



APPENDIX 11-2

CARBON CALCULATIONS

Core input data
ENTER INPUT DATA HERE! VALUES SHOULD ONLY BE CHANGED ON THIS SHEET. DO NOT USE EXAMPLE VALUES AS DEFAULTS! ENTER YOUR OWN VALUES THAT ARE SPECIFIC TO YOUR PARTICULAR SITE.
Note: The input parameters include some variables that can be specified by default values, but others that must be site specific. Variables that can be taken from defaults are marked with purple tags on left hand side.

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Input data	Expected values		Possible range of values			
	Enter expected value here	Record source of data	Enter minimum value here	Record source of data	Enter maximum value here	Record source of data
Windfarm characteristics						
Dimensions	23		23		23	
No. of turbines	35		35		35	
Lifetime of windfarm (years)	6.3		6		7.2	
Performance	Direct input of capacity fac: ▼		Direct input of capacity fac: ▼		Direct input of capacity fac: ▼	
Power rating of turbines (turbine capacity) (MW)	0.4		0.4		0.4	
Capacity factor	Enter estimated capacity factor (percentage efficiency)					
Backup	5		5		5	
Extra capacity required for backup (%)	10		10		10	
Additional emissions due to reduced thermal efficiency of the reserve generation (%)	Calculate wt installed cap: ▼		Calculate wt installed cap: ▼		Calculate wt installed cap: ▼	
Carbon dioxide emissions from turbine life - (no. manufacture, construction, decommissioning)						
Characteristics of peatland before windfarm development						
Type of peatland	Acid b ▼		Acid b ▼		Acid b ▼	
Average annual air temperature at site (°C)	10		5.7		15.2	
Average depth of peat at site (m)	0.00		0.00		0.00	
C Content of dry peat (% by weight)	53.23		19.57		64.28	
Average extent of drainage around drainage features at site (m)	15.00		15.00		15.00	
Average water table depth at site (m)	0.50		0.10		1.00	
Dry soil bulk density (g cm ⁻³)	0.13		0.07		0.29	
Characteristics of bog plants						
Time required for regeneration of bog plants after restoration (years)	10		5		15	
Carbon accumulation due to C fixation by bog plants in undrained peats (tC ha ⁻¹ yr ⁻¹)	0.25		0.2		0.3	
Forestry Plantation Characteristics						
Method used to calculate CO ₂ loss from forest felling	Enter simple data ▼		Enter simple data ▼		Enter simple data ▼	
Area of forestry plantation to be felled (ha)	69.27		69.27		69.27	
Average rate of carbon sequestration in timber (tC ha ⁻¹ yr ⁻¹)	3.50		3.45		3.55	
Counterfactual emission factors						
To update counterfactual emission factors from the web	0.919		0.919		0.919	
Coal-fired plant emission factor (t CO ₂ MWh ⁻¹)	0.177		0.177		0.177	
Grid-mix emission factor (t CO ₂ MWh ⁻¹)	0.448		0.448		0.448	
Fossil fuel-mix emission factor (t CO ₂ MWh ⁻¹)						
Borrow pits						
Number of borrow pits	5		5		5	
Average length of pits (m)	125.2		125.2		125.2	
Average width of pits (m)	107.4		107.4		107.4	
Average depth of peat removed from pit (m)	0.00		0.00		0.00	
Foundations and hard-standing area associated with each turbine						
Method used to calculate CO ₂ loss from foundations and hard-standing	Rectangular with vertical x ▼		Rectangular with vertical x ▼		Rectangular with vertical x ▼	
Average length of turbine foundations (m)	25		25		25	
Average width of turbine foundations (m)	25		25		25	
Average depth of peat removed from turbine foundations (m)	0.00		0.00		0.00	
Average length of hard-standing (m)	79		79		79	
Average width of hard-standing (m)	35		35		35	
Average depth of peat removed from hard-standing (m)	0.00		0.00		0.00	
Access tracks						
Total length of access track (m)	22200		22200		22200	
Existing track length (m)	8700		8700		8700	
Length of access track that is floating road (m)	0		0		0	
Floating road width (m)	0.00		0.00		0.00	
Length of floating road that is drained (m)	0.00		0.00		0.00	
Average depth of drains associated with floating roads (m)	13500		13500		13500	
Length of access track that is excavated road (m)	5		5		5	
Excavated road width (m)	0.00		0.00		0.00	
Average depth of peat excavated for road (m)	0.00		0.00		0.00	
Length of access track that is rock filled road (m)						
Rock filled road width (m)						
Rock filled road depth (m)						
Length of rock filled road that is drained (m)						
Average depth of drains associated with rock filled roads (m)						
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)						
Average depth of peat cut for cable trenches (m)	0.00		0.00		0.00	
Additional peat excavated (not already accounted for above)						
Volume of additional peat excavated (m ³)	0		0		0	
Area of additional peat excavated (m ²)	0		0		0	
Peat Landslide Hazard						
Reblink, Peat Landslide Hazard and Risk Assessments, Best Practice Guide for Proposed Electricity Generation Developments						
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)						
Water table depth in degraded bog before improvement (m)						
Water table depth in degraded bog after improvement (m)						
Time required for hydrology and habitat of bog to return to its previous state on improvement (years)						
Period of time when effectiveness of the improvement in degraded bog can be guaranteed (years)	25		25		25	
Improvement of felled plantation land						
Area of felled plantation to be improved (ha)						
Water table depth in felled area before improvement (m)						
Water table depth in felled area after improvement (m)						
Time required for hydrology and habitat of felled plantation to return to its previous state on improvement (years)						
Period of time when effectiveness of the improvement in felled plantation can be guaranteed (years)	25		25		25	
Restoration of peat removed from borrow pits						
Area of borrow pits to be restored (ha)						
Depth of water table in borrow pit before restoration with respect to the restored surface (m)						
Depth of water table in borrow pit after restoration with respect to the restored surface (m)						
Time required for hydrology and habitat of borrow pit to return to its previous state on restoration (years)						
Period of time when effectiveness of the restoration of peat removed from borrow pits can be guaranteed (years)	25		25		25	
Early removal of drainage from foundations and hardstanding						
Water table depth around foundations and hardstanding before restoration (m)						
Water table depth around foundations and hardstanding after restoration (m)	10.00		5.00		15.00	
Time to completion of backfilling, removal of any surface drains, and full restoration of the hydrology (years)						
Restoration of site after decommissioning						
Will the hydrology of the site be restored on decommissioning?	No		No		No	
Will you attempt to block any gullies that have formed due to the windfarm?	No		No		No	
Will you attempt to block all artificial ditches and facilitate rewetting?	No		No		No	
Will the habitat of the site be restored on decommissioning?	No		No		No	
Will you control grazing on degraded areas?	No		Yes		No	
Will you manage areas to favour reintroduction of species	No		No		No	
Choice of methodology for calculating emission factors						
Site specific (required for planning applications)						

