Emissions due to loss of bog plants

Note: Annual C fixation by the site is calculated by multiplying area of the windfarm by the annual C accumulation due to bog plant fixation

	Expected	Minimum	Maximum
Area where carbon accumulation by bog plants is lost			
Total area of land lost due to windfarm construction (m^2)	159175	741809	959268
Total area affected by drainage due to windfarm construction (m^{-2})	280757	73658	260049
Total area where fixation by plants is lost (m^2)	439932	815466	1219317
Total loss of carbon accumulation			
Carbon accumulation in undrained peats (tC ha^{-1} yr^{-1})	0.25	0.12	0.31
Lifetime of windfarm (years)	50	50	50
Time required for regeneration of bog plants after restoration (years)	10	10	20
Carbon accumulation up to time of restoration (tCO_2 eq. ha^{-1})	55	26	80
RESULTS			
Total loss of carbon accumulation by bog plants			
Total area where fixation by plants is lost (ha)	44	82	122
Carbon accumulation over lifetime of windfarm (tCO_2 eq. ha^{-1})	55	26	80
Total loss of carbon fixation by plants at the site (t CO_2)	**2420**	**2153**	**9703**
Additional CO_2 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	1	2
…fossil fuel - mix of electricity generation (months)	0	0	1

Assumptions:
1. Bog plants are 100% lost from the area where peat is removed for construction.
2. Bog plants are 100% lost from the area where peat is drained.
3. The recovery of carbon accumulation by plants on restoration of land is as given in inputs.

Click here to move to Payback Time Click here

Emissions due to loss of bog plants

Note: Annual C fixation by the site is calculated by multiplying area of the windfarm by the annual C accumulation due to bog plant fixation

Emissions due to loss of soil organic carbon

Note: Loss of C stored in peatland is estimated from % site lost by peat removal (sheet 5a), CO_2 loss from removed peat (sheet 5b), % site affected by drainage (sheet 5c), and the CO2 loss from drained peat (sheet 5d).

		Expected result	Minimum result	Maximum result
	CO_2 loss due to windfarm construction			
Check	CO_2 loss from removed peat (t CO_2 equiv)	16277	-84216	153505
Check	CO_2 loss from drained peat (t CO_2 equiv)	0	0	0
	RESULTS			
	Total CO_2 loss from peat (removed + drained) (t CO_2 equiv)	**16277**	**-84216**	**153505**
	Additional CO_2 payback time of windfarm due to loss of soil CO2			
	…coal-fired electricity generation (months)	1	-6	8
	…grid-mix of electricity generation (months)	5	-28	35
	…fossil fuel - mix of electricity generation (months)	2	-14	17

Click here to move to Payback Time Click here

Emissions due to loss of soil organic carbon

Note: Loss of C stored in peatland is estimated from % site lost by peat removal (sheet 5a), CO_2 loss from removed peat (sheet 5b), % site affected by drainage (sheet 5c), and the CO2 loss from drained peat (sheet 5d).

Volume of Peat Removed

Note: % 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 sheet.

Peat removed from borrow pits	Total		
	Exp	Min	Max
Number of borrow pits	5	5	5
Average length of pits (m)	147.5	172	244
Average width of pits (m)	68.7	210	327
Average depth of peat removed from pit (m)	0.2	0.27	0.27
Area of land lost in borrow pits (m^2)	50666.3	180600	398940
Volume of peat removed from borrow pits (m^3)	10133.3	48762	107714

Peat removed from turbine foundations	Total			Construction Area 1			Construction Area 2			Construction Area 3			Construction Area 4			Construction Area 5		
	Exp	Min	Max	Exp	Min	Max	Exp	Min	Max	Exp	Min	Max	Exp	Min	Max	Exp	Min	Max
Method used to calculate CO_2 loss from foundations	Enter detailed information																	
Calculation method code		2																
No. of turbines	15	15	15	15	15	15	0	0	0	0	0	0	0	0	0	0	0	0
Length at surface (m)				30	30	30	0	0	0	0	0	0	0	0	0	0	0	0
Width at surface (m)				25	25	25	0	0	0	0	0	0	0	0	0	0	0	0
Length at bottom (m)				30	30	30	0	0	0	0	0	0	0	0	0	0	0	0
Width at bottom (m)				25	25	25	0	0	0	0	0	0	0	0	0	0	0	0
Depth of foundations (m)				0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
"Area" of land lost in hard-standing (m^2)	11250	11250	11250	11250	11250	11250	0	0	0	0	0	0	0	0	0	0	0	0
Volume of peat removed from foundation area (m^3)	3937.5	3937.5	3937.5	3937.5	3937.5	3937.5	0	0	0	0	0	0	0	0	0	0	0	0

