# Technical Appendix 15.1: Carbon Calculator

## Aultmore Wind Farm Redesign

### Vattenfall Wind Power Limited

Prepared by:

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SLR Project No.: 405.03640.00016

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Making Sustainability Happen

## Revision Record

| Revision | Date | Prepared By | Checked By | Authorised By |
|---|---|---|---|---|
| 0 | 30 October 2023 | R. Watson | A. Huntridge | T. Doggett |
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# Basis of Report

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# 1.0 Introduction

SLR has been commissioned by Vattenfall Wind Power Limited (The Applicant) to calculate the carbon pay-back period for the proposed Aultmore Wind Farm Redesign (the 'proposed development') using the Scottish Government Carbon Calculator Tool[1] in accordance with the associated guidance[2]. The 'Site' refers to all land within the red-line boundary, as displayed in **Figure 1.1** of the EIA Report.

The Site is located within Moray Council in the northeast of Scotland, approximately 6km north of Keith and 7km south of Buckie. The Site is currently an active commercial forestry area with ongoing harvesting and replanting operations.

The Carbon Calculator Tool has been developed by the Scottish Government to support the process of determining the carbon pay-back period for wind farm developments in Scotland. The carbon payback period is derived by comparing the carbon costs of wind farm developments (particularly during construction) with the carbon savings likely to be achieved through their operation.

The Carbon Calculator Tool v1.7.0 uses methods given in Nayak et al, 2008 (http://www.scotland.gov.uk/Publications/2008/06/25114657/0) and revised equations for GHG emissions (Nayak, D.R., Miller, D., Nolan, A., Smith, P. and Smith, J.U., 2010 & 2011, and Wind Farm and Carbon Savings – Technical Note v.2 2.10.0. Input Parameters).

To calculate the pay-back period, the Scottish Government's Carbon Calculator Tool considers the following carbon saving and carbon loss parameters, as shown in Annex A:

- Carbon emissions savings, based on emissions from different power sources;
- Carbon saving due to improvement of habitat;
- Loss of carbon due to production, transportation, erection, operation and decommissioning of the wind farm;
- Loss of carbon from backup power generation;
- Loss of carbon-fixing potential of peatland;
- Loss and/or saving of carbon stored in peatland (by peat removal or changes in drainage); and
- Loss and/or saving of carbon-fixing potential as a result of forestry clearance.

[1] Scottish Government Wind Farm Developments on Peat Land: Carbon Calculator Tool v1.7.0 https://informatics.sepa.org.uk/CarbonCalculator/

[2] Calculating Carbon Savings from Wind Farms on Scottish Peatlands – A New Approach (Nayak et al., 2008; Nayak et al., 2010 and Smith et al,. 2011)

# 2.0 Context

By 2030, the Scottish Government aims to have reduced greenhouse gas emissions by at least 75% compared to 1990 levels and generate 50% of Scotland's overall energy consumption from renewable sources, with aims to have decarbonised Scotland's energy system and economy completely by 2050.

Large scale wind farm development in Scotland has raised concerns about the reliability of methods used to calculate the time taken for these proposals to reduce greenhouse gas emissions, largely due to the potential siting of wind farms on peatland which represent large stores of carbon. The implication for carbon emissions is therefore a factor that should be included in the consideration of proposed wind farm development.

Applications for wind farms (or extensions of wind farms) submitted under Section 36 of the Electricity Act (with a generation capacity exceeding 50MW) are screened to establish whether they are on deep peat sites (i.e. peat depth greater than 0.5 metres) and where loss or disturbance to peat could occur. Where development does occur on deep peat sites applicants are expected to use the Carbon Calculator to determine the pay-back period of the proposal and submit this with the Section 36 application.

# 3.0 Input Data

The input data is presented within Annex A of this report. However, if several parameters are varied together, this can have the effect of 'cancelling out' a single parameter change.

For this reason, the approach for this assessment has been to include 'maximum values' as those values which would result in the longest (maximum) payback period; and 'minimum values' as those values which would result in the shortest (minimum) payback period. The expected value is based on the most realistic option for the proposed development.

The calculation spreadsheet within the Carbon Calculator Tool (online version reference number 92GI-M8YX-0BR7 v2) allows a range of data to be input in order to utilise expected, minimum and maximum values, where relevant and applicable.

