Appendix 10.1 Carbon Calculator Input and Results

RECEIVED: 19/01/2024

Model based on 4.2MW Capacity Turbines

Carbon Calculator Available at:

https://informatics.sepa.org.uk/CarbonCalculator/

CARBON CALCULATOR TOOL v1.7.0 Help About...

Scottish Government and SEPA users only:

Application Status Control

The Scottish Government
Riaghaltas na h-Alba

Start Carbon Calculator

This tool calculates payback time for windfarm sited on peatlands using methods given in Nayak et al, 2008 (http://www.gov.scot/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, 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

CARBON CALCULATOR TOOL v1.7.0

- Will the site be drained on construction of the windfarm?
- Is the soil at the site highly organic?
- Does windfarm construction require a significant amount of deforestation?
  i.e. is removal in excess of keyholing the turbines within the forest boundary?

New application

If you already have an Application Reference, type it here (or paste it in the first box):

Search

Carbon Payback Results- MEC 4.2MW

Payback Time and CO_2 emissions [redacted]

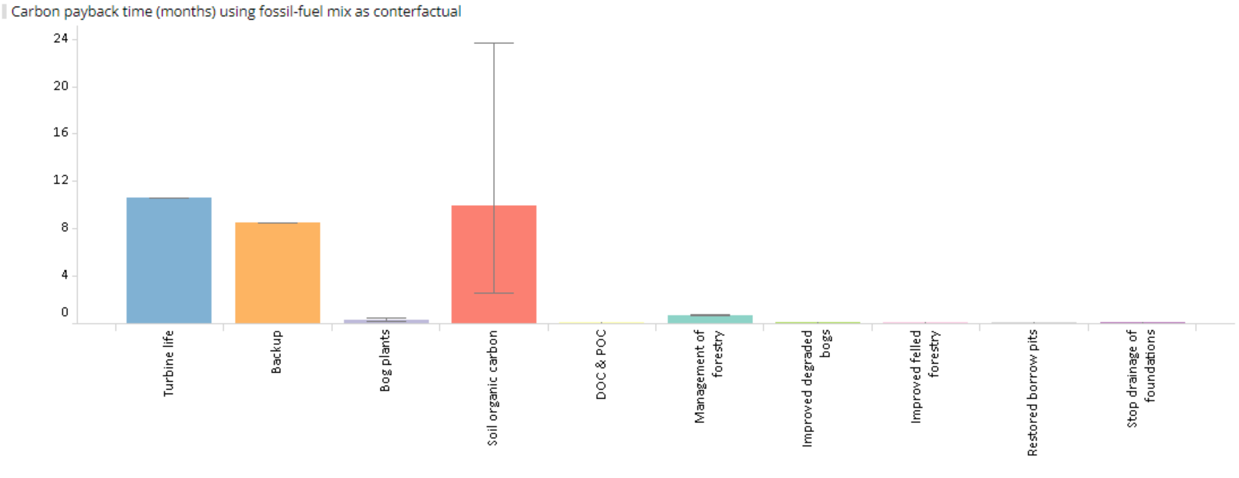
1. Windfarm CO2 emission saving over...	Exp.	Min.	Max.
...coal-fired electricity generation (t CO2 / yr)	41,732	40,257	43,206
...grid-mix of electricity generation (t CO2 / yr)	8,054	7,769	8,339
...fossil fuel-mix of electricity generation (t CO2 / yr)	17,992	17,356	18,628
Energy output from windfarm over lifetime (MWh)	1,665,942	1,607,075	1,724,809

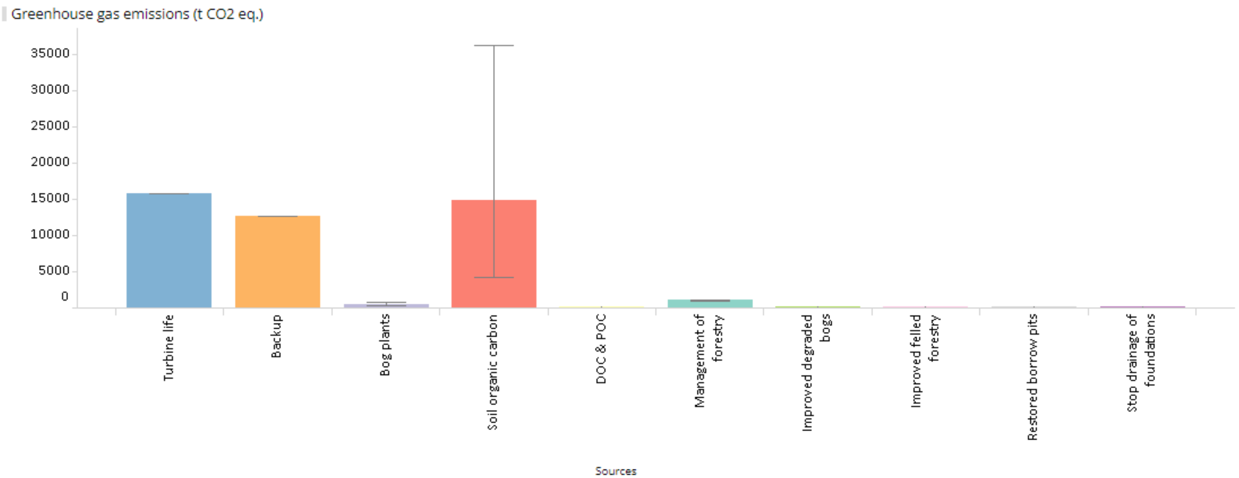
Total CO2 losses due to wind farm (tCO2 eq.)	Exp.	Min.	Max.
2. Losses due to turbine life (eg. manufacture, construction, decomissioning)	15,820	15,818	15,849
3. Losses due to backup	12,715	12,715	12,715
4. Lossess due to reduced carbon fixing potential	464	246	785
5. Losses from soil organic matter	14,903	4,288	36,228
6. Losses due to DOC & POC leaching	0	0	0
7. Losses due to felling forestry	1,056	975	1,140
Total losses of carbon dioxide	44,958	34,042	66,717

