporated into the analysis:

- The expected values for excavated new roads width accommodate a 5 m running width as per Chapter 4: Project Description, however, as required when populating the online tool, an additional width to account for drainage/cable trench (2.5 m) on one side, and a working area/cut and fill area of 7 m is added, giving a total width of 14.5 m. In some areas, cut and fill areas would be smaller or larger than in expected scenario therefore minimum and maximum values of 12.5 m and 16.5 m have been provided respectively.
- Working areas, excavation areas and batters have been included around turbine foundations and the average length and width included for the range of turbines sizes considered (indicative dimensions of 25 m x 25 m,

[6] JNCC Report 445 (2011), Towards an assessment of the state of UK Peatlands.

[7] Scottish Government, NatureScot, SEPA (2017) Guidance on Developments on Peatland – Peatland Survey.

which includes an additional excavation area of 5 m). Minimum and maximum values allow tolerance to account for changes in these areas that may be required. In most cases, the turbine foundation footprint and working areas will overlap with the hardstandings/working areas/laydown areas. As such, the minimum dimensions included within this assessment for turbine foundations should be considered worst-case as there is an element of double counting.

- Dimensions for hardstandings consider the permanent crane hardstanding area including the temporary hardstanding/laydown areas around the turbines, a 5 m working area and a 20% tolerance for additional excavation areas.
- No floating roads have been entered into the tool to present a worst-case scenario.

A9.1.1.31 The working areas presented within this carbon balance assessment represent those areas where peat and/or peat vegetation may be removed or damaged/disturbed. As such, the peat volumes reported in the carbon balance assessment are considered to be highly precautionary and considered to be unrealistically worst-case. In fact, latest guidance[8] states that peat depth measurements of less than 0.5 m are not categorised as peat (rather peat soils), and deep peat deposits are considered being >0.5 m in depth.

A9.1.1.32 The carbon calculator also requires information relating to other ancillary infrastructure not explicitly accounted for above, namely the substation, met mast and construction compounds. Table A9.1.2 utilises the expected dimensions of the additional infrastructure and peat depths used to calculate the total area and total volume of excavations.

Table A9.1.2: Additional peat excavated calculations

Additional Peat Excavated			
	Expected	**Minimum**	**Maximum**
Substation (m^2)	14,000	10,800	17,600
Substation Average Peat Depth (m)	0.31	0.25	0.37
Construction Compounds (m^2)	10,000	5,000	40,000
Construction Compounds Average Peat Depth (m)	0.2	0.18	0.22
Met Mast (m^2)	100	64	144
Met Mast Average Peat Depth (m)	0.21	0.12	0.30
Total Area of Peat Removed (m^2)	24,100	15,864	57,744
Total Volume of Peat Removed (m^3)	6,361	3,608	15,355

A9.1.1.33 The CO_2 release associated with the volume of peat excavated assumes a worst-case scenario that 100% of the peat is lost. Sheet 5, Table 5a of the carbon calculator calculates the total expected area of land lost due to the wind farm construction as 19.26 ha (does not include drained peat areas) and expected volume of 'peat' removed over the footprint of the wind farm is expected to be 57,934 m^3. However, as previously described within paragraphs A9.1.22 and A9.1.23, only a small area of this 19.26 ha will be directly impacted by preparation and construction activities; with permanent loss confined to only *c.*6.5 ha in total (*c.*6%) in the worst-case scenario. Therefore, it is considered that the carbon calculator's assumption that 57,934 m^3 of peat will be lost through construction of the Proposed Development is considered to be highly precautionary as many other types of habitats and soils exist within the wind farm construction area, not only peat.

A9.1.1.34 Total volumes and areas have been stated within the results of the tool, and these values are not rounded which conveys a false accuracy and it should be borne in mind that these values are only highly indicative as not all of the volume and areas reported as removed will be peat habitat.