Peat removed from hard-standing																		
Method used to calculate CO_2 loss from foundations	Enter detailed information																	
Calculation method code		2																
No. of turbines	15	15	15	15	15	15	0	0	0	0	0	0	0	0	0	0	0	0
Length at surface (m)				97	97	97	0	0	0	0	0	0	0	0	0	0	0	0
Width at surface (m)				30	30	30	0	0	0	0	0	0	0	0	0	0	0	0
Length at bottom (m)				97	97	97	0	0	0	0	0	0	0	0	0	0	0	0
Width at bottom (m)				30	30	30	0	0	0	0	0	0	0	0	0	0	0	0
Depth of hardstanding (m)				0	0.35	0.35	0	0	0	0	0	0	0	0	0	0	0	0
Area of land lost in hard-standing (m^2)	43650	43650	43650	43650	43650	43650	0	0	0	0	0	0	0	0	0	0	0	0
Volume of peat removed from hardstandingarea (m^3)	15277.5	15277.5	15277.5	15277.5	15277.5	15277.5	0	0	0	0	0	0	0	0	0	0	0	0

Peat removed from access tracks	Total		
	Exp	Min	Max
Floating roads			
Length of access track that is floating road (m)	0	2001	2003
Floating road width (m)	5	5.5	5
Floating road depth (m)	0	0.63	0.63
Area of land lost in floating roads (m^2)	0	11005.5	10015
Volume of peat removed for floating roads	0	6933.47	6309.45
Excavated roads			
Length of access track that is excavated road (m)	7890	12534	12554
Excavated road width (m)	5.5	5.5	5.5
Average depth of peat excavated for road (m)	0.36	0.36	0.36
Area of land lost in excavated roads (m^2)	43395	68937	69047
Volume of peat removed for excavated roads	15622.2	24817.3	24856.9
Rock-filled roads			
Length of access track that is rock filled road (m)	0	0	0
Rock filled road width (m)	5	5	5
Rock filled road depth (m)	0	0	0
Area of land lost in excavated roads (m^2)	0	0	0
Volume of peat removed for rock-filled roads	0	0	0
Total area of land lost in access tracks (m^2)	43395	79942.5	79062
Total volume of peat removed due to access tracks (m^3)	15622.2	31750.8	31166.4

Additional peat excavated - (not already accounted for above)			
Volume of additional peat excavated (m^3)	1430	191460	191460
Area of additional peat excavated (m^2)	10214	426366	426366

RESULTS	Total		
	Exp	Min	Max
Total volume of peat removed (m^3) due to windfarm construction	**46400.5**	**291188**	**349555**
Total area of land lost due to windfarm construction (m^2)	**159175**	**741809**	**959268**

Click here to move to 5b. CO2 loss from removed peat — Click here

Click here to move to Payback Time — Click here

Volume of Peat Removed

Note: % 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 to the volume of peat removed, area of land lost and % site lost at the bottom of this worksheet.

CO_2 loss from removed peats

Note: 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

	Expected	Minimum	Maximum
CO_2 loss from removed peat			
C Content of dry peat (% by weight)	55.5	19	65
Dry soil bulk density (g cm^{-3})	0.25	0.09	0.25
% C contained in removed peat that is lost as CO_2	100	100	100
Check Total volume of peat removed (m^3) due to windfarm construction	46400	291188	349555
CO_2 loss from removed peat (t CO_2)	23608	18259	208296

Assumption: If peat is not restored, 100% of the carbon contained in the removed peat is lost as CO_2

CO_2 loss from undrained peat left in situ			
Total area of land lost due to windfarm construction (ha)	16	74	96
CO_2 loss from undrained peat left in situ (t CO_2 ha^{-1})	461	1381	571
CO_2 loss from undrained peat left in situ (t CO_2)	7331	102475	54791