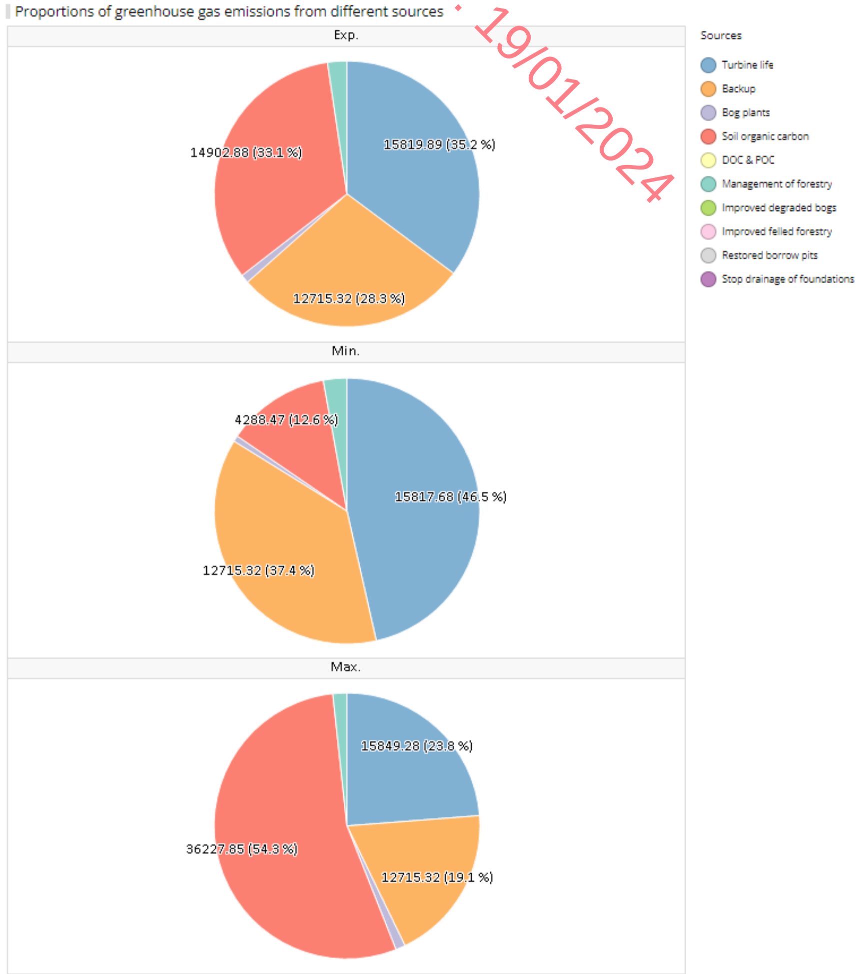
8. Total CO2 gains due to improvement of site (t CO2 eq.)	Exp.	Min.	Max.
8a. Change in emissions due to improvement of degraded bogs	0	0	0
8b. Change in emissions due to improvement of felled forestry	0	0	0
8c. Change in emissions due to restoration of peat from borrow pits	0	0	0
8d. Change in emissions due to removal of drainage from foundations & hardstanding	0	0	0
Total change in emissions due to improvements	0	0	0

RESULTS	Exp.	Min.	Max.
Net emissions of carbon dioxide (t CO2 eq.)	44,958	34,042	66,717
Carbon Payback Time			
...coal-fired electricity generation (years)	1.1	0.8	1.7
...grid-mix of electricity generation (years)	5.6	4.1	8.6
...fossil fuel-mix of electricity generation (years)	2.5	1.8	3.8
Ratio of soil carbon loss to gain by restoration (not used in Scottish applications)	No gains!	No gains!	No gains!
Ratio of CO2 eq. emissions to power generation (g/kWh) (for info. only)	26.99	19.74	41.51

Payback Time and CO_2 emissions • [redacted] MENU







View Input Data [redacted]

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Carbon Calculator v1.7.0
Letter Wind Farm Location: 54.16531 -8.188789
Letter Wind Farm Ltd.