The data inputs for the online calculator tool have been extracted from the sources listed below:

- Aultmore Wind Farm Redesign EIAR Chapter 2: Proposed Development Description;
- Aultmore Wind Farm Redesign EIAR Technical Appendix 10.1: Peat Landslide Hazard Risk Assessment; and
- Aultmore Wind Farm Redesign EIAR Technical Appendix 10.2: Peat Management Plan.

The final turbine choice is not yet finalised but would likely be 6.6 MW. For this reason, the factors which have been used in this assessment include the following:

- The recommended capacity factor within the calculation spreadsheet has been amended to a site-specific value (44.5%).
- The choice of methodology for calculating the emission factors used the 'site-specific methodology' defined within the calculation spreadsheet.
- Default values for carbon content and bulk density of peat have been used for the assessment. The carbon content ranges from 49% to 62% with an expected value of 55.5% used. This reflects a range of values typical of the carbon content anticipated from Scottish Peatlands (Birnie et al 1991[3] and Lindsay 2010[4]). Typical bulk density values have been sourced from the Windfarm Carbon Calculator Web Tool, User Guidance. Generic hydrological parameters have been used for average groundwater. A value of 0.3 m has been used as the expected value. A 'minimum' value of 0.05 m has been used to represent areas of intact peat (the higher the water table, the longer the payback period), and a 'maximum' value of 0.2 m has been used to represent areas of eroded peat.
- Smith et al. (2011)[5], identified the average extent of drainage impact at three sites (Cross Lochs, Farr Windfarm and Exe Head) as ranging from 3 m to 9 m. However, the actual extent of drainage at any given location will be dependent on local site conditions, including underlying substrata and topography. As site specific values are not available, the standard values from 'Windfarm Carbon Calculator Web Tool, User

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[3] Birnie R.V., Clayton P., Griffiths P., Hulme P.D., Robertson, R.A., Sloane B.D., and S.A. Ward. (1991). Scottish peat resources and their energy potential. Department of Energy

[4] Lindsay, R. (2010). Peatbogs and Carbon: a critical synthesis. RSPB

[5] Smith J.U., Graves P., Nayak D.R., Smith P., Perks M., Gardiner B., Miller D., Nolan A., Morrice J., Xenakis S., Waldron S., Drew S. (2011) Carbon implications of windfarms located on peatlands – update of the Scottish Government Carbon Calculator tool. Final Report, RERAD Report CR/2010/05

Guidance' have been used. Therefore, the expected value is 10 m (minimum 5 m, maximum 25 m).

- The most recent values for the three required counterfactual factors provided in the online carbon calculator have been included are: Grid Mix 0.19338 t $CO^2$ MWh-1, fuel mix: 0.432 t $CO^2$ MWh-1 and coal: 1.002 t $CO^2$ MWh-1.
- Infrastructure dimensions, including estimated excavation size for turbine foundations, hardstands and track lengths is outlined in Chapter 2.
- Although none of the borrow pits are sited on peatland, conservatively, each location has been included in the assessment. The final dimensions of each borrow pit have yet to be defined. Average dimensions from the search areas identified have been used, however it is unlikely that actual borrow pits would be as large.
- The assessment is based on a series of average soil depths taken from peat surveys undertaken at the site. Probe locations sited on mineral / organic soils (<0.5 m) are conservatively included within the averages.
- An estimate of the total volume of concrete has been included, based on an anticipated 730 $m^3$ concrete being required for each turbine foundation.
- An area of 153.3ha has been used for the area of plantation forestry to be felled presenting a worst case scenario, notwithstanding that the site being a commercial plantation and that compensatory planting will be required for any felling, resulting in an actual net loss of 0ha.

# 4.0 Results

The model calculates carbon emissions savings and losses from the various aspects of the model; and also calculates a payback period based on the three counterfactual emission factors, coal-fired plant, normal grid mix (the current grid mix including nuclear and renewables) and fossil fuel (current grid excluding renewables and nuclear) mix. The emission factors are set by the calculator and updated regularly to reflect the UK electricity grid composition.