CO_2 loss attributable to peat removal only			
CO_2 loss from removed peat (t CO_2)	23608	18259	208296
CO_2 loss from undrained peat left in situ (t CO_2)	7331	102475	54791
RESULTS			
CO_2 loss attributable to peat removal only (t CO_2)	**16277**	**-84216**	**153505**

Click here to move to 5. Loss of soil CO_2 Click here

Click here to move to Payback Time Click here

CO_2 loss from removed peats

Note: 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

Volume of peat drained

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

Extent of drainage around each metre of drainage ditch	Total		
	Exp	Min	Max
Average extent of drainage around drainage features at site (m)	10	2	6

Peat affected by drainage around borrow pits	Total		
	Exp	Min	Max
Number of borrow pits	5	5	5
Average length of pits (m)	148	172	244
Average width of pits (m)	69	210	327
Average depth of peat removed from pit (m)	0.2	0.3	0.3
Area affected by drainage per borrow pit (m^2)	4724	1544	6996
Total area affected by drainage around borrowpits (m^2)	23620	7720	34980
Total volume affected by drainage around borrowpits (m^3)	2362	1042	4722

Peat affected by drainage around turbine foundation and hardstanding	Total			Construction Area 1			Construction Area 2			Construction Area 3			Construction Area 4			Construction Area 5		
	Exp	Min	Max	Exp	Min	Max	Exp	Min	Max	Exp	Min	Max	Exp	Min	Max	Exp	Min	Max
No. of turbines	15	15	15	15	15	15	0	0	0	0	0	0	0	0	0	0	0	0
Average length of turbine foundations at base (m)				30	30	30	0	0	0	0	0	0	0	0	0	0	0	0
Average width of turbine foundations at base(m)				25	25	25	0	0	0	0	0	0	0	0	0	0	0	0
Average depth of peat removed from turbine foundations (m)				0.4	0.4	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Average length of hard-standing at base (m)				97	97	97	0	0	0	0	0	0	0	0	0	0	0	0
Average width of hard-standing at base (m)				30	30	30	0	0	0	0	0	0	0	0	0	0	0	0
Average depth of peat removed from hard-standing (m)				0.4	0.4	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Maximum depth of drains (m)				0.4	0.4	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total length of foundation and hardstanding (m)				127	127	127	0	0	0	0	0	0	0	0	0	0	0	0
Total width of foundation and hardstanding (m)				55	55	55	0	0	0	0	0	0	0	0	0	0	0	0
Area affected by drainage of foundation and hardstanding area (m^2)	4040	744	2328	4040	744	2328	0	0	0	0	0	0	0	0	0	0	0	0
Total area affected by drainage of foundation and hardstanding area (m^2)	60600	11160	34920	60600	11160	34920	0	0	0	0	0	0	0	0	0	0	0	0
Total volume affected by drainage of foundation and hardstanding area (m^3)	10605	1953	6111	10605	1953	6111	0	0	0	0	0	0	0	0	0	0	0	0

Peat affected by drainage of access tracks	Total		
	Exp	Min	Max
Floating roads			
Length of floating road that is drained (m)	0	0	1500
Floating road width (m)	5.0	5.5	5.0
Average depth of drains associated with floating roads (m)	0.00	0.00	0.00
Area affected by drainage of floating roads (m^2)	0	0	25500
Volume affected by drainage of floating roads (m^3)	0	0	0
Excavated Road			
Length of access track that is excavated road (m)	7890	12534	12554
Excavated road width (m)	6	6	6
Average depth of peat excavated for road (m)	0.4	0.4	0.4
Area affected by drainage of excavated roads (m^2)	157800	50136	150648
Volume affected by drainage of excavated roads (m^3)	28404	9024	27117
Rock-filled roads			
Length of rock filled road that is drained (m)	0	0	0
Rock filled road width (m)	5	5	5
Average depth of drains associated with rock filled roads (m)	0.0	0.0	0.0
Area affected by drainage of rock-filled roads (m^2)	0	0	0
Volume affected by drainage of rock-filled roads (m^2)	0	0	0
Total area affected by drainage of access track (m^2)	157800	50136	176148
Total volume affected by drainage of access track (m^3)	28404	9024	27117