Core input data

Input data	Expected value	Minimum value	Maximum value	Source of data
Windfarm characteristics				
Dimensions				
No. of turbines	4	4	4	Chapter 2: Project Description
Duration of consent (years)	40	40	40	Chapter 2: Project Description
Performance				
Power rating of 1 turbine (MW)	4.2	4.2	4.2	Chapter 2: Project Description
Capacity factor	28.3	27.3	29.3	Chapter 2: Project Description
Backup				
Fraction of output to backup (%)	5	5	5	SNH Calculator Guidance
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	Chapter 5: Terrestrial Ecology
Average annual air temperature at site (°C)	10.5	10	11	Chapter 10: Air and Climate
Average depth of peat at site (m)	1.98	0.1	5.5	Chapter 8: Soils and Geology
C Content of dry peat (% by weight)	55	50	60	Chapter 8: Soils and Geology
Average extent of drainage around drainage features at site (m)	10	5	15	Chapter 9: Hydrology and Hydrogeology
Average water table depth at site (m)	0.5	0.1	1	Chapter 8: Soils and Geology
Dry soil bulk density (g cm^{-3})	0.1	0.09	0.11	Chapter 8: Soils and Geology
Characteristics of bog plants				
Time required for regeneration of bog plants after restoration (years)	10	5	15	Best Practice from Bog Restoration Ireland
Carbon accumulation due to C fixation by bog plants in undrained peats (tC ha^{-1} yr^{-1})	0.25	0.24	0.26	Default Values
Forestry Plantation Characteristics				
Area of forestry plantation to be felled (ha)	2	1.9	2.1	Chapter 2: Project Description
Average rate of carbon sequestration in timber (tC ha^{-1} yr^{-1})	3.6	3.5	3.7	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	1	0	2	Chapter 2: Project Description
Average length of pits (m)	100	99	101	Chapter 2: Project Description
Average width of pits (m)	50	49	51	Chapter 2: Project Description
Average depth of peat removed from pit (m)	4	3	5	Chapter 2: Project Description

View Input Data [redacted] MENU

Average length of pits (m)	100	99	101	Chapter 2: Project Description
Average width of pits (m)	50	49	51	Chapter 2: Project Description
Average depth of peat removed from pit (m)	4	3	5	Chapter 2: Project Description
Foundations and hard-standing area associated with each turbine				
Average length of turbine foundations (m)	49.1	48.1	51.1	Appendix 2.1
Average width of turbine foundations (m)	10	9	11	Appendix 2.1
Average depth of peat removed from turbine foundations(m)	3.2	2.2	4.2	Appendix 2.1
Average length of hard-standing (m)	191.2	190.2	192.2	Chapter 2: Project Description
Average width of hard-standing (m)	20	19	21	Chapter 2: Project Description
Average depth of peat removed from hard-standing (m)	2	1.4	2.5	Appendix 2.1
Volume of concrete used in construction of the ENTIRE windfarm				
Volume of concrete (m^3)	6307	6300	6400	Chapter 15: Traffic and Transportation
Access tracks				
Total length of access track (m)	2573	2560	2580	Chapter 2: Project Description
Existing track length (m)	828	820	830	Chapter 2: Project Description
Length of access track that is floating road (m)	1745	1740	1750	Chapter 2: Project Description
Floating road width (m)	5	5	6	Chapter 2: Project Description
Floating road depth (m)	1.2	1	1.5	Chapter 2: Project Description
Length of floating road that is drained (m)	1745	1740	1750	Chapter 2: Project Description
Average depth of drains associated with floating roads (m)	0	0	0	Chapter 2: Project Description
Length of access track that is excavated road (m)	0	0	0	Chapter 2: Project Description
Excavated road width (m)	5	5	6	Chapter 2: Project Description
Average depth of peat excavated for road (m)	0	0	0	Chapter 2: Project 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	Chapter 2: Project Description
Average depth of peat cut for cable trenches (m)	3	2	4	Chapter 2: Project Description
Additional peat excavated (not already accounted for above)				
Volume of additional peat excavated (m^3)	179	170	180	Chapter 2: Project Description
Area of additional peat excavated (m^2)	0	0	0	Chapter 2: Project Description
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				