Table 4-1 demonstrates that the total lifetime net emissions of carbon dioxide due directly to the development are estimated at 166,863 tonnes of $CO_2$, with an estimated payback period of 1.3 years when considered against the fossil fuel grid mix. Therefore, the proposed development will produce a reduction in emissions from the electricity grid of around 177,833 tonnes of $CO_2$ per year compared to the fossil fuel grid mix.

A summary of the anticipated carbon emission savings per and carbon payback of the proposed development are provided in **Table 4.1** and **Table 4.2**.

**Table 4-1 Estimate of $CO_2$ Emission Savings**

| Wind Farm $CO_2$ emission saving over… | Exp. | Min. | Max. |
|---|---|---|---|
| …coal-fired electricity generation (t $CO_2$/yr) | 412,473 | 407,839 | 417,108 |
| …grid-mix of electricity generation (t $CO_2$/yr)) | 79,605 | 78,710 | 80,499 |
| …fossil fuel – mix of electricity generation (t $CO_2$/yr) | 177,833 | 175,835 | 179,831 |
| **Energy output from Wind Farm over lifetime (MWh)** | 14,407,747 | 14,245,862 | 14,569,632 |

**Table 4-2 $CO_2$ Emissions and Payback Time**

| Results | Exp. | Min. | Max. |
|---|---|---|---|
| **Net emissions of carbon dioxide (t $CO_{2\ eq}$) (carbon losses minus carbon gains) per annum.** | 237,689 | 188,182 | 323,598 |
| **Carbon Payback Time** | | | |
| …coal-fired electricity generation (years) | 0.6 | 0.5 | 0.8 |
| …grid-mix of electricity generation (years) | 3.0 | 2.3 | 4.1 |
| **…fossil fuel – mix of electricity generation (years)** | 1.3 | 1.0 | 1.8 |
| **Ratio of $CO_2$ eq. emissions to power generation (g/kWh)**<br>(Target ratio by 2030 (electricity generation) <50 g/kWh) | 16.50 | 12.92 | 22.72 |

# 5.0 Conclusions

The calculations of total carbon dioxide emission savings and payback time for the proposed development indicates that the overall payback period will be around 1.3 years (16 months) when compared to the fossil fuel grid mix of electricity generation. This means that the proposed development is anticipated to take just less than a year to repay the carbon exchange to the atmosphere (the $CO_2$ debt) through construction; the Site would in effect be in a net gain situation following this time period and can then claim to contribute to national emissions reduction objectives thereafter for its remaining operational life.

# 6.0 References

Carbon Calculator Tool v1.7.0. Available at https://informatics.sepa.org.uk/CarbonCalculator/ - accessed March 2023.

Carbon Calculator Tool User Guidance. Available at https://informatics.sepa.org.uk/CarbonCalculator/assets/Carbon_calculator_User_Guidance.pdf

Calculating Carbon Savings from Wind Farms on Scottish Peatlands - A New Approach, Nayak et al; 2008 and 2010 and Smith et al; 2011. (http://www.gov.scot/Publications/2008/06/25114657/0)

Nayak, D.R., Miller, D., Nolan, A., Smith, P. and Smith, J.U., 2010, Calculating carbon budgets of wind farms on Scottish peatland. Mires and Peat 4: Art. 9. Online. (http://mires-and-peat.net/pages/volumes/map04/map0409.php)

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Scottish Natural Heritage (SNH), SEPA, Scottish Government & The James Hutton Institute. (2014). Peat Survey Guidance; Developments on Peatland: Site Surveys.

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Scottish Renewables & SEPA. (2012). Developments on Peatland Guidance on the Assessment of Peat Volumes, Reuse of Excavated Peat and the Minimisation of Waste. http://www.scottishrenewables.com/static/uploads/publications/a4_developments_on_peatland.pdf

Scottish Government. 2020. Update to the Climate Change Plan 2018 – 2032 Securing a Green Recovery on a Path to Net Zero. Available at https://www.gov.scot/binaries/content/documents/govscot/publications/strategy-plan/2020/12/securing-green-recovery-path-net-zero-update-climate-change-plan-20182032/documents/update-climate-change-plan-2018-2032-securing-green-recovery-path-net-zero/update-climate-change-plan-2018-2032-securing-green-recovery-path-net-zero/govscot%3Adocument/update-climate-change-plan-2018-2032-securing-green-recovery-path-net-zero.pdf - Accessed March 2023.