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Windfarm CO₂ emission saving

Note: The total emission savings are given by estimating the total possible electrical output of the windfarm multiplied by the emission factor for the counterfactual case (coal-fire generation and electricity from grid)

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Values taken from input sheet	Total			Forestry Area 1			For
	Exp	Min	Max	Exp	Min	Max	Exp
Power Generation Characteristics							
No. of turbines	23	23	23	0	0	0	0
Power rating of turbines (turbine capacity) (MW)	6.3	6	7.2	6.3	6	7.2	6.3
Power of windfarm (MW)	144.9	138	165.6	0	0	0	0
Estimated downtime for maintenance etc (%)	0	0	0	0	0	0	0
Counterfactual emission factors							
Coal-fired plant emission factor (t CO ₂ MWh ⁻¹)	0.919	0.919	0.919	0.919	0.919	0.919	0.919
Grid-mix emission factor (t CO ₂ MWh ⁻¹)	0.177	0.177	0.177	0.177	0.177	0.177	0.177
Fossil fuel-mix emission factor (t CO ₂ MWh ⁻¹)	0.448	0.448	0.448	0.448	0.448	0.448	0.448

Calculation of capacity factor		1 Direct input of capacity factor		
		Exp	Min	Max
Entered capacity factor (%)		0.35	0.35	0.35

Parameters	Slope (a)			Intercept (b)		
	Exp	Min	Max	Exp	Min	Max
Partial power curves for different turbines						
User-defined	0.0	0.0	0.0	0.0	0.0	0.0
Vestas 2.0 MW Optispeed C2	1392.5	1392.5	1392.5	-4291.9	-4291.9	-4291.9

Calculation of capacity factor from forestry management	Total			Forestry Area 1			For
	Exp	Min	Max	Exp	Min	Max	Exp
Wind speed ratio calculated in 7d				#####	#####	#####	#####
Average site windspeed (m s ⁻¹)	0	0	0	0	0	0	0
Annual theoretical energy output from turbine (MW turbine ⁻¹ yr ⁻¹)	55188	52560	63072	55188	52560	63072	55188
Power curve				User-defined	User-defined	User-defined	Partial power curves for different turbines
(Power curve code)				1	1	1	0
Slope (a)				0	0	0	Exp
Intercept (b)				0	0	0	Exp

Annual power output from an individual turbine (MW turbine ⁻¹ yr ⁻¹)				#####	#####	#####	#####
Calculated capacity factor (%)				#####	#####	#####	#####