View Input Data [redacted] MENU

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	Chapter 2: Project Description
Average depth of peat cut for cable trenches (m)	3	2	4	Chapter 2: Project Description
Additional peat excavated (not already accounted for above)				
Volume of additional peat excavated (m^3)	179	170	180	Chapter 2: Project Description
Area of additional peat excavated (m^2)	0	0	0	Chapter 2: Project Description
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)	19	18	20	Chapter 5: Terrestrial Ecology
Water table depth in degraded bog before improvement (m)	2.9	2.8	3	Chapter 5: Terrestrial Ecology
Water table depth in degraded bog after improvement (m)	0.9	0.8	1	Chapter 5: Terrestrial Ecology
Time required for hydrology and habitat of bog to return to its previous state on improvement (years)	2	2	2	Chapter 5: Terrestrial Ecology
Period of time when effectiveness of the improvement in degraded bog can be guaranteed (years)	2	2	2	Chapter 5: Terrestrial Ecology
Improvement of felled plantation land				
Area of felled plantation to be improved (ha)	0	0	0	Chapter 2: Project Description
Water table depth in felled area before improvement (m)	0	0	0	Chapter 2: Project Description
Water table depth in felled area after improvement (m)	0	0	0	Chapter 2: Project Description
Time required for hydrology and habitat of felled plantation to return to its previous state on improvement (years)	2	2	2	Default Vallue
Period of time when effectiveness of the improvement in felled plantation can be guaranteed (years)	2	2	2	Default Value
Restoration of peat removed from borrow pits				
Area of borrow pits to be restored (ha)	0	0	0	Chapter 2: Project Description
Depth of water table in borrow pit before restoration with respect to the restored surface (m)	0	0	0	Chapter 2: Project Description
Depth of water table in borrow pit after restoration with respect to the restored surface (m)	0	0	0	Chapter 2: Project Description
Time required for hydrology and habitat of borrow pit to return to its previous state on restoration (years)	2	2	2	Chapter 2: Project Description
Period of time when effectiveness of the restoration of peat removed from borrow pits can be guaranteed (years)	2	2	2	Default Value
Early removal of drainage from foundations and hardstanding				
Water table depth around foundations and hardstanding before restoration (m)	0	0	0	Chapter 2: Project Description
Water table depth around foundations and hardstanding after restoration (m)	0	0	0	Chapter 2: Project Description
Time to completion of backfilling, removal of any surface drains, and full restoration of the hydrology (years)	0.1	0.1	0.1	Default Value
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	Chapter 9: Hydrology and Hydrogeology
Will you attempt to block all artificial ditches and facilitate rewetting?	Yes	Yes	Yes	Appendix 5.4: Habitat Management Plan
Will the habitat of the site be restored on decommissioning?	No	No	No	
Will you control grazing on degraded areas?	Yes	Yes	Yes	Appendix 5.4 Habitat Management Plan
Will you manage areas to favour reintroduction of species	No	No	No	Appendix 5.4 Habitat Management Plan
Methodology				
Choice of methodology for calculating emission factors	IPCC default			

Forestry input data

N/A

Construction input data

1. Windfarm CO_2 emission saving • [redacted]

MENU

Emissions due to turbine life

The carbon payback time of the windfarm due to turbine life (eg. manufacture, construction, decomissioning) is calculated by comparing the emissions due to turbine life with carbon-savings achieved by the windfarm while displacing electricity generated from coal-fired capacity or grid-mix.

Capacity factor calculated from forestry data

Area name	Value type	Capacity factor (%)	Wind speed ratio	Average site windspeed (m/s)	Annual theoretical energy output (MW / turbine yr)

Capacity factor - Direct input

	Exp.	Min.	Max.
Capacity factor (%)	28.3	27.3	29.3

	Exp.	Min.	Max.
Annual energy output from windfarm (MW/yr)			
RESULTS			
Emissions saving over coal-fired electricity ge...	41,732	40,257	43,206
Emissions saving over grid-mix of electricity g...	8,054	7,769	8,339
Emissions saving over fossil fuel - mix of elect...	17,992	17,356	18,628

2. CO_2 loss due to turbine life • [redacted]

MENU

Emissions due to turbine life
The carbon payback time of the windfarm due to turbine life (eg. manufacture, construction, decomissioning) is calculated by comparing the emissions due to turbine life with carbon-savings achieved by the windfarm while displacing electricity generated from coal-fired capacity or grid-mix.

Calculation of emissions with relation to installed capacity

	Exp.	Min.	Max.
Emissions due to turbine frome energy output (t CO2)	3457	3457	3457
Emissions due to cement used in construction (t CO2)	1993	1991	2022

Direct input of emissions due to turbine life

	Exp.	Min.	Max.
Emissions due to turbine life (tCO2/windfarm)			

RESULTS

	Exp.	Min.	Max.
Losses due to turbine life (manufacture, construction, etc.) (t CO2)	15820	15818	15849
Additional CO2 payback time of windfarm due to turbine life			
...coal-fired electricity generation (months)	5	5	4
...grid-mix of electricity generation (months)	24	24	23
...fossil fuel - mix of electricity generation (months)	11	11	10

3. CO_2 loss due to backup • [redacted]

MENU

Emissions due to backup power generation
CO2 loss due to back up is calculated from the extra capacity required for backup of the windfarm given in the input data.

