APPENDIX 11-1

CARBON CALCULATIONS

Payback Time

1. Windfarm CO2 emission saving over...	Exp.	Min.	Max.
...coal-fired electricity generation (t CO2 / yr)	2,295	1,967	2,659
...grid-mix of electricity generation (t CO2 / yr)	503	431	582
...fossil fuel-mix of electricity generation (t CO2 / yr)	1,030	883	1,193
Energy output from windfarm over lifetime (MWh)	84,990	62,441	112,548

Total CO2 losses due to wind farm (tCO2 eq.)	Exp.	Min.	Max.
2. Losses due to turbine life (eg. manufacture, construction, decomissioning)	68,857	68,857	69,885
3. Losses due to backup	51,479	44,125	59,651
4. Lossess due to reduced carbon fixing potential	2,169	982	4,107
5. Losses from soil organic matter	2,076	-1,478	19,877
6. Losses due to DOC & POC leaching	0	0	0
7. Losses due to felling forestry	4,759	3,927	5,644
Total losses of carbon dioxide	129,340	116,414	159,163

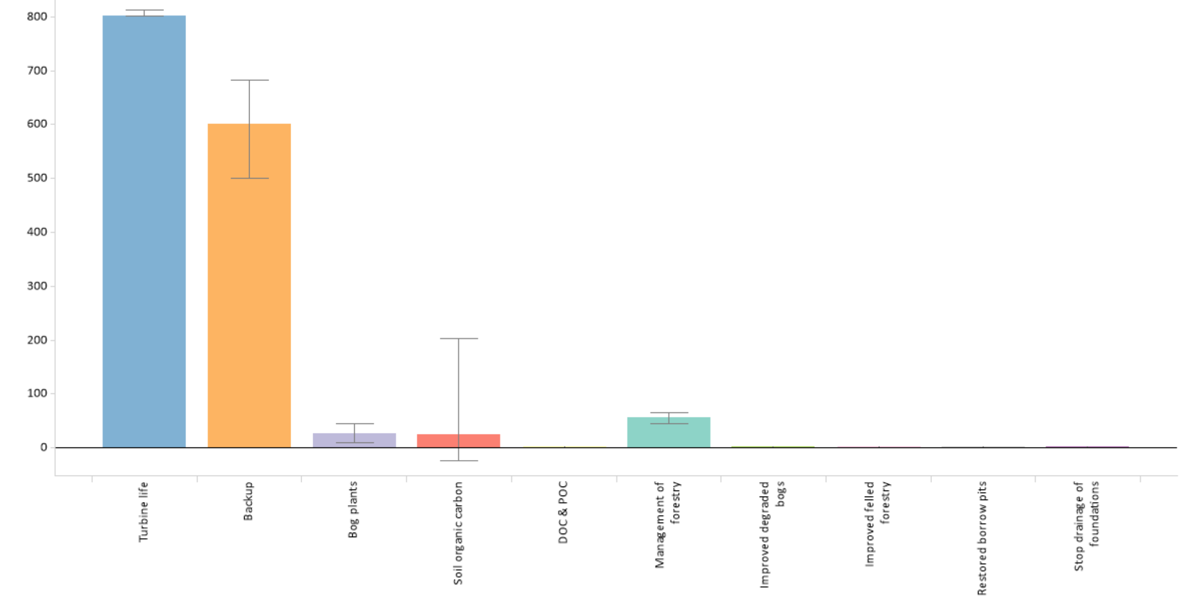
8. Total CO2 gains due to improvement of site (t CO2 eq.)	Exp.	Min.	Max.
8a. Change in emissions due to improvement of degraded bogs	0	0	0
8b. Change in emissions due to improvement of felled forestry	0	0	0
8c. Change in emissions due to restoration of peat from borrow pits	0	0	0
8d. Change in emissions 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.)	129,340	116,414	159,163
Carbon Payback Time			
...coal-fired electricity generation (years)	56.4	43.8	80.9
...grid-mix of electricity generation (years)	257.3	199.9	369.4
...fossil fuel-mix of electricity generation (years)	125.6	97.6	180.4
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)	1521.83	1034.34	2549.01