# Annex A

## Carbon Calculator Inputs and Outputs

### Aultmore Wind Farm Redesign

**Vattenfall Wind Power Limited**

SLR Project No.: 405.03640.00016

4 December 2023

Carbon Calculator v1.7.0
Aultmore Wind Farm Location: 57.610659 -2.921419
Vattenfall Wind Power Ltd

## Core input data

| Input data | Expected value | Minimum value | Maximum value | Source of data |
|---|---|---|---|---|
| Windfarm characteristics | | | | |
| Dimensions | | | | |
| No. of turbines | 16 | 16 | 16 | Chapter 2 Proposed Development Description |
| Duration of consent (years) | 35 | 35 | 35 | Chapter 2 Proposed Development Description |
| Performance | | | | |
| Power rating of 1 turbine (MW) | 6.6 | 6.6 | 6.6 | Chapter 2 Proposed Development Description |
| Capacity factor | 44.5 | 44 | 45 | Chapter 2 Proposed Development Description |
| Backup | | | | |
| Fraction of output to backup (%) | 5 | 5 | 5 | Dale et al 2004 |
| 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 | TA 10.1 PLHRA |
| Average annual air temperature at site (°C) | 6.75 | 6 | 7 | TA 10.1 PLHRA |
| Average depth of peat at site (m) | 0.3 | 0 | 4.5 | TA 10.1 PLHRA |
| C Content of dry peat (% by weight) | 55.5 | 49 | 62 | Birnie et al. 1991 |
| Average extent of drainage around drainage features at site (m) | 10 | 5 | 25 | TA 10.1 PLHRA |
| Average water table depth at site (m) | 0.1 | 0.05 | 0.2 | TA 10.1 PLHRA |
| Dry soil bulk density (g $cm^{-3}$) | 0.2 | 0.18 | 0.22 | Lilly et al. 2010 |
| Characteristics of bog plants | | | | |
| Time required for regeneration of bog plants after restoration (years) | 6 | 4 | 8 | Conservative Estimate |
| Carbon accumulation due to C fixation by bog plants in undrained peats (tC $ha^{-1}$ $yr^{-1}$) | 0.25 | 0.12 | 0.31 | TA 10.1 PLHRA |
| Forestry Plantation Characteristics | | | | |
| Area of forestry plantation to be felled (ha) | 153.3 | 153 | 155 | Chapter 2 Proposed Development Description |
| Average rate of carbon sequestration in timber (tC $ha^{-1}$ $yr^{-1}$) | 3.6 | 2.5 | 4.7 | Scottish Government and SNH Guidance |
| Counterfactual emission factors | | | | |
| Coal-fired plant emission factor (t CO2 $MWh^{-1}$) | 1.002 | 1.002 | 1.002 | |
| Grid-mix emission factor (t CO2 $MWh^{-1}$) | 0.19338 | 0.19338 | 0.19338 | |
| Fossil fuel-mix emission factor (t CO2 $MWh^{-1}$) | 0.432 | 0.432 | 0.432 | |
| Borrow pits | | | | |
| Number of borrow pits | 4 | 4 | 4 | TA 10.2 PMP |
| Average length of pits (m) | 166 | 80 | 230 | TA 10.2 PMP |
| Average width of pits (m) | 85 | 60 | 100 | TA 10.2 PMP |
| Average depth of peat removed from pit (m) | 0.12 | 0.06 | 0.27 | TA 10.2 PMP |
| Access tracks | | | | |
| Total length of access track (m) | 24300 | 24100 | 24500 | TA 10.2 PMP |
| Existing track length (m) | 15900 | 15800 | 16000 | TA 10.2 PMP |
| Length of access track that is floating road (m) | 0 | 0 | 0 | TA 10.2 PMP |
| Floating road width (m) | 5 | 5 | 5 | TA 10.2 PMP |
| Floating road depth (m) | 0 | 0 | 0 | TA 10.2 PMP |
| Length of floating road that is drained (m) | 0 | 0 | 0 | TA 10.2 PMP |
| Average depth of drains associated with floating roads (m) | 0 | 0 | 0 | TA 10.2 PMP |
| Length of access track that is excavated road (m) | 8400 | 8300 | 8500 | TA 10.2 PMP |
| Excavated road width (m) | 6 | 5 | 7 | TA 10.2 PMP |
| Average depth of peat excavated for road (m) | 0.31 | 0.3 | 0.32 | TA 10.2 PMP |
| Length of access track that is rock filled road (m) | 0 | 0 | 0 | TA 10.2 PMP |
| Rock filled road width (m) | 5 | 5 | 5 | TA 10.2 PMP |
| Rock filled road depth (m) | 0 | 0 | 0 | TA 10.2 PMP |
| Length of rock filled road that is drained (m) | 0 | 0 | 0 | TA 10.2 PMP |
| Average depth of drains associated with rock filled roads (m) | 0 | 0 | 0 | TA 10.2 PMP |
| 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 | Chapter 2 Proposed Development Description |
| Average depth of peat cut for cable trenches (m) | 0 | 0 | 0 | Chapter 2 Proposed Development Description |
| Additional peat excavated (not already accounted for above) | | | | |
| Volume of additional peat excavated ($m^3$) | 14795 | 14700 | 14800 | TA 10.2 PMP |
| Area of additional peat excavated ($m^2$) | 50350 | 50300 | 50400 | TA 10.2 PMP |
| 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) | 0.7 | 0.6 | 0.8 | Chapter 2 Proposed Development Description |