Peat affected by drainage of cable trenches	Total		
	Exp	Min	Max
Length of any cable trench on peat that does not follow access tracks and is lined with a permeable medium (eg. sand) (m)	1742	0	0
Average depth of peat cut for cable trenches (m)	0.3	0.0	0.0
Total area affected by drainage of cable trenches (m^2)	34840	0	0
Total volume affected by drainage of cable trenches (m^3)	5051.80	0.00	0.00

Drainage around additional peat excavated	Total		
	Exp	Min	Max
Volume of additional peat excavated (m^3)	1430.0	191460.0	191460.0
Area of additional peat excavated (m^2)	10214.0	426366.0	426366.0
Average depth of excavated peat (m)	0	0	0
Radius of area excavated (m)	57	368	368
Radius of excavated and drained area (m)	67	370	374
Total area affected by drainage (m^2)	3897	4642	14001

Assumption: Area excavated is assumed to be a circle

Total volume affected by drainage (m^3)	545.57	2084.49	6287.32

RESULTS	Total Exp	Min	Max
Total area affected by drainage due to windfarm (m^2)	**280757**	**73658**	**260049**
Total volume affected by drainage due to windfarm (m^3)	**46968.37**	**14104.17**	**44237.26**

Click here to move to 5d. CO2 loss from drained peat Click here

Click here to move to Payback Time Click here

Volume of peat drained

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

CO_2 loss due to drainage

Note: 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 derived directly from experimental data for acid bogs and fens (see Nayak et al, 2008 - Final report).

Click here to move to 5. Loss of soil CO_2 Click here
Click here to move to Payback Time Click here

	Expected	Minimum	Maximum
Drained Land			
Total area affected by drainage due to wind farm construction (ha)	28	7	26
Will the hydrology of the site be restored on decommissioning?	No	No	No
Will the habitat of the site be restored on decommissioning?	Yes	No	No

Calculations of C Loss from Drained Land if Site is NOT Restored after Decommissioning

Check Total volume affected by drainage due to wind farm (m^3)	46968	14104	44237
C Content of dry peat (% by weight)	56	19	65
Dry soil bulk density (g cm^{-3})	0.25	0.09	0.25
Total GHG emissions from Drained Land (t CO_2 equiv.)	23897	884	26360
Total GHG Emissions from Undrained Land (t CO_2 equiv.)	23897	884	26129

Assumption: Losses of GHG from drained and undrained land have the same proportion throughout the emission period.

Calculations of C loss from Drained Land if Site IS Restored after Decommissioning

1. Losses if Land is Drained

Flooded period (days $year^{-1}$)	0	0	0
Lifetime of windfarm (years)	50	50	50
Time required for regeneration of bog plants after restoration (years)	10	10	20
Methane Emissions from Drained Land			
Check Rate of methane emission in drained soil ((t CH_4-C) ha^{-1} yr^{-1})	0.036	-0.008	0.067
Conversion factor: CH_4-C to CO_2 equivalents	30.67	30.67	30.67
CH_4 emissions from drained land (t CO_2 equiv.)	1844	-114	3738
Carbon Dioxide Emissions from Drained Land			
Check Rate of carbon dioxide emission in drained soil (t CO_2 ha^{-1} yr^{-1})	6.58	23.28	6.18
CO_2 emissions from drained land (t CO_2)	11086	10290	11247
Total GHG emissions from Drained Land (t CO_2 equiv.)	12931	10175	14985

Assumption: The drained soil is not flooded at any time of the year.

Note:Conversion = (23 x 16/12) = 30.67 CO_2 equiv. $(CH_4\text{-}C)^{-1}$

2. Losses if Land is Undrained

Flooded period (days $year^{-1}$)	178	178	178
Lifetime of windfarm (years)	50	50	50
Time required for regeneration of bog plants after restoration (years)	10	10	20
Methane Emissions from Undrained Land			
Check Rate of methane emission in undrained soil ((t CH_4-C) ha^{-1} yr^{-1})	0.04	-0.01	0.15
Conversion factor: CH_4-C to CO_2 equivalents	30.67	30.67	30.67
CH_4 emissions from undrained land (t CO_2 equiv.)	1844	-114	6032
Carbon Dioxide Emissions from Undrained Land			
Check Rate of carbon dioxide emission in undrained soil (t CO_2 ha^{-1} yr^{-1})	6.58	23.28	3.45
CO_2 emissions from undrained land (t CO_2)	11086	10290	8821
Total GHG Emissions from Undrained Land (t CO_2 equiv.)	12931	10175	14853