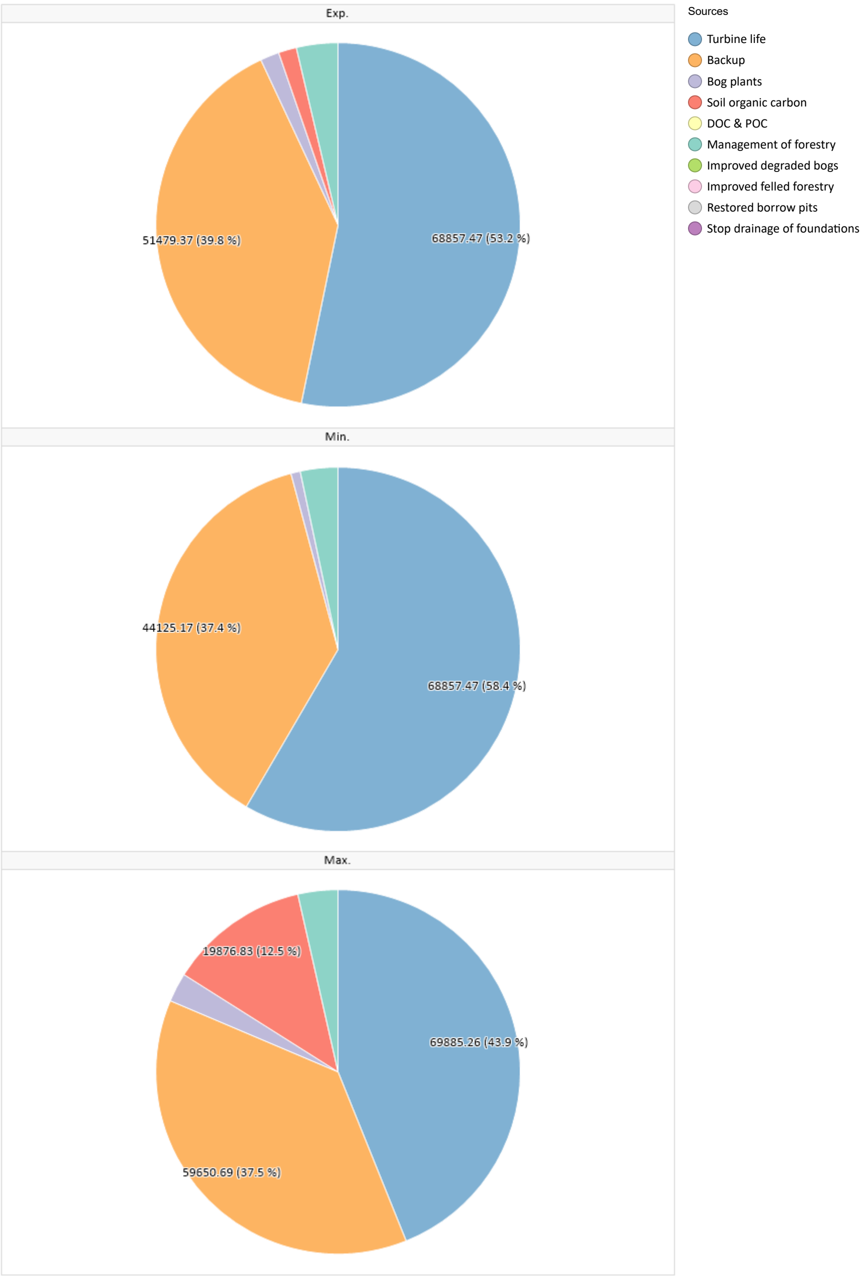
Payback Time - Charts

Payback Time
Payback Time - ChartsInput Data
1. Windfarm CO2 emission saving 2. CO2 loss due to turbine life 3. CO2 loss due to backup 4. Loss of CO2 fixing potential 5. Loss of soil CO2 (a,b) 5. Loss of soil CO2 (c,d,e) 6. CO2 loss by DOC & POC loss 7. Forestry CO2 loss 8. CO2 gain - site improvement
Edit input... New app...
MENU≡