A9.1.1.35 The total expected amount of CO_2 loss, attributable to peat removal only, (i.e. CO_2 emissions from peat that is excavated for the wind farm only, no impacts from drainage of peat) is -5,516 tCO_2 equiv. Therefore, the value for this parameter actually indicated a carbon gain rather than a carbon loss. This can occur when the carbon emissions of soil that has remained in situ and undrained (i.e. not excavated) is actually greater than the emissions in the scenario where the soil is removed. This occurs because, the online tool bases its calculations on the assumption that when flooded, peat soils emit less carbon dioxide but more methane than when drained.

Loss of Carbon Dioxide from Drained Areas (Indirect Loss)

A9.1.1.36 Carbon is also lost from peat habitats through drainage that occurs in the peat around the Proposed Development's infrastructure. The carbon calculator and associated guidance refers to this CO_2 loss as an "indirect loss". The extent of the site affected by drainage assumes an expected, minimum and maximum extent of drainage around each drainage feature e.g. turbine foundation, tracks etc. It is important to bear in mind that the extent of drainage is dependent on existing drainage conditions on site and also topography. The carbon calculator, however, assumes no existing drainage on site and flat terrain which is not representative of the actual site characteristics. Therefore, results using this parameter should only be considered as indicative at best.

[8] Scottish Government, NaturScot, SEPA (2017) Peatland Survey. Guidance on Developments on Peatland, Available online from: Guidance+on+developments+on+peatland+-+peatland+survey+-+2017.pdf (www.gov.scot) (last accessed 18/10/2021)

A9.1.1.37 Hydrological and site investigation specialists visually noted and recorded water table depths during surveys which informed the site design evolution. Extent of drainage is a reasonable estimation based on knowledge of the site (topography etc.), experience at similar sites and expert judgement. As such, a recommended average extent around the drainage feature of 10 m was considered as an appropriate expected average for the calculation. Values of 5 m and 25 m were inserted as inputs to represent best- and worst-case scenarios respectively.

A9.1.1.38 Page 5, Table 5 of the carbon calculator calculates the total expected CO_2 loss from removed peat **and** drained peat as -5,516 tCO_2 equiv. This is the same carbon gain value as for CO_2 loss from peat removal only, as in Table 5d the tool assumes that the emissions from drained and undrained peat have the same proportion over the emissions period and therefore the net emissions due to drainage is 0 tCO_2 equiv.

Loss of Carbon Dioxide from DOC and POC loss

A9.1.1.39 Additional CO_2 emissions from organic matter can occur as carbon dioxide and methane, which can leach out of peat that is restored to conditions where the water table depth is higher after restoration than before restoration, and is a further consideration of the carbon calculator. Dissolved Organic Carbon (DOC) is defined as the organic matter that is able to pass through a filter (range in size generally between 0.7 and 0.22 µm). Conversely, Particulate Organic Carbon (POC) is the fraction of soil carbon that is larger in particle size. The assessment tool assumes that 100% of the losses due to leaching DOC and POC from restored drained and improved land are eventually lost as gaseous CO_2.

A9.1.1.40 Only restored drained and improved land has been included in the calculations within the carbon calculator for DOC and POC, because if the land is not restored or improved, then the carbon loss has already been accounted for in the calculations for excavated and drained peat (i.e. the carbon assessment assumes that if land is not restored then 100% of the carbon will be lost from the removed or drained volume of soil).

A9.1.1.41 The carbon calculator calculates that there will be an expected less than 1 tCO_2 equiv. lost due to DOC and POC leaching over the operational life of the wind farm.

Total Loss of Carbon Dioxide from Impact on Peat

A9.1.1.42 The following calculations on total loss of CO_2 from impacts on peat have been based on a number of key assumptions (some of which are built into the tool itself), specifically in relation to peat, in order to demonstrate a worst-case (unrealistic) scenario using on-site data with input from ecology and hydrology specialists. In summary, these assumptions are:

- 100% of the area potentially affected by the wind farm is covered in peat forming mire habitat;
- The terrain is relatively flat with no existing drainage;
- Infrastructure dimensions for foundations, tracks and hardstandings include working/laydown areas;
- 100% of the carbon stored in the excavated peat will be lost as carbon dioxide and not reinstated on site;
- 10 m metre expected average extent of drainage to demonstrate a conservative expected scenario and 25 m worst- case scenario;
- The average extent of drainage assumes that the depth of peat affected by drainage is equal to the depth of peat removed;
- Emissions from drained and undrained land have the same proportion over the emissions period;
- The peat depth data used to inform the volumes of peat removed assume that all recorded depths are in peat; and
- The model assumes no micrositing to further reduce impacts on peat.