Total				Forestry Area 1			For
Calculation of annual energy output from wind farm							
Direct input of capacity factor							
Capacity factor(%)	0	0	0	0	0	0	0
Annual energy output from windfarm (MW yr⁻¹)	4443	4231	5077	0	0	0	0

Total				Area 1			
RESULTS							
Windfarm CO₂ emission saving over...							
...coal-fired electricity generation (tCO ₂ yr ⁻¹)	4083	3888.4	4666	0	0	0	0
...grid-mix of electricity generation (tCO ₂ yr ⁻¹)	786	748.9	898.68	0	0	0	0
...fossil fuel - mix of electricity generation (tCO ₂ yr ⁻¹)	1990	1895.5	2274.6	0	0	0	0

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Windfarm CO₂ emission saving

Note: The total emission savings are given by estimating the total possible electrical output of the windfarm multiplied by the emission factor for the counterfactual case (coal-fire generation and electricity from grid)

Emissions due to turbine life

Note: The carbon payback time of the windfarm due to turbine life (eg. manufacture, construction, decommissioning) 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.

Method used to estimate CO₂ emissions from turbine life (eg. manufacture, construction,	Calculate wrt installed capacity
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	Exp	Min	Max
Direct input of emissions due to turbine life (t CO₂ windfarm⁻¹)	0	0	0
Calculation of emissions due to turbine life from energy output			
CO ₂ emissions due to turbine life (tCO ₂ turbine ⁻¹)	5419	5139	6260
No. of turbines	23	23	23
Total calculated CO ₂ emission of the wind farm due to turbine life (t CO ₂ windfarm ⁻¹)	124634	118187	143975

	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
Calculation of emissions due to cement used in construction																		
Volume of cement used (m ³)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
CO ₂ emission rate (t CO ₂ m ⁻³ cement)	0.316	0.316	0.316	0.316	0.316	0.316	0.316	0.316	0.316	0.316	0.316	0.316	0.316	0.316	0.316	0.316	0.316	0.316
Total CO ₂ emissions due to cement used in construction	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

RESULTS			
Losses due to turbine life (eg. manufacture, construction, decommissioning)	124634	118187	143975
Additional CO₂ payback time of windfarm due to turbine life (eg. manufacture, construction, decommissioning)			
...coal-fired electricity generation (months)	366	365	370
...grid-mix of electricity generation (months)	1902	1894	1922
...fossil fuel - mix of electricity generation (months)	751	748	760

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Emissions due to turbine life

Note: The carbon payback time of the windfarm due to turbine life (eg. manufacture, construction, decommissioning) 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.

http://www.concretecentre.com/PDF/SCF_Table%207%20Embodied%20CO2_April%202013.pdf



Embodied carbon dioxide (CO₂e) of concretes used in buildings

CONCRETE APPLICATION	Concrete designation	CO ₂ e (kgCO ₂ e/m ³) ¹			CO ₂ e (kgCO ₂ e/tonne) ¹		
		CEM I concrete	30% fly ash concrete	50% ggbs concrete	CEM I concrete	30% fly ash concrete	50% ggbs concrete
Blinding, mass fill, strip footings, mass foundations, trench foundations ²	GEN1	177	128	101	77	55	44
Reinforced Foundations ²	RC25/30**	316	263	197	133	111	83
Ground floors ²	RC28/35 *	316	261	186	134	110	79
Structural: in situ floors, superstructure, walls, basements ²	RC32/40 **	369	313	231	154	131	96
High strength concrete ²	RC40/50 **	432	351	269	178	146	111
		CO ₂ e (kgCO ₂ e/m ³)			CO ₂ e (kgCO ₂ e/tonne)		
Unreinforced Precast flooring ³		-			165		
Reinforced precast flooring ³		-			171		
Average Generic Concrete Block ⁴		-			84		

* includes 30kg/m³ steel reinforcement

** includes 100kg/m³ steel reinforcement

Emissions due to backup power generation

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

	Expected	Minimum	Maximum
Reserve capacity required for backup			
No. of turbines	23	23	23
Power rating of turbines (turbine capacity) (MW)	6.3	6	7.2
Power of wind farm (MW h ⁻¹)	144.9	138	165.6
Rated capacity (MW yr ⁻¹)	1269324	1208880	1450656
Extra capacity required for backup (%)	5	5	5
Additional emissions due to reduced thermal efficiency of the reserve generation (%)	10	10	10
Reserve capacity (MWh yr ⁻¹)	6347	6044	7253