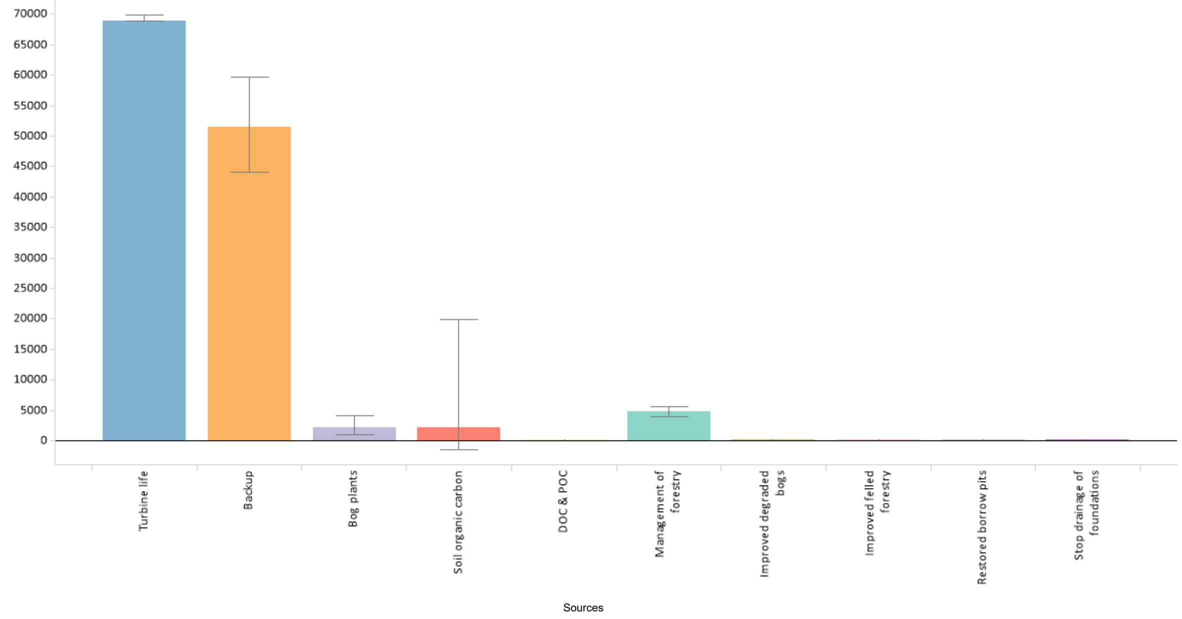
Carbon payback time (months) using fossil-fuel mix as conterfactual



Proportions of greenhouse gas emissions from different sources



Greenhouse gas emissions (t CO2 eq.)