A9.1.1.43 The combined expected impact of the Proposed Development on peat and vegetation over the operational lifetime for the proposed layout is calculated as shown in Table A9.1.3.

Table A9.1.3: Total CO_2 (tCO_2 eq.) loss/gains on peat

	CO_2 loss from plants +	CO_2 loss from removed peat + CO_2 loss from drained peat (i.e. soil organic matter loss)	+ CO_2 DOC & POC loss
	1,470	-5,516	1
Total CO_2 loss/gains equiv.		-4,045	

Source: Online Tool Reference 2X0P-76LR-I0SQ v5

A9.1.1.44 Based on the calculated emissions for fossil fuel-mix generation, the payback time for loss of soil organic carbon is actually a carbon gain which reduces the overall payback of the construction of the wind farm by over a month.

Loss of Carbon Fixing due to Forest Felling

A9.1.1.45 The site is unforested and therefore there will be no loss of carbon fixing associated with forest felling on the site.

Carbon Gain Due to Site Improvement and Restoration

A9.1.1.46 Restoration of areas within a proposed site can reverse emissions and act as carbon storage, reducing the total CO_2 emissions as a result of the Proposed Development. The carbon calculator takes into account reductions for emissions resulting from the improvement of degraded bog, felled plantation land as well as the restoration of borrow pits and early removal of drainage from turbine foundations.

A9.1.1.47 The drainage associated with the hardstandings and foundations will have an expected draw down on the water table during the construction period until such a time when they are removed/backfilled. This work will where possible, intend to raise the water table depth above that which is already present before construction. All construction ditches and drainage on site will be blocked to minimise indirect habitat damage and loss through drainage.

A9.1.1.48 Opportunities for habitat management and potential peat restoration have been investigated and are reported in the Outline Habitat Management Plan presented in Chapter 7 Ecology of the EIAR. To present a worst-case scenario for this assessment however, no values for improvement of degraded bog, felled plantation or peat restoration of borrow pits have been entered into the tool. Although the borrow pit will be reinstated, Chapters 7: Ecology and 9: Hydrology, Geology & Hydrogeology within the EIAR clearly indicate that the majority of the infrastructure at the Proposed Development is not located on peat and therefore, no values have been inserted for peat restoration of borrow pits.

A9.1.1.49 The results report -562 tCO_2 equiv. in carbon gains from the removal; of drainage measures in the expected scenario and -2,827 tCO_2 equiv. in carbon gains in the maximum (best-case) scenario. It is important to note that the minimum scenario does not show any carbon gains accrued from improvements of the site as the tool has assumed that no improvement has occurred at all.

Carbon Balance Summary

A9.1.1.50 Table A9.1.4 reveals the carbon losses and carbon gains for each of the above parameters for the proposed development. Table A9.1.4 also reveals the net CO_2 emissions.

Table A9.1.4: Expected CO_2 losses and gains

Carbon Balance Input Parameter	Expected Results
1. Windfarm CO_2 emission saving over other types of energy generation	
Coal fired electricity generation (tCO_2yr^{-1})	100,966
Grid mix of electricity generation (tCO_2yr^{-1})	27,829
Fossil fuel mix of electricity generation (tCO_2yr^{-1})	49,385
Energy output from windfarm over lifetime (MWh)	**3,841,085**
Total CO_2 losses due to wind farm (tCO_2 eq.)	
2 Losses due to turbine life (e.g. manufacture, construction, decommissioning)	43,320
3. Losses due to backup	33,113
4. Losses due to reduced carbon fixing potential	1,470
5. Losses from soil organic matter	-5,516
6. Losses due to DOC & POC leaching	1
7. Losses due to felling forestry	0
Total losses (tCO_2 eq.)	**72,388**
8. Total CO_2 gains due to improvement of site (tCO_2 eq.)	
8a. Gains due to improvement of degraded bogs	0
8b. Gains due to improvement of felled forestry	0
8c. Gains due to restoration of peat from borrow pits	0
8d. Gains due to removal of drainage from foundations and hardstandings	-562
Total gains (tCO_2 eq.)	**-562**
Net CO_2 emissions (tCO_2 eq.)	**71,826**