Note:Conversion = (23 x 16/12) = 30.67 CO_2 equiv. $(CH_4\text{-}C)^{-1}$

3. CO_2 Losses due to Drainage

Total GHG emissions from drained land (t CO_2 equiv.)	23897	884	26360
Total GHG emissions from undrained land (t CO_2 equiv.)	23897	884	26129
RESULTS			
Total GHG emissions due to drainage (t CO_2 equiv.)	**0**	**0**	**0**

Click here to move to 5. Loss of soil CO_2 Click here
Click here to move to Payback Time Click here

CO_2 loss due to drainage

Note: 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 derived directly from experimental data for acid bogs and fens (see Nayak et al, 2008 - Final report).

Emission rates from soils

Note: 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).

Click here to move to 5d. Click here
Click here to move to Payback Time Click here

Selected Methodology = Site specific (required for planning applications)
Type of peatland = Acid Bog

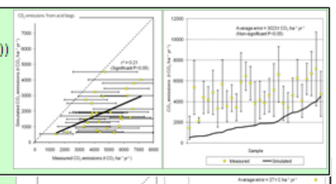
Calculations following IPCC default methodology	**Expected**	**Minimum**	**Maximum**
Emission characteristics of acid bogs (IPCC, 1997)			
Flooded period (days year^{-1})	178	178	178
Annual rate of methane emission (t CH_4-C ha^{-1} yr^{-1})	0.04015	0.04015	0.04015
Annual rate of carbon dioxide emission (t CO_2 ha^{-1} yr^{-1})	35.2	35.2	35.2
Emission characteristics of fens (IPCC, 1997)			
Flooded period (days year^{-1})	169	169	169
Annual rate of methane emission (t CH_4-C ha^{-1} yr^{-1})	0.219	0.219	0.219
Annual rate of carbon dioxide emission (t CO_2 ha^{-1} yr^{-1})	35.2	35.2	35.2
Selected emission characteristics (IPCC, 1997)			
Flooded period (days year^{-1})	178	178	178
Annual rate of methane emission (t CH_4-C ha^{-1} yr^{-1})	0.04015	0.04015	0.04015
Annual rate of carbon dioxide emission (t CO_2 ha^{-1} yr^{-1})	35.2	35.2	35.2
Calculations following ECOSSE based methodology			
Drained Land			
Total area affected by drainage due to wind farm construction (ha)	28	7	26
Total volume affected by drainage due to wind farm construction (m^3)	46968	14104	44237
Soil Characteristics that Determine Emission Rates			
Average annual air temperature at the site (^{o}C)	8.5	8	12
Average water table depth at site (m)	0.20	1.00	0.10
Average water table depth of drained land (m)	0.20	1.00	0.17
Annual Emission Rates following site specific methodology			
Acid bogs			
Rate of carbon dioxide emission in drained soil (t CO_2 ha^{-1} yr^{-1})	6.58	23.28	6.18
Rate of carbon dioxide emission in undrained soil (t CO_2 ha^{-1} yr^{-1})	6.58	23.28	3.45
Rate of methane emission in drained soil ((t CH_4-C) ha^{-1} yr^{-1})	0.036	-0.008	0.067
Rate of methane emission in undrained soil ((t CH_4-C) ha^{-1} yr^{-1})	0.04	-0.01	0.15
Fens			
Rate of carbon dioxide emission in drained soil (t CO_2 ha^{-1} yr^{-1})	16.88	63.80	14.92
Rate of carbon dioxide emission in undrained soil (t CO_2 ha^{-1} yr^{-1})	16.88	63.80	8.89
Rate of methane emission in drained soil ((t CH_4-C) ha^{-1} yr^{-1})	0.077	-0.005	0.106
Rate of methane emission in undrained soil ((t CH_4-C) ha^{-1} yr^{-1})	0.08	0.00	0.21
Selected emission characteristics following site specific methodology			
Rate of carbon dioxide emission in drained soil (t CO_2 ha^{-1} yr^{-1})	6.58	23.28	6.18
Rate of carbon dioxide emission in undrained soil (t CO_2 ha^{-1} yr^{-1})	6.58	23.28	3.45
Rate of methane emission in drained soil ((t CH_4-C) ha^{-1} yr^{-1})	0.036	-0.008	0.067
Rate of methane emission in undrained soil ((t CH_4-C) ha^{-1} yr^{-1})	0.04	-0.01	0.15