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Carbon Calculator v1.8.1

Clonberne Wind Farm Location: 53.560777 -8.647888

Clonberne LTD

Core input data

Input data	Expected value	Minimum value	Maximum value	Source of data
Windfarm characteristics				
Dimensions				
No. of turbines	11	11	11	Ch 4 Description
Duration of consent (years)	35	30	40	Ch 4 Description
Performance				
Power rating of 1 turbine (MW)	7.2	7.2	7.3	Ch 4 Description
Capacity factor	0.35	0.3	0.4	Enduring Connection Policy 2.2 Constraints Report Solar and Wind
Backup				
Fraction of output to backup (%)	5	5	5	SNH 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	Default Value Used
Average annual air temperature at site (°C)	9.8	5.1	15	Ch 11 Climate
Average depth of peat at site (m)	1.68	1.65	1.72	Peat Management Plan
C Content of dry peat (% by weight)	53.23	53	53.46	Default Value Used
Average extent of drainage around drainage features at site (m)	15	10	20	Default Value Used
Average water table depth at site (m)	0.5	0.1	1	Default Value Used
Dry soil bulk density (g cm^{-3})	0.132	0.112	0.152	Default Value Used
Characteristics of bog plants				
Time required for regeneration of bog plants after restoration (years)	10	5	15	Default Value Used
Carbon accumulation due to C fixation by bog plants in undrained peats (tC ha^{-1} yr^{-1})	0.25	0.2	0.3	SNH Guidance
Forestry Plantation Characteristics				
Area of forestry plantation to be felled (ha)	10.3	10.2	10.4	Chapter 4 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})	0.945	0.945	0.945	
Grid-mix emission factor (t CO2 MWh^{-1})	0.207	0.207	0.207	
Fossil fuel-mix emission factor (t CO2 MWh^{-1})	0.424	0.424	0.424	
Borrow pits				
Number of borrow pits	1	1	1	Ch 4 Descritpion
Average length of pits (m)	76	75	77	Manually Determined in QGIS
Average width of pits (m)	276	275	277	Manually Determined in QGIS
Average depth of peat removed from pit (m)	0	0	0.1	Peat Management Plan
Foundations and hard-standing area associated with each turbine				
Average length of turbine foundations (m)	25	20	30	Ch 4 Description
Average width of turbine foundations (m)	25	20	30	Ch 4 Description
Average depth of peat removed from turbine foundations(m)	0.9	0.8	1	Peat Management Plan
Average length of hard-standing (m)	55	50	60	Ch 4 Description
Average width of hard-standing (m)	35	30	40	Ch 4 Description
Average depth of peat removed from hard-standing (m)	0.7	0.6	0.8	Peat and Spoil Management Plan
Volume of concrete used in construction of the ENTIRE windfarm				
Volume of concrete (m^3)	0.0001	0.0001	0.0001	Default Value Used
Access tracks				
Total length of access track (m)	12200	12100	12300	N/A
Existing track length (m)	2200	2200	2200	Ch 4 Description
Length of access track that is floating road (m)	2400	2350	2450	Ch 4 Description
Floating road width (m)	6	6	6	Ch 4 Description
Floating road depth (m)	1	0.9	1.1	Peat Management Plan
Length of floating road that is drained (m)	2400	2350	2450	Peat Management Plan
Average depth of drains associated with floating roads (m)	1	1	1	Peat Management Plan
Length of access track that is excavated road (m)	7600	7550	7650	Ch 4 Description

1. CO2 Emission Saving

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 (%)	0.4	0.3	0.4

	Exp.	Min.	Max.
Annual energy output from windfarm (MW/yr)			
RESULTS			
Emissions saving over coal-fired electricity generatio...	2,295	1,967	2,659
Emissions saving over grid-mix of electricity generati...	503	431	582
Emissions saving over fossil fuel - mix of electricity g...	1,030	883	1,193

2. CO2 Loss Turbine Life

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)	6260	6260	6353
Emissions due to cement used in construction (t CO2)	0	0	0

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)	68857	68857	69885
Additional CO2 payback time of windfarm due to turbine life			
...coal-fired electricity generation (months)	360	420	315
...grid-mix of electricity generation (months)	1644	1918	1440
...fossil fuel - mix of electricity generation (months)	803	936	703

3. CO2 Loss Backup

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 report 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)	34,690	34,690	35,171
Annual emissions due to backup from fossil fuel-mix of electricity generation (tCO2/yr)	1,471	1,471	1,491
RESULTS			
Total emissions due to backup from fossil fuel-mix of electricity generation (tCO2)	51,479	44,125	59,651

4. Loss CO2 Fixing Pot

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)	52.57	38.27	67.88
Total loss of carbon accumulation up to time of restoration (tCO2 eq./ha)	41	26	61
RESULTS			
Total loss of carbon fixation by plants at the site (t CO2)	2169	982	4107
Additional CO2 payback time of windfarm due to loss of CO2 fixing potential			
...coal-fired electricity generation (months)	11	6	19
...grid-mix of electricity generation (months)	52	27	85
...fossil fuel - mix of electricity generation (months)	25	13	41

5. Loss of soil CO2 (a,b)

Emissions due to loss of soil organic carbon
Loss of C stored in peatland is estimated from % site lost by peat removal (table 5a), CO_2 loss from removed peat (table 5b), % site affected by drainage (table 5c), and the CO_2 loss from drained peat (table 5d).