Wind generated electricity is inherently variable, providing unique challenges to the electricity generating industry for provision of a supply to meet consumer demand (Netz, 2004). Backup power is required to accompany wind generation to stabilise the supply to the consumer. This backup power will usually be obtained from a fossil fuel source. At a high level of wind power penetration in the overall generating mix, and with current grid management techniques, the capacity for fossil fuel backup may become strained because it is being used to balance the fluctuating consumer demand with a variable and highly unpredictable output from wind turbines (White, 2007). The Carbon Trust (Carbon Trust/DTI, 2004) concluded that increasing levels of intermittent generation do not present major technical issues at the percentages of renewables expected by 2010 and 2020, but the UK renewables target at the time of that repor was only 20%. When national reliance on wind power is low (less than ~20%), the additional fossil fuel generated power requirement can be considered to be insignificant and may be obtained from within the spare generating capacity of other power sectors (Dale et al, 2004). However, as the national supply from wind power increases above 20%, without improvements in grid management techniques, emissions due to backup power generation may become more significant. The extra capacity needed for backup power generation is currently estimated to be 5% of the rated capacity of the wind plant if wind power contributes more than 20% to the national grid (Dale et al 2004). Moving towards the SG target of 50% electricity generation from renewable sources, more short-term capacity may be required in terms of pumped-storage hydro-generated power, or a better mix of offshore and onshore wind generating capacity. Grid management techniques are anticipated to reduce this extra capacity, with improved demand side management, smart meters, grid reinforcement and other developments. However, given current grid management techniques, it is suggested that 5% extra capacity should be assumed for backup power generation if wind power contributes more than 20% to the national grid. At lower contributions, the extra capacity required for backup should be assumed to be zero. These assumptions should be revisited as technology improves.

Assumption: Backup assumed to be by fossil-fuel-mix of electricity generation. Note that hydroelectricity may also be used for backup, so this assumption may make the value for backup generation too high. These assumptions should be revisited as technology develops.

	Exp.	Min.	Max.
Reserve energy (MWh/yr)	7,358	7,358	7,358
Annual emissions due to backup from fossil fuel-mix of electricity generati...	318	318	318
RESULTS			
Total emissions due to backup from fossil fuel-mix of electricity generatio...	12,715	12,715	12,715

4. Loss of CO_2 fixing potential • [redacted]

MENU

Emissions due to loss of bog plants
Annual C fixation by the site is calculated by multiplying area of the windfarm by the annual C accumulation due to bog plant fixation.

	Exp.	Min.	Max.
Area where carbon accumulation by bog plants is lost (ha)	10.12	6.20	14.98
Total loss of carbon accumulation up to time of restoration (tCO2 eq./ha)	46	40	52
RESULTS			
Total loss of carbon fixation by plants at the site (t CO2)	464	246	785
Additional CO2 payback time of windfarm due to loss of CO2 fixing potential			
...coal-fired electricity generation (months)	0	0	0
...grid-mix of electricity generation (months)	1	0	1
...fossil fuel - mix of electricity generation (months)	0	0	1

5. Loss of soil CO_2 (a, b) [redacted]

MENU

Emissions due to loss of soil organic carbon
Loss of C stored in peatland is estimated from % site lost by peat removal (table 5a), CO2 loss from removed peat (table 5b), % site affected by drainage (table 5c), and the CO2 loss from drained peat (table 5d).

5. Loss of soil CO2

	Exp.	Min.	Max.
CO2 loss from removed peat (t CO2 equiv.)	10730.89	3344.44	24356.53
CO2 loss from drained peat (t CO2 equiv.)	4171.99	944.03	11871.32
RESULTS			
Total CO2 loss from peat (removed + drained) (t CO2 e...	14902.88	4288.47	36227.85
Additional CO2 payback time of windfarm due to loss ...			
...coal-fired electricity generation (months)	4.29	1.28	10.06
...grid-mix of electricity generation (months)	22.2	6.62	52.14
...fossil fuel - mix of electricity generation (months)	9.94	2.96	23.34

CO_2 loss from removed peats
If peat is treated in such a way that it is permanently restored, so that less than 100% of the C is lost to the atmosphere, a lower percentage can be entered in cell C10.

5b. CO2 loss from removed peat

	Exp.	Min.	Max.
CO2 loss from removed peat (t CO2)	13617.83	5431.32	28373.62
CO2 loss from undrained peat left in situ (t CO2)	2886.94	2086.88	4017.09
RESULTS			
CO2 loss atributable to peat removal only (t CO2)	10730.89	3344.44	24356.53

Volume of Peat Removed
% site lost by peat removal is estimated from peat removed in borrow pits, turbine foundations, hard-standing and access tracks. If peat is removed for any other reason, this must be added in as additional peat excavated in the core input data entry.