Source: Online Tool Reference 2X0P-76LR-I0SQ v5: Payback Time and CO_2 emissions page.

A9.1.1.51 The net emissions of CO_2 of the Proposed Development are calculated by deducting the total CO_2 gains produced by improvement and restoration of the site from the total CO_2 emissions from manufacture of, construction of, and impacts on peat from, the individual elements of the Proposed Development (described in the preceding paragraphs).

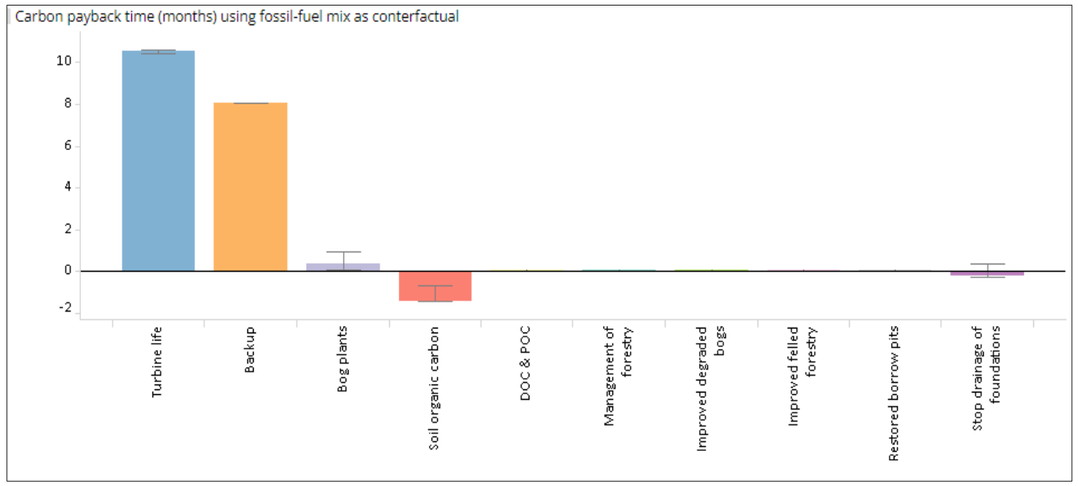
A9.1.1.52 The wind farm CO_2 emissions savings of the Proposed Development over other types of generation (i.e. coal-fired, grid-mix, fossil fuel-mix) is calculated by multiplying the energy output of the Proposed Development by the emissions factor of the other type of generation. However, this parameter only takes into consideration the energy output of the Proposed Development and does not take into account any of the carbon losses or gains that are produced from manufacture of, construction of, and impacts on peat from, the individual elements of the Proposed Development. The parameter that takes all parameters into account is the carbon payback time and it is this value that provides an indication of the carbon balance of the Proposed Development.

A9.1.1.53 The carbon payback time for the Proposed Development is calculated by comparing the net loss of CO_2 from the site due to wind farm development with the carbon savings achieved by the wind farm while displacing electricity generated from coal-fired generation, grid-mix generation or fossil-fuel mix electricity generation. Figures A9.1.1 and A9.1.2 below illustrate the payback times for the alternative Proposed Development in years.