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.

5. Loss of soil C02

	Exp.	Min.	Max.
CO2 loss from removed peat (t CO2 equiv.)	2075.85	-1478.33	11719.37
CO2 loss from drained peat (t CO2 equiv.)	0	0	8157.45
RESULTS			
Total CO2 loss from peat (removed + drained) (t CO2 equiv.)	2075.85	-1478.33	19876.83
Additional CO2 payback time of windfarm due to loss of soil C...			
...coal-fired electricity generation (months)	10.86	-9.02	89.71
...grid-mix of electricity generation (months)	49.56	-41.17	409.52
...fossil fuel - mix of electricity generation (months)	24.19	-20.1	199.93

5a. Volume of peat removed

	Exp.	Min.	Max.
Peat removed from borrow pits			
Area of land lost in borrow pits (m2)	20976	20625	21329
Volume of peat removed from borrow pits (m3)	0	0	2132.9
Peat removed from turbine foundations			
Area of land lost in foundation (m2)	6875	4400	9900
Volume of peat removed from foundation area (m3)	6187.5	3520	9900
Peat removed from hard-standing			
Area of land lost in hard-standing (m2)	21175	16500	26400
Volume of peat removed from hard-standing area (m3)	14822.5	9900	21120
Peat removed from access tracks			
Area of land lost in floating roads (m2)	14400	14100	14700
Volume of peat removed from floating roads (m3)	14400	12690	16170
Area of land lost in excavated roads (m2)	45600	45300	45900
Volume of peat removed from excavated roads (m3)	13680	9060	18360
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)	60000	59400	60600
Total volume of peat removed due to access tracks (m3)	28080	21750	34530
RESULTS			
Total area of land lost due to windfarm construction (m2)	134546	126445	143749
Total volume of peat removed due to windfarm construction (m3)	51730	37810	70322.9

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)	13327.49	8229.55	20952.93
CO2 loss from undrained peat left in situ (t CO2)	11251.64	9707.88	9233.55
RESULTS			
CO2 loss atributable to peat removal only (t CO2)	2075.85	-1478.33	11719.37

5. Loss of soil CO2 (c, d, e)

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.

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).

5c. Volume of peat drained

	Exp.	Min.	Max.
Total area affected by drainage around borrow pits (m2)	11460	7400	15760
Total volume affected by drainage around borrow pits (m3)	0	0	788
Peat affected by drainage around turbine foundation and hardstanding			
Total area affected by drainage of foundation and hardstanding area (m2)	56100	30800	88000
Total volume affected by drainage of foundation and hardstanding area (m3)	25245	12320	44000
Peat affected by drainage of access tracks			
Total area affected by drainage of access track(m2)	314400	212100	418700
Total volume affected by drainage of access track(m3)	77400	45650	117550
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)	9201.33	5977.14	12582.6
Total volume affected by drainage (m3)	951.86	618.33	1301.65
RESULTS			
Total area affected by drainage due to windfarm (m2)	391161.33	256277.14	535042.6
Total volume affected by drainage due to windfarm (m3)	103596.86	58588.33	163639.65

5d. CO2 loss from drained peat

	Exp.	Min.	Max.
Calculations of C Loss from Drained Land if Site is NOT Restored after Decomissioning			
Total GHG emissions from Drained Land (t CO2 equiv.)	26690.23	12752.06	48756.94
Total GHG emissions from Undrained Land (t CO2 equiv.)	26690.23	12752.06	40599.49
Calculations of C Loss from Drained Land if Site IS Restored after Decomissioning			
Losses if Land is Drained			
CH4 emissions from drained land (t CO2 equiv.)	-56.15	-513.56	2503.7
CO2 emissions from drained land (t CO2)	32767.68	20189.36	38769.52
Total GHG emissions from Drained Land (t CO2 equiv.)	26690.23	12752.06	48756.94
Losses if Land is Undrained			
CH4 emissions from undrained land (t CO2 equiv.)	-56.15	-513.56	8404.66
CO2 emissions from undrained land (t CO2)	32767.68	20189.36	25963.19
Total GHG emissions from Undrained Land (t CO2 equiv.)	26690.23	12752.06	40599.49
RESULTS			
Total GHG emissions due to drainage (t CO2 equiv.)	0	0	8157.45

Emission rates from soils
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).