| Input data | Expected value | Minimum value | Maximum value | Source of data |
|---|---|---|---|---|
| Water table depth in degraded bog before improvement (m) | 0.3 | 0.1 | 0.5 | Typical values |
| Water table depth in degraded bog after improvement (m) | 0.1 | 0.05 | 0.3 | Typical values |
| Time required for hydrology and habitat of bog to return to its previous state on improvement (years) | 10 | 5 | 15 | Typical values |
| Period of time when effectiveness of the improvement in degraded bog can be guaranteed (years) | 20 | 15 | 25 | Wind farm lifetime minus time for improvement |
| Improvement of felled plantation land | | | | |
| Area of felled plantation to be improved (ha) | 0 | 0 | 0 | Chapter 2 Proposed Development Description |
| 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) | 10 | 5 | 15 | . |
| Period of time when effectiveness of the improvement in felled plantation can be guaranteed (years) | 20 | 15 | 25 | . |
| Restoration of peat removed from borrow pits | | | | |
| Area of borrow pits to be restored (ha) | 6.2 | 6.1 | 6.3 | TA 10.2 PMP |
| Depth of water table in borrow pit before restoration with respect to the restored surface (m) | 0.3 | 0.1 | 0.5 | Typical values |
| Depth of water table in borrow pit after restoration with respect to the restored surface (m) | 0.1 | 0.05 | 0.3 | Typical values |
| Time required for hydrology and habitat of borrow pit to return to its previous state on restoration (years) | 5 | 2 | 10 | Typical values |
| Period of time when effectiveness of the restoration of peat removed from borrow pits can be guaranteed (years) | 25 | 20 | 28 | Wind farm lifetime minus time for improvement |
| Early removal of drainage from foundations and hardstanding | | | | |
| Water table depth around foundations and hardstanding before restoration (m) | 0.3 | 0.1 | 0.5 | Typical values |
| Water table depth around foundations and hardstanding after restoration (m) | 0.1 | 0.05 | 0.3 | Typical values |
| Time to completion of backfilling, removal of any surface drains, and full restoration of the hydrology (years) | 2 | 1 | 5 | Typical values |
| Restoration of site after decomissioning | | | | |
| Will the hydrology of the site be restored on decommissioning? | No | No | No | |
| Will you attempt to block any gullies that have formed due to the windfarm? | No | No | No | Currently unspecified |
| Will you attempt to block all artificial ditches and facilitate rewetting? | Yes | Yes | Yes | Assumed |
| Will the habitat of the site be restored on decommissioning? | No | No | No | |
| Will you control grazing on degraded areas? | No | No | No | Currently unspecified |
| Will you manage areas to favour reintroduction of species | No | No | No | Currently unspecified |
| Methodology | | | | |
| Choice of methodology for calculating emission factors | IPCC default | | | |