RESULTS	Exp.	Min.	Max.
Net emissions of carbon dioxide (t CO2 eq.)	71,826	67,894	78,272
Carbon Payback Time			
...coal-fired electricity generation (years)	0.7	0.7	0.9
...grid-mix of electricity generation (years)	2.6	2.4	3.1
...fossil fuel-mix of electricity generation (years)	1.5	1.3	1.8

Source: Online Tool Reference 2X0P-76LR-I0SQ v5:

Figure.A9.1.1: Carbon payback time for the Proposed Development



Source: Online Tool Reference 2X0P-76LR-I0SQ v5:

Figure A9.1.2: Carbon payback time for different elements of the assessment

A9.1.1.54 The results from the carbon calculator reveal that the Proposed Development would have effectively paid back its expected carbon debt from manufacture, construction, impact on habitat and decommissioning within 1.5 years, if it replaced the fossil fuel-mix electricity generation method. Based on the minimum and maximum scenarios however, the analysis shows that the payback time for fossil fuel-mix generation ranges between 1.3 to 1.8 years respectively.

A9.1.1.55 The Institute of Environmental Management and Assessment (IEMA) has identified the online carbon calculator tool for wind farm carbon assessments. This tool provides a consistent and the most comprehensive method for carbon assessment for wind farm developments on peat lands to date. However, the online tool does not define what level of impact on peat is considered to be a 'significant effect' as the existing carbon balance literature using this carbon assessment tool does not state this requirement.

A9.1.1.56 In this regard, IEMA concludes that:

"…when evaluating significance, all new Green House Gas (GHG) emissions contribute to a significant negative environmental effect; however; some projects will replace existing development that have higher GHG profiles. The significance of a project's emissions should therefore be based on its net impact, which may be positive or negative."

A9.1.1.57 In this context, the results of this assessment reveal that the net impact of the Proposed Development will be positive overall, as over its 35-year lifespan, it is expected to generate over 33 years' worth of clean energy if it replaced fossil fuel-mix electricity generation and nearly 32 years' worth of clean energy even if it replaces cleaner grid-mix electricity generation. Therefore, over the expected 33 years that the wind farm is likely to be generating carbon-free electricity, this could result in expected CO_2 emission savings of over 1,629,705 tonnes[9] of CO_2 when replacing fossil fuel-mix electricity generation. This illustrates a positive net impact through contributing significantly towards the reduction of GHG from energy production.

[9] Calculation is 33 years x 49,385 tCO_2 (as shown in Table 4 and online submission).

Annex A: Laboratory Results

DETS

Certificate of Analysis

Certificate Number 21-12020 *Issued:* 17-Jun-21

Client MATTest Ltd.
10 Queenslie Point
120 Stepps Road
Glasgow
G33 3NQ

Our Reference 21-12020
Client Reference 21/662
Order No MATSC3541
Contract Title Scawd Law
Description 3 Soil samples.
Date Received 08-Jun-21
Date Started 08-Jun-21
Date Completed 17-Jun-21
Test Procedures Identified by prefix DETSn (details on request).
Notes Opinions and interpretations are outside the laboratory's scope of ISO 17025 accreditation. This certificate is issued in accordance with the accreditation requirements of the United Kingdom Accreditation Service. The results reported herein relate only to the material supplied to the laboratory. This certificate shall not be reproduced except in full, without the prior written approval of the laboratory.

Approved By

Adam Fenwick
Contracts Manager

UKAS TESTING
2139

Derwentside Environmental Testing Services Limited
Unit 2, Park Road Industrial Estate South, Consett, Co Durham, DH8 5PY
Tel: 01207 582333 • email: info@dets.co.uk • www.dets.co.uk

Page 1 of 3

Summary of Chemical Analysis
Soil Samples

Our Ref 21-12020
Client Ref 21/662
Contract Title Scawd Law

			Lab No	1859266	1859267	1859268
			.Sample ID	T6	T6	TRACK
			Depth	0.00-0.50	0.50-1.00	0.00-0.50
			Other ID			
			Sample Type	ES	ES	ES
			Sampling Date	27/05/2021	27/05/2021	27/05/2021
			Sampling Time	n/s	n/s	n/s
Test	**Method**	**LOD**	**Units**			
Inorganics						
Loss on Ignition at 440oC	DETSC 2003#	0.01	%	95	96	98
Carbon, Total	DETSC 2084*	0.5	%	48	54	52
Total Organic Carbon	DETSC 2002	0.1	%	> 15	> 15	> 15

Key: * -not accredited. # -MCERTS (accreditation only applies if report carries the MCERTS logo). n/s -not supplied.