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)	39.12	25.63	53.5
Average water table depth of drained land (m)	0.5	1	0.31
Selected emission characteristics following site specific methodology			
Rate of carbon dioxide emission in drained soil (t CO2/ha year)	18.62	22.51	13.17
Rate of carbon dioxide emission in undrained soil (t CO2/ha year)	18.62	22.51	4.25

6. CO2 Loss DOC & POC

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 CO2 Loss

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 farm (t CO2)	
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)	10.3	10.2	10.4
Carbon sequestered (t C ha-1 yr-1)	3.6	3.5	3.7
Lifetime of windfarm (years)	35	30	40
Carbon sequestered over the lifetime of the windfarm (t C ha-1)	126	105	148
RESULTS			
Total carbon loss due to felling of forestry (t CO2)	4758.64	3927.04	5643.78
Additional CO2 payback time of windfarm due to management of forestry			
...coal-fired electricity generation (months)	24.88	23.96	25.47
...grid-mix of electricity generation (months)	113.6	109.38	116.28
...fossil fuel - mix of electricity generation (months)	55.46	53.4	56.77

8. CO2 Gain - Site Improvement

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)	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)	0.498	0.481	0.516
CH4 emissions from improved land (t CO2 equiv.)	0	0	0
Selected annual rate of carbone dioxide emissions (t CO2 ha-1 yr-1)	0.482	-0.768	1.865
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)	0.498	0.481	0.516
CH4 emissions from improved land (t CO2 equiv.)	0	0	0
Selected annual rate of carbone dioxide emissions (t CO2 ha-1 yr-1)	0.482	-0.768	1.865
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 equiv.)	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)	0.498	0.481	0.516
CH4 emissions from improved land (t CO2 equiv.)	0	0	0
Selected annual rate of carbone dioxide emissions (t CO2 ha-1 yr-1)	0.482	-0.768	1.865
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)	0.498	0.481	0.516
CH4 emissions from improved land (t CO2 equiv.)	0	0	0
Selected annual rate of carbone dioxide emissions (t CO2 ha-1 yr-1)	0.482	-0.768	1.865
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 equiv.)	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)	0.498	0.481	0.516
CH4 emissions from improved land (t CO2 equiv.)	0	0	0
Selected annual rate of carbone dioxide emissions (t CO2 ha-1 yr-1)	0.482	-0.768	1.865
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)	0.498	0.481	0.516
CH4 emissions from improved land (t CO2 equiv.)	0	0	0
Selected annual rate of carbone dioxide emissions (t CO2 ha-1 yr-1)	0.482	-0.768	1.865
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 equiv.)	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)	35	30	40
Selected annual rate of methane emissions (t CH4-C ha-1 yr-1)	0.498	0.481	0.516
CH4 emissions from improved land (t CO2 equiv.)	0	0	0
Selected annual rate of carbone dioxide emissions (t CO2 ha-1 yr-1)	0.482	-0.768	1.865
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)	35	30	40
Selected annual rate of methane emissions (t CH4-C ha-1 yr-1)	0.498	0.481	0.516
CH4 emissions from improved land (t CO2 equiv.)	0	0	0
Selected annual rate of carbone dioxide emissions (t CO2 ha-1 yr-1)	0.482	-0.768	1.865
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 equiv.)	0	0	0