**Forestry input data**

N/A

## Construction input data

| Input data | Expected value | Minimum value | Maximum value | Source of data |
|---|---|---|---|---|
| Turbines | | | | |
| Number of turbines in this area | 16 | 16 | 16 | TA 10.2 PMP |
| Turbine foundations | | | | |
| Depth of hole dug when constructing foundations (m) | 0.23 | 0.08 | 0.77 | TA 10.2 PMP |
| Aproximate geometric shape of whole dug when constructing foundations | Circular | Circular | Circular | TA 10.2 PMP |
| Diameter at bottom | 25 | 25 | 25 | |
| Diameter at surface | 25 | 25 | 25 | |
| Hardstanding | | | | |
| Depth of hole dug when constructing hardstanding (m) | 0.25 | 0.09 | 0.51 | TA 10.2 PMP |
| Aproximate geometric shape of whole dug when constructing hardstanding | Rectangular | Rectangular | Rectangular | TA 10.2 PMP |
| Length at surface | 90 | 90 | 90 | |
| Width at surface | 36 | 36 | 36 | |
| Length at bottom | 90 | 90 | 90 | |
| Width at bottom | 36 | 36 | 36 | |
| Piling | | | | |
| Is piling used? | No | No | No | TA 10.2 PMP |
| Volume of Concrete | | | | |
| Volume of concrete used ($m^3$) in the entire area | 11700 | 11600 | 11800 | TA 10.4 BPA |

# Payback Time and $CO_2$ emissions • 92GI-M8YX-0BR7 v2

| 1. Windfarm CO2 emission saving over... | Exp. | Min. | Max. |
| --- | --- | --- | --- |
| ...coal-fired electricity generation (t CO2 / yr) | 412,473 | 407,839 | 417,108 |
| ...grid-mix of electricity generation (t CO2 / yr) | 79,605 | 78,710 | 80,499 |
| ...fossil fuel-mix of electricity generation (t CO2 / yr) | 177,833 | 175,835 | 179,831 |
| Energy output from windfarm over lifetime (MWh) | 14,407,747 | 14,245,862 | 14,569,632 |

| Total CO2 losses due to wind farm (tCO2 eq.) | Exp. | Min. | Max. |
| --- | --- | --- | --- |
| 2. Losses due to turbine life (eg. manufacture, construction, decomissioning) | 94,884 | 94,852 | 94,915 |
| 3. Losses due to backup | 69,934 | 69,934 | 69,934 |
| 4. Lossess due to reduced carbon fixing potential | 1,788 | 502 | 4,696 |
| 5. Losses from soil organic matter | 11,737 | 760 | 60,540 |
| 6. Losses due to DOC & POC leaching | 6 | 0 | 21 |
| 7. Losses due to felling forestry | 70,825 | 49,088 | 93,492 |
| Total losses of carbon dioxide | 249,175 | 215,136 | 323,598 |

| 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 | -242 | 0 | -554 |
| 8b. Change in emissions due to improvement of felled forestry | 0 | 0 | 0 |
| 8c. Change in emissions due to restoration of peat from borrow pits | -4,290 | 0 | -5,667 |
| 8d. Change in emissions due to removal of drainage from foundations & hardstanding | -6,953 | 0 | -20,734 |
| Total change in emissions due to improvements | -11,486 | 0 | -26,955 |

| RESULTS | Exp. | Min. | Max. |
| --- | --- | --- | --- |
| Net emissions of carbon dioxide (t CO2 eq.) | 237,689 | 188,182 | 323,598 |
| | | | |
| Carbon Payback Time | | | |
| ...coal-fired electricity generation (years) | 0.6 | 0.5 | 0.8 |
| ...grid-mix of electricity generation (years) | 3.0 | 2.3 | 4.1 |
| ...fossil fuel-mix of electricity generation (years) | 1.3 | 1.0 | 1.8 |
| | | | |
| Ratio of soil carbon loss to gain by restoration (not used in Scottish applications) | 1.02 | 0.03 | No gains! |
| Ratio of CO2 eq. emissions to power generation (g/kWh) (for info. only) | 16.50 | 12.92 | 22.72 |

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