5a. Volume of peat removed

	Exp.	Min.	Max.
Peat removed from borrow pits			
Area of land lost in borrow pits (m2)	5000	0	10302
Volume of peat removed from borrow pits (m3)	20000	0	51510
Peat removed from turbine foundations			
Area of land lost in foundation (m2)	1964	1731.6	2248.4
Volume of peat removed from foundation area (m3)	6284.8	3809.52	9443.28
Peat removed from hard-standing			
Area of land lost in hard-standing (m2)	15296	14455.2	16144.8
Volume of peat removed from hard-standing area (m3)	30592	20237.28	40362
Peat removed from access tracks			
Area of land lost in floating roads (m2)	8725	8700	10500
Volume of peat removed from floating roads (m3)	10470	8700	15750
Area of land lost in excavated roads (m2)	0	0	0
Volume of peat removed from excavated roads (m3)	0	0	0
Area of land lost in rock-filled roads (m2)	0	0	0
Volume of peat removed from rock-filled roads (m3)	0	0	0
Total area of land lost in access tracks (m2)	8725	8700	10500
Total volume of peat removed due to access tracks (m3)	10470	8700	15750
RESULTS			
Total area of land lost due to windfarm construction (m2)	30985	24886.8	39195.2
Total volume of peat removed due to windfarm constructio...	67525.8	32916.8	117245.28

5. Loss of soil CO_2 (c, d, e) [redacted]

MENU

Volume of peat drained

Extent of site affected by drainage is calculated assuming an average extent of drainage around each drainage feature as given in the input data.

5c. Volume of peat drained

	Exp.	Min.	Max.
Total area affected by drainage around borrow pits (m2)	3400	0	10920
Total volume affected by drainage around borrow pits (m3)	6800	0	27300
Peat affected by drainage around turbine foundation and hardst...			
Total area affected by drainage of foundation and hardstanding ...	23224	11052	36636
Total volume affected by drainage of foundation and hardstandi...	37158.4	12157.2	76935.6
Peat affected by drainage of access tracks			
Total area affected by drainage of access track(m2)	43625	26100	63000
Total volume affected by drainage of access track(m3)	0	0	0
Peat affected by drainage of cable trenches			
Total area affected by drainage of cable trenches(m2)	0	0	0
Total volume affected by drainage of cable trneches(m3)	0	0	0
Drainage around additional peat excavated			
Total area affected by drainage (m2)	0	0	0
Total volume affected by drainage (m3)	0	0	0
RESULTS			
Total area affected by drainage due to windfarm (m2)	70249	37152	110556
Total volume affected by drainage due to windfarm (m3)	43958.4	12157.2	104235.6

CO_2 loss due to drainage

Note, CO2 losses are calculated using two approaches: IPCC default methodology and more site specific equations derived for this project. The IPCC methodology is included because it is the established approach, although it contains no site detail. The new equations have been derived directly from experimental data for acid bogs and fens (see Nayak et al, 2008 - Final report).

5d. CO2 loss from drained peat

	Exp.	Min.	Max.
Calculations of C Loss from Drained Land if Site is NOT Restored after De...			
Total GHG emissions from Drained Land (t CO2 equiv.)	8865.02	2005.96	25225.24
Total GHG emissions from Undrained Land (t CO2 equiv.)	4693.03	1061.93	13353.92
Calculations of C Loss from Drained Land if Site IS Restored after Decomi...			
Losses if Land is Drained			
CH4 emissions from drained land (t CO2 equiv.)	0	0	0
CO2 emissions from drained land (t CO2)	12363.82	5884.88	21403.64
Total GHG emissions from Drained Land (t CO2 equiv.)	8865.02	2005.96	25225.24
Losses if Land is Undrained			
CH4 emissions from undrained land (t CO2 equiv.)	210.91	100.39	365.11
CO2 emissions from undrained land (t CO2)	6334.34	3014.99	10965.7
Total GHG emissions from Undrained Land (t CO2 equiv.)	4693.03	1061.93	13353.92
RESULTS			
Total GHG emissions due to drainage (t CO2 equiv.)	4171.99	944.03	11871.32

Emission rates from soils

Note, CO_2 losses are calculated using two approaches: IPCC default methodology and more site specific equations derived for this project. The IPCC methodology is included because it is the established approach, although it contains no site detail. The new equations have been thoroughly tested against experimental data (see Nayak et al, 2008 - Final report).