Information in Support of the Analytical Results

Our Ref 21-12020
Client Ref 21/662
Contract Scawd Law

Containers Received & Deviating Samples

Lab No	Sample ID	Date Sampled	Containers Received	Holding time exceeded for tests	Inappropriate container for tests
1859266	T6 0.00-0.50 SOIL		PT 1L		
1859267	T6 0.50-1.00 SOIL		PT 1L		
1859268	TRACK 0.00-0.50 SOIL		PT 1L		

Key: P-Plastic T-Tub

DETS cannot be held responsible for the integrity of samples received whereby the laboratory did not undertake the sampling. In this instance samples received may be deviating. Deviating Sample criteria are based on British and International standards and laboratory trials in conjunction with the UKAS note 'Guidance on Deviating Samples'. All samples received are listed above. However, those samples that have additional comments in relation to hold time, inappropriate containers etc are deviating due to the reasons stated. This means that the analysis is accredited where applicable, but results may be compromised due to sample deviations. If no sampled date (soils) or date+time (waters) has been supplied then samples are deviating. However, if you are able to supply a sampled date (and time for waters) this will prevent samples being reported as deviating where specific hold times are not exceeded and where the container supplied is suitable.

Soil Analysis Notes

Inorganic soil analysis was carried out on a dried sample, crushed to pass a 425µm sieve, in accordance with BS1377.
Organic soil analysis was carried out on an 'as received' sample. Organics results are corrected for moisture and expressed on a dry weight basis.
The Loss on Drying, used to express organics analysis on an air dried basis, is carried out at a temperature of 28°C +/-2°C.

Disposal

From the issue date of this test certificate, samples will be held for the following times prior to disposal :-
Soils - 1 month, Liquids - 2 weeks, Asbestos (test portion) - 6 months

End of Report

MATtest Limited
materials testing & consultancy

10 Queenslie Point
Queenslie Industrial Estate
120 Stepps Road
Glasgow
G33 3NQ

Tel: 0141 774 4032

email: info@mattest.org
Website: www.mattest.org

LABORATORY TEST CERTIFICATE

Certificate No : **21/662 - 01**

To : **James Blaikie**

Client : **The Natural Power Consultants**
The Green House
Forrest Estate
Dalry
Castle Douglas
DG7 3XS

Dear Sirs,

LABORATORY TESTING OF SOIL

Introduction

We refer to samples taken from Scawd Law and delivered to our laboratory on 27th May 2021.

Material & Source

Sample Reference	:	See Report Plates
Sampled By	:	Client
Sampling Certificate	:	Not Supplied
Location	:	See Report Plates
Description	:	See Page 2
Date Sampled	:	Not Supplied
Date Tested	:	02nd June 2021 Onwards
Source	:	Scawd Law

Test Results;

As Detailed On Page 2 to Page 3 inclusive

Comments;

Opinions and interpretations expressed herein are outside the scope of UKAS accreditation
This report should not be reproduced except in full without the written approval of the laboratory
All remaining samples for this project will be disposed of 28 days after issue of this test certificate

Remarks;

Approved for Issue

T McLelland (Director)

Date 08/06/2021

UKAS TESTING 2643

THE NATURAL POWER CONSULTANTS
SCAWD LAW

MATtest Limited
materials testing & consultancy

BOREHOLE	SAMPLE	DEPTH (m)	SAMPLE DESCRIPTION
T6	B	0.00-0.50	PEAT
T6	B	0.50-1.00	PEAT
Track	B	0.00-0.50	PEAT

SUMMARY OF SAMPLE DESCRIPTIONS

THE NATURAL POWER CONSULTANTS
SCAWD LAW

MATtest Limited
materials testing & consultancy

BOREHOLE	SAMPLE	DEPTH (m)	MOISTURE CONTENT (%)	BULK DENSITY (Mg/m^3)	DRY DENSITY (Mg/m^3)
T6	B	0.00-0.50	905	1.01	0.10
T6	B	0.50-1.00	1027	1.19	0.11
Track	B	0.00-0.50	1017	1.07	0.10