TII Carbon Assessment Tool

Ch 15: Material Assets, Section 15.1.4.2 , Table 15-6					Distance Assumptions	TII Embodied Carbon Tool Inputs						TII Transport Inputs		
Material	Total no. Truck Loads	Truck Type	TII Embodied Carbon	TII Traffic	Distance (km)	Category	Sub-Category	Material	Quantity	Unit	Emodied tCO2e	Transport Type	Distance (km)	Transport TCO2e
Concrete	1,173	Truck	✓	✓	53.06	Series 1700 - Structural Concrete	Concrete - Construction General		9384.00	m3	2308.46	HGV - Rigid - All	62239.38	62.1
Delivery of plant	43	Large artic		✓	53.06							HGV-All-Average	2281.58	2.45
Fencing & gates	4	Large artic		✓	53.06							HGV-All-Average	212.24	0.23
Compound setup	44	Large artic		✓	53.06							HGV-All-Average	2334.64	2.51
Steel	31	Large artic	✓	✓	108.7	Series 1800 - Structural Steelwork	General		620	tonne	1111.72	HGV-All-Average	3368.15	3.61
Sand / binding	241	Truck		✓	53.06	Series 800 - Road Pavements - Unbound and Cement Bound Mixtures	Sand	sand	4820	tonnes	33.74	HGV - Rigid - All	12787.46	12.76
Ducting and cabling (internal)	323	Large artic		✓	53.06							HGV-All-Average	17138.38	18.39
Tree felling	103	Truck		✓	53.06							HGV - Rigid - All	5465.18	5.45
Crane (to lift steel)	1	Large artic		✓	108.7							HGV-All-Average	108.7	0.12
Stone for Proposed Wind Farm	666	Truck	✓	✓	53.06	Series 2400 - Brickwork, Blockwork and Stonework	Brickwork and Blockwork		13320	tonne	1052.28	HGV - Rigid - All	35337.96	35.26
Trip generation	378	Truck		✓	108.7							HGV - Rigid - All	41069.7	20.01

for Grid connection														
Substation	100	Large artic		✓	108.7							HGV-All-Average	10000	11.66
Cranes for turbines	12	Large artic		✓	108.65							HGV-All-Average	1303.8	1.4
Refuelling for plant	227	Large artic		✓	53.06							HGV-All-Average	12044.62	12.92
Site maintenance	165	Large artic			53.06							HGV-All-Average	8754.9	9.39
Miscellaneous	110	Large artic		✓	53.06							HGV-All-Average	5836.6	6.26
Total											**4506.2**			**204.5**

List of Assumptions

Embodied Carbon Assumptions			Traffic Assumptions		
Item	Description	Assumption	Item	Description	Assumption
Volume of Concrete Mixer	Calculation completed based on the average concrete mixer holding 7.6m3 of concrete	8	Import (P) Distance	For modelling purposes, the average distance from Shannon Foynes Port, Limerick City and Galway Harbour, Galway City for transport of all turbine infrastructre to Site.	108.7
Volume of Average Artic Truck	Calculation completed based on the average artic truck having a carrying capacity of 30 tonnes	20	Quarry (Q) Distance	For modelling purposes the average distsance between Galway, Athlone, roscommon, loughrea and Castlebarfor the transport of all other materials to Site.	53.06
Ducting and cabling (internal)	Embodied carbon of electrical equipment not included as an option in TII Carbon Tool	-	Concrete Mixer Emission factor	Calculated from an HGV - Rigid - Average emission factor as provided in the TII Carbon Tool	
Grid connection cable laying	Embodied carbon of electrical equipment not included as an option in TII Carbon Tool	-	Large Artic Emission Factor	Calcuated from an HGV - All - Average emission factor as provided in the TII Carbon Tool	
Tree Felling	Embodied carbon of tree felling is included in the Macauley Institute Carbon Calculatior for Wind Farms on Peatland	-	Truck Emissions Factor	Calculated from an LGV - Average emission factor as provided in the TII Carbon Tool	
Turbine Lifecycle	Embodied carbon of the oevrall turbine lifecycle is included in the Macauley Institute Carbon Calculatior for Wind Farms on Peatland	-			