5e. Emission rates from soils

	Exp.	Min.	Max.
Calculations following IPCC default methodology			
Flooded period (days/year)	178	178	178
Annual rate of methane emission (t CH4-C/ha year)	0.04	0.04	0.04
Annual rate of carbon dioxide emission (t CO2/ha year)	35.2	35.2	35.2
Calculations following ECOSSE based methodology			
Total area affected by drainage due to wind farm construction (ha)	7.02	3.72	11.06
Average water table depth of drained land (m)	0.63	1	0.94

	Exp.	Min.	Max.
Selected emission characteristics following site specific methodol...			
Rate of carbon dioxide emission in drained soil (t CO2/ha year)	21.3	23.81	23.91
Rate of carbon dioxide emission in undrained soil (t CO2/ha year)	18.8	23.81	3.19
Rate of methane emission in drained soil (t CH4-C/ha year)	0	0	0
Rate of methane emission in undrained soil (t CH4-C/ha year)	0	0	0.15
RESULTS			
Selected rate of carbon dioxide emission in drained soil (t CO2/ha...	35.2	35.2	35.2
Selected rate of carbon dioxide emission in undrained soil (t CO2/...	0	0	0
Selected rate of methane emission in drained soil (t CH4-C/ha year)	0	0	0
Selected rate of methane emission in undrained soil (t CH4-C/ha y...	0.04	0.04	0.04

6. CO_2 loss by DOC & POC loss • [redacted]

MENU

Emissions due to loss of DOC and POC
Note, CO2 losses from DOC and POC are calculated using a simple approach derived from generic estimates of the percentage of the total CO2 loss that is due to DOC or POC leaching.

No POC losses for bare soil included yet. If extensive areas of bare soil is present at site need modified calculation (Birnie et al, 1991)

	Exp.	Min.	Max.
Gross CO2 loss from restored drained land (t CO2)	0.00	0.00	0.00
Gross CH4 loss from restored drained land (t CO2 equiv.)	0.00	0.00	0.00
Gross CO2 loss from improved land (t CO2)	0.00	0.00	0.00
Gross CH4 loss from improved land (t CO2 equiv.)	0.00	0.00	0.00
Total gaseous loss of C (t C)	0.00	0.00	0.00
Total C loss as DOC (t C)	0.00	0.00	0.00
Total C loss as POC (t C)	0.00	0.00	0.00
RESULTS			
Total CO2 loss due to DOC leaching (t CO2)	0.00	0.00	0.00
Total CO2 loss due to POC leaching (t CO2)	0.00	0.00	0.00
Total CO2 loss due to DOC & POC leaching (t CO2)	0.00	0.00	0.00
Additional CO2 payback time of windfarm due to DOC & POC			
...coal-fired electricity generation (months)	0	0	0
...grid-mix of electricity generation (months)	0	0	0
...fossil fuel - mix of electricity generation (months)	0	0	0

7. Forestry CO_2 loss • [redacted]

MENU

CO_2 loss from forests - calculation using detailed management information

Forest carbon calculator (Perks et al, 2009)

Total potential carbon squestration loss due to felling of forestry for the wind ...
Total emissions due to cleared land (t CO2)
Emissions due to harvesting operations (t CO2)
Fossil fuel equivalent saving from use of felled forestry as biofuel (t CO2)
Fossil fuel equivalent saving from use of replanted forestry as biofuel (t CO2)
RESULTS
Total carbon loss associated with forest management(t CO2)

Emissions due to forest felling - calculation using simple management data

Emissions due to forestry felling are calculated from the reduced carbon sequestered per crop rotation. If the forestry was due to be removed before the planned development, this C loss is not attributable to the wind farm and so the area of forestry to be felled should be entered as zero.

	Exp.	Min.	Max.
Area of forestry plantation to be felled (ha)	2	1.9	2.1
Carbon sequestered (t C ha-1 yr-1)	3.6	3.5	3.7
Lifetime of windfarm (years)	40	40	40
Carbon sequestered over the lifetime of the windfarm (t C ha-1)	144	140	148
RESULTS			
Total carbon loss due to felling of forestry (t CO2)	1056.01	975.34	1139.61
Additional CO2 payback time of windfarm due to management of forestry			
...coal-fired electricity generation (months)	0.3	0.29	0.32
...grid-mix of electricity generation (months)	1.57	1.51	1.64
...fossil fuel - mix of electricity generation (months)	0.7	0.67	0.73

8. CO_2 gain - site improvemer [redacted]

Gains due to site improvement

Note, CO2 losses are calculated using two approaches: IPCC default methodology and more site specific equations derived for this project. The IPCC methodology is included because it is the established approach, although it contains no site detail. The new equations have been thoroughly tested against experimental data (see Nayak et al, 2008 - Final report).