Tested in accordance with BS1377 Part 2 : 1990
Bulk Density : Linear Measurement

SUMMARY OF MOISTURE CONTENT AND DENSITY TEST RESULTS

Issue No. 01 **Page 3 of 3** **Certificate No. 21/662 - 01**

Annex B: Core Input Page

02/11/2021, 09:35 Reference: 2X0P-76LR-I0SQ v5

Carbon Calculator v1.6.1
Scawd Law Location: 55.652064 -2.999677
Fred Olsen Renewables Ltd.

Core input data

Input data	Expected value	Minimum value	Maximum value	Source of data
Windfarm characteristics				
Dimensions				
No. of turbines	8	8	8	Appendix 9.1, Table 1 Data Sources
Duration of consent (years)	35	35	35	Appendix 9.1, Table 1 Data Sources
Performance				
Power rating of 1 turbine (MW)	6	6	6	Appendix 9.1, Table 1 Data Sources
Capacity factor	26.1	23.6	27	Appendix 9.1, Table 1 Data Sources
Backup				
Fraction of output to backup (%)	5	5	5	Appendix 9.1, Table 1 Data Sources
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	Appendix 9.1, Table 1 Data Sources
Average annual air temperature at site (°C)	8.09	4.73	11.45	Appendix 9.1, Table 1 Data Sources
Average depth of peat at site (m)	0.25	0.24	0.26	Appendix 9.1, Table 1 Data Sources
C Content of dry peat (% by weight)	52	48	54	Appendix 9.1, Table 1 Data Sources
Average extent of drainage around drainage features at site (m)	10	5	25	Appendix 9.1, Table 1 Data Sources
Average water table depth at site (m)	0.75	0.5	1	Appendix 9.1, Table 1 Data Sources
Dry soil bulk density (g cm^{-3})	0.11	0.1	0.12	Appendix 9.1, Table 1 Data Sources
Characteristics of bog plants				
Time required for regeneration of bog plants after restoration (years)	7	5	10	Appendix 9.1, Table 1 Data Sources
Carbon accumulation due to C fixation by bog plants in undrained peats (tC ha^{-1} yr^{-1})	0.25	0.12	0.31	Appendix 9.1, Table 1 Data Sources
Forestry Plantation Characteristics				
Area of forestry plantation to be felled (ha)	0	0	0	Appendix 9.1, Table 1 Data Sources
Average rate of carbon sequestration in timber (tC ha^{-1} yr^{-1})	0	0	0	Appendix 9.1, Table 1 Data Sources
Counterfactual emission factors				
Coal-fired plant emission factor (t CO2 MWh^{-1})	0.92	0.92	0.92	
Grid-mix emission factor (t CO2 MWh^{-1})	0.25358	0.25358	0.25358	
Fossil fuel-mix emission factor (t CO2 MWh^{-1})	0.45	0.45	0.45	
Borrow pits				