Assumption: The period of flooding is taken to be 178 days yr^{-1} for acid bogs and 169 days yr^{-1} based on the monthly mean temperature and the lengths of inundation (IPCC, 1997, Revised 1996 IPCC guidelines for national greenhouse gas inventories, Vol 3, table 5-13)

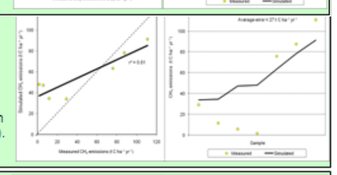
Assumption: The CH_4 emission rate provided for acid bogs is 11 (1-38) mg CH_4-C m^{-2} day^{-1} x 365 days; and for fens is 60 (21-162) mg CH_4-C m^{-2} day^{-1} x 365 days (Aselmann & Crutzen ,1989. J.Atm.Chem. 8, 307-358)

Assumption: CO_2 emissions on drainage of organic soils for upland crops (e.g., grain, vegetables) are 3.667x9.6 (7.9-11.3) t CO_2 ha^{-1} yr^{-1} in temperate climates (Armentano and Menges, 1986. J. Ecol. 74, 755-774).

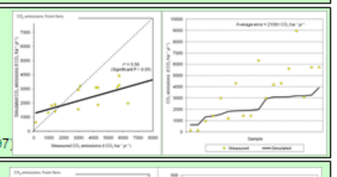
Note: Carbon dioxide emissions from acid bogs. Equation derived by regression analysis against 60 measurements (Nayak et al, 2009). The equation derived was
$R_{CO2} = (3.667/1000) \times ((6700 \times \exp(-0.26 \times \exp(-0.0515 \times ((W \times 100)-50)))) + ((72.54 \times T) - 800))$
where R_{CO2} is the annual rate of CO_2 emissions (t CO_2 (ha)$^{-1}$ yr^{-1}),
T = average annual peat temperature (°C) and
W is the water table depth (m).
The equation shows a significant correlation with measurements (r^2 =0.53 P > 0.05).
Evaluation against 29 independent experiments shows a significant association (r^2 = 0.21; P>0.05) and an average error of 3023 t CO_2 ha^{-1} yr^{-1} which is non-significant (P<0.05) (Smith et al, 1997).



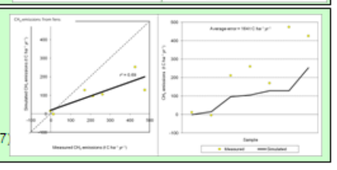
measurements (Nayak et al, 2009). The equation derived was
$R_{CH4} = (1/1000) \times (500 \times \exp(-0.1234 \times (W \times 100)) + ((3.529 \times T) - 36.67))$
where R_{CH4} is the annual rate of CH_4 emissions (t CH_4-C (ha)$^{-1}$ yr^{-1}),
T = average annual air temperature (°C) and
W is the water table depth (m).
The equation shows a significant correlation with measurements (r^2 = 0.54, P > 0.05).
Evaluation against 7 independent experiments shows a significant association (r^2 = 0.81; P>0.05) and an average error of 27 t CH_4-C ha^{-1} yr^{-1} (significance not defined due to lack of replicates - Smith et al, 1997).



Note: Carbon dioxide emissions from fens. Equation derived by regression analysis against 44 measurements (Nayak et al, 2009). The equation derived was
$R_{CO2} = (3.667/1000) \times (16244 \times \exp(-0.175 \times \exp(-0.073 \times ((W \times 100)-50)))+(153.23 \times T))$
where R_{CO2} is the annual rate of CO_2 emissions (t CO_2 (ha)$^{-1}$ yr^{-1}),
T = average annual peat temperature (°C) and
W is the water table depth (m).
The equation shows a significant correlation with measurements (r^2 = 0.42, P > 0.05).
Evaluation against 18 independent experiments shows a significant association (r^2 = 0.56; P>0.05) and an average error of 2108 t CO_2 ha^{-1} yr^{-1} (significance not defined due to lack of replicates-Smith et al, 1997