Degraded Bog

	Exp.	Min.	Max.
1. Description of site			
Area to be improved (ha)	19	18	20
Depth of peat above water table before improvement (m)	1.98	0.1	3
Depth of peat above water table after improvement (m)	0.9	0.1	0.8
2. Losses with improvement			
Improved period (years)	0	0	0
Selected annual rate of methane emissions (t CH4-C ha-1 yr-1)	0.04	0.04	0.04
CH4 emissions from improved land (t CO2 equiv.)	0	0	0
Selected annual rate of carbone dioxide emissions (t CO2 ha-...	0	0	0
CO2 emissions from improved land (t CO2 equiv.)	0	0	0
Total GHG emissions from improved land (t CO2 eqiv.)	0	0	0
3. Losses without improvement			
Improved period (years)	0	0	0
Selected annual rate of methane emissions (t CH4-C ha-1 yr-1)	0	0	0
CH4 emissions from improved land (t CO2 equiv.)	0	0	0
Selected annual rate of carbone dioxide emissions (t CO2 ha-...	35.2	35.2	35.2
CO2 emissions from unimproved land (t CO2 equiv.)	0	0	0
Total GHG emissions from unimproved land (t CO2 eqiv.)	0	0	0
RESULTS			
4. Reduction in GHG emissions due to improvement of site			
Reduction in GHG emissions due to improvement (t CO2 equ...	0	0	0

Felled Forestry

	Exp.	Min.	Max.
1. Description of site			
Area to be improved (ha)	0	0	0
Depth of peat above water table before improvement (m)	0	0	0
Depth of peat above water table after improvement (m)	0	0	0
2. Losses with improvement			
Improved period (years)	0	0	0
Selected annual rate of methane emissions (t CH4-C ha-1 yr-1)	0.04	0.04	0.04
CH4 emissions from improved land (t CO2 equiv.)	0	0	0
Selected annual rate of carbone dioxide emissions (t CO2 ha-...	0	0	0
CO2 emissions from improved land (t CO2 equiv.)	0	0	0
Total GHG emissions from improved land (t CO2 eqiv.)	0	0	0
3. Losses without improvement			
Improved period (years)	0	0	0
Selected annual rate of methane emissions (t CH4-C ha-1 yr-1)	0	0	0
CH4 emissions from improved land (t CO2 equiv.)	0	0	0
Selected annual rate of carbone dioxide emissions (t CO2 ha-...	35.2	35.2	35.2
CO2 emissions from unimproved land (t CO2 equiv.)	0	0	0
Total GHG emissions from unimproved land (t CO2 eqiv.)	0	0	0
RESULTS			
4. Reduction in GHG emissions due to improvement of site			
Reduction in GHG emissions due to improvement (t CO2 equ...	0	0	0

Borrow Pits

	Exp.	Min.	Max.
1. Description of site			
Area to be improved (ha)	0	0	0
Depth of peat above water table before improvement (m)	0	0	0
Depth of peat above water table after improvement (m)	0	0	0
2. Losses with improvement			
Improved period (years)	0	0	0
Selected annual rate of methane emissions (t CH4-C ha-1 yr-1)	0.04	0.04	0.04
CH4 emissions from improved land (t CO2 equiv.)	0	0	0
Selected annual rate of carbone dioxide emissions (t CO2 ha-...	0	0	0
CO2 emissions from improved land (t CO2 equiv.)	0	0	0
Total GHG emissions from improved land (t CO2 eqiv.)	0	0	0
3. Losses without improvement			
Improved period (years)	0	0	0
Selected annual rate of methane emissions (t CH4-C ha-1 yr-1)	0	0	0
CH4 emissions from improved land (t CO2 equiv.)	0	0	0
Selected annual rate of carbone dioxide emissions (t CO2 ha-...	35.2	35.2	35.2
CO2 emissions from unimproved land (t CO2 equiv.)	0	0	0
Total GHG emissions from unimproved land (t CO2 eqiv.)	0	0	0
RESULTS			
4. Reduction in GHG emissions due to improvement of site			
Reduction in GHG emissions due to improvement (t CO2 equ...	0	0	0

Foundations & Hardstanding

	Exp.	Min.	Max.
1. Description of site			
Area to be improved (ha)	0	0	0
Depth of peat above water table before improvement (m)	0	0	0
Depth of peat above water table after improvement (m)	0	0	0
2. Losses with improvement			
Improved period (years)	39.9	39.9	39.9
Selected annual rate of methane emissions (t CH4-C ha-1 yr-1)	0.04	0.04	0.04
CH4 emissions from improved land (t CO2 equiv.)	0	0	0
Selected annual rate of carbone dioxide emissions (t CO2 ha-...	0	0	0
CO2 emissions from improved land (t CO2 equiv.)	0	0	0
Total GHG emissions from improved land (t CO2 eqiv.)	0	0	0
3. Losses without improvement			
Improved period (years)	39.9	39.9	39.9
Selected annual rate of methane emissions (t CH4-C ha-1 yr-1)	0	0	0
CH4 emissions from improved land (t CO2 equiv.)	0	0	0
Selected annual rate of carbone dioxide emissions (t CO2 ha-...	35.2	35.2	35.2
CO2 emissions from unimproved land (t CO2 equiv.)	0	0	0
Total GHG emissions from unimproved land (t CO2 eqiv.)	0	0	0
RESULTS			
4. Reduction in GHG emissions due to improvement of site			
Reduction in GHG emissions due to improvement (t CO2 equ...	0	0	0