1/6

Input data	Expected value	Minimum value	Maximum value	Source of data
Number of borrow pits	1	1	1	Appendix 9.1, Table 1 Data Sources
Average length of pits (m)	80	50	90	Appendix 9.1, Table 1 Data Sources
Average width of pits (m)	50	30	70	Appendix 9.1, Table 1 Data Sources
Average depth of peat removed from pit (m)	0.2	0.17	0.22	Appendix 9.1, Table 1 Data Sources
Foundations and hard-standing area associated with each turbine				
Average length of turbine foundations (m)	25	23	27	Appendix 9.1, Table 1 Data Sources
Average width of turbine foundations (m)	25	23	27	Appendix 9.1, Table 1 Data Sources
Average depth of peat removed from turbine foundations(m)	0.46	0.38	0.55	Appendix 9.1, Table 1 Data Sources
Average length of hard-standing (m)	150	120	180	Appendix 9.1, Table 1 Data Sources
Average width of hard-standing (m)	50	40	60	Appendix 9.1, Table 1 Data Sources
Average depth of peat removed from hard-standing (m)	0.36	0.32	0.4	Appendix 9.1, Table 1 Data Sources
Volume of concrete used in construction of the ENTIRE windfarm				
Volume of concrete (m^3)	7000	6000	8000	Appendix 9.1, Table 1 Data Sources
Access tracks				
Total length of access track (m)	6864	6178	7550	Appendix 9.1, Table 1 Data Sources
Existing track length (m)	0	0	0	Appendix 9.1, Table 1 Data Sources
Length of access track that is floating road (m)	0	0	0	Appendix 9.1, Table 1 Data Sources
Floating road width (m)	0	0	0	
Floating road depth (m)	0	0	0	
Length of floating road that is drained (m)	0	0	0	
Average depth of drains associated with floating roads (m)	0	0	0	
Length of access track that is excavated road (m)	6864	6178	7550	Appendix 9.1, Table 1 Data Sources
Excavated road width (m)	14.5	12.5	16.5	Appendix 9.1, Table 1 Data Sources
Average depth of peat excavated for road (m)	0.27	0.25	0.29	Appendix 9.1, Table 1 Data Sources
Length of access track that is rock filled road (m)	0	0	0	Appendix 9.1, Table 1 Data Sources
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	Appendix 9.1, Table 1 Data Sources
Average depth of peat cut for cable trenches (m)	0	0	0	Appendix 9.1, Table 1 Data Sources
Additional peat excavated (not already accounted for above)				
Volume of additional peat excavated (m^3)	6361	3608	15355	Appendix 9.1, Table 1 Data Sources

Input data	Expected value	Minimum value	Maximum value	Source of data
Area of additional peat excavated (m^2)	24100	15864	57744	Appendix 9.1, Table 1 Data Sources
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	Appendix 9.1, Table 1 Data Sources
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)	0	0	0	Appendix 9.1, Table 1 Data Sources
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 improvement (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)	0	0	0	Appendix 9.1, Table 1 Data Sources and Appendix 9.2
Depth of water table in borrow pit before restoration with respect to the restored surface (m)	0	0	0	
Depth of water table in borrow pit after restoration with respect to the restored surface (m)	0	0	0	0
Time required for hydrology and habitat of borrow pit to return to its previous state on restoration (years)	0	0	0	0
Period of time when effectiveness of the restoration of peat removed from borrow pits can be guaranteed (years)	0	0	0	0
Early removal of drainage from foundations and hardstanding				
Water table depth around foundations and hardstanding before restoration (m)	0.6	0.4	0.8	Appendix 9.1, Table 1 Data Sources
Water table depth around foundations and hardstanding after restoration (m)	0.3	0.1	0.4	Appendix 9.1, Table 1 Data Sources
Time to completion of backfilling, removal of any surface drains, and full restoration of the hydrology (years)	3	2	5	Appendix 9.1, Table 1 Data Sources
Restoration of site after decomissioning				
Will the hydrology of the site be restored on decommissioning?	Yes	Yes	Yes	

Input data	Expected value	Minimum value	Maximum value	Source of data
Will you attempt to block any gullies that have formed due to the windfarm?	Yes	Yes	Yes	Appendix 9.1, Table 1 Data Sources
Will you attempt to block all artificial ditches and facilitate rewetting?	Yes	Yes	Yes	Appendix 9.1, Table 1 Data Sources
Will the habitat of the site be restored on decommissioning?	No	No	No	
Will you control grazing on degraded areas?	No	No	No	Appendix 9.1, Table 1 Data Sources
Will you manage areas to favour reintroduction of species	No	No	No	Appendix 9.1, Table 1 Data Sources
Methodology				
Choice of methodology for calculating emission factors	Site specific (required for planning applications)			

Forestry input data

N/A

Construction input data

N/A