Note: Methane emissions from fens. Equation derived by regression analysis against experimental data from 36 measurements (Nayak et al, 2009). The equation derived was
$R_{CH4} = (1/1000) \times (-10+563.62 \times \exp(-0.097 \times (W \times 100))+(0.662 \times T))$
where R_{CH4} is the annual rate of CH_4 emissions (t CH_4-C (ha)$^{-1}$ yr^{-1}),
T = average annual air temperature (°C) and
W is the water table depth (m).
The equation shows a significant correlation with measurements (r^2 = 0.41, P>0.05).
Evaluation against 7 independent experiments shows a significant association (r^2 = 0.69; P>0.05) and an average error of 164 t CH_4-C ha^{-1} yr^{-1} (significance not defined due to lack of replicate-Smith et al, 1997



RESULTS
Selected Emission Rates

Rate of carbon dioxide emission in drained soil (t CO_2 ha^{-1} yr^{-1})	6.58	23.28	6.18
Rate of carbon dioxide emission in undrained soil (t CO_2 ha^{-1} yr^{-1})	6.58	23.28	3.45
Rate of methane emission in drained soil ((t CH_4-C) ha^{-1} yr^{-1})	0.036	-0.008	0.067
Rate of methane emission in undrained soil ((t CH_4-C) ha^{-1} yr^{-1})	0.04	-0.01	0.15

Click here to move to 5d. CO2 loss from drained peat Click here
Click here to move to Payback Time Click here

Emission rates from soils

Note: 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).

Emissions due to loss of DOC and POC

Note: Note, CO_2 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)

	Expected	Minimum	Maximum
Total C loss			
Gross CO_2 loss from restored drained land (t CO_2)	0	0	0
Gross CH_4 loss from restored drained land (t CO_2 equiv.)	0	0	0
Gross CO_2 loss from improved land (t CO_2)			
Degraded Bog	0	0	0
Felled Forestry	0	0	0
Borrow Pits	0	0	0
Foundations & Hardstanding	0	0	0
Gross CH_4 loss from improved land (t CO_2 equiv.)			
Degraded Bog	491	0	177
Felled Forestry	0	0	0
Borrow Pits	269	0	1483
Foundations & Hardstanding	0	0	1241
Conversion factor: CH_4-C to CO_2 equivalents	30.6667	30.6667	30.6667
% total soil C losses, lost as DOC	26	7	40
% DOC loss emitted as CO_2 over the long term	100	100	100
% total soil C losses, lost as POC	8	4	10
% POC loss emitted as CO_2 over the long term	100	100	100
Total gaseous loss of C (t C)	19	0	71
Total C loss as DOC (t C)	5	0	28
Total C loss as POC (t C)	1	0	7

Note: Only restored drained land included because if land is not restored, the C lost has already been counted as carbon dioxide

Assumption: DOC loss ranges between 7 - 40% of the total gaseous loss if calculated from the reported (minimum and maximum) values in Worrall 2009 and is **26%** of the total gaseous loss if calculated from the mean of reported maximum and minimum value in Worrall 2009. These DOC values are flux based on soil water concentration (i.e. 12.5 - 85.9 MgC/KM^2/yr) and not on flux at catchment outlet (i.e. 10.3 - 21.8 MgC/KM^2/yr)

Worrall, F. et al., 2009. The multi-annual carbon budget of a peat-covered catchment. *Science of The*

Assumption: In the long term, 100% of leached DOC is assumed to be lost as CO_2

Assumption: POC loss ranges between 4-10% of the total gaseous loss if calculated from the reported values and is **8%** of the total gaseous loss if calculated from the mean of reported maximum and minimum value in Worrall 2009. POC range is (7 - 22.4 MgC/KM^2/yr) (Worrall et al, 2009).

Assumption: In the long term, 100% of leached POC is assumed to be lost as CO_2

RESULTS			
Total CO_2 loss due to DOC leaching (t CO_2)	**18**	**0**	**104**
Total CO_2 loss due to POC leaching (t CO_2)	**5**	**0**	**26**
Total CO_2 loss due to DOC & POC leaching (t CO_2)	**23**	**0**	**130**
Additional CO_2 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

Click here to move to Payback Time Click here

Emissions due to loss of DOC and POC

Note: Note, CO_2 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)