Carbon dioxide emissions due to backup power generation			
Coal-fired plant emission factor (t CO ₂ MWh ⁻¹)	0.919	0.919	0.919
Grid-mix emission factor (t CO ₂ MWh ⁻¹)	0.177	0.177	0.177
Fossil fuel- mix emission factor (t CO ₂ MWh ⁻¹)	0.448	0.448	0.448
Lifetime of windfarm (years)	35	35	35
Annual emissions due to backup from...			
...coal-fired electricity generation (tCO ₂ yr ⁻¹)	5833	5555	6666
...grid-mix of electricity generation (tCO ₂ yr ⁻¹)	1123	1070	1284
...fossil fuel - mix of electricity generation (tCO ₂ yr ⁻¹)	2843	2708	3249

RESULTS			
Total emissions due to backup from...			
...coal-fired electricity generation (tCO ₂)	204139	194418	233302
...grid-mix of electricity generation (tCO ₂)	39317	37445	44934
...fossil fuel - mix of electricity generation (tCO ₂)	99515	94776	113731
Additional CO₂ payback time of windfarm due to backup			
...coal-fired electricity generation (months)	600	600	600
...grid-mix of electricity generation (months)	600	600	600
...fossil fuel - mix of electricity generation (months)	600	600	600

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Emissions due to backup power generation

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

Note: 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.

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

Expected

Area where carbon accumulation by bog plants is lost	
Total area of land lost due to windfarm construction (m ²)	198327
Total area affected by drainage due to windfarm construction (m ²)	578250
Total area where fixation by plants is lost (m ²)	776577

Total loss of carbon accumulation	
Carbon accumulation in undrained peats (tC ha ⁻¹ yr ⁻¹)	0.25
Lifetime of windfarm (years)	35
Time required for regeneration of bog plants after restoration (years)	10
Carbon accumulation up to time of restoration (tCO ₂ eq. ha ⁻¹)	41

RESULTS	
Total loss of carbon accumulation by bog plants	
Total area where fixation by plants is lost (ha)	78
Carbon accumulation over lifetime of windfarm (tCO ₂ eq. ha ⁻¹)	41
Total loss of carbon fixation by plants at the site (t CO₂)	3204
Additional CO₂ payback time of windfarm due to loss of CO₂ fixing potential	
...coal-fired electricity generation (months)	9
...grid-mix of electricity generation (months)	49
...fossil fuel - mix of electricity generation (months)	19

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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

Minimum	Maximum
198327	198327
578250	578250
776577	776577

0.2	0.3
35	35
5	15
29	55

78	78
29	55
2278	4272

7	11
37	57
14	23

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.

to bog plant fixation

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)	198327	198327	198327
Total area affected by drainage due to windfarm construction (m ²)	578250	578250	578250
Total area where fixation by plants is lost (m ²)	776577	776577	776577
Total loss of carbon accumulation			
Carbon accumulation in undrained peats (tC ha ⁻¹ yr ⁻¹)	0.25	0.2	0.3
Lifetime of windfarm (years)	35	35	35
Time required for regeneration of bog plants after restoration (years)	10	5	15
Carbon accumulation up to time of restoration (tCO ₂ eq. ha ⁻¹)	41	29	55
RESULTS			
Total loss of carbon accumulation by bog plants			
Total area where fixation by plants is lost (ha)	78	78	78
Carbon accumulation over lifetime of windfarm (tCO ₂ eq. ha ⁻¹)	41	29	55
Total loss of carbon fixation by plants at the site (t CO₂)	3204	2278	4272
Additional CO₂ payback time of windfarm due to loss of CO₂ fixing potential			
...coal-fired electricity generation (months)	9	7	11
...grid-mix of electricity generation (months)	49	37	57
...fossil fuel - mix of electricity generation (months)	19	14	23

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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

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.

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), CO₂ 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
Check	CO₂ loss due to windfarm construction			
	CO ₂ loss from removed peat (t CO ₂ equiv)	-16654	-17582	-9203
Check	CO ₂ loss from drained peat (t CO ₂ equiv)	0	0	0
RESULTS				
Total CO₂ loss from peat (removed + drained) (t CO₂ equiv)		-16654	-17582	-9203
Additional CO₂ payback time of windfarm due to loss of soil CO₂				
...coal-fired electricity generation (months)		-49	-54	-24
...grid-mix of electricity generation (months)		-254	-282	-123
...fossil fuel - mix of electricity generation (months)		-100	-111	-49

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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), CO₂ 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	Exp	Total Min	Max
Number of borrow pits	5	5	5
Average length of pits (m)	125.2	125.2	125.2
Average width of pits (m)	107.4	107.4	107.4
Average depth of peat removed from pit (m)	0	0	0
Area of land lost in borrow pits (m ²)	67232	67232	67232
Volume of peat removed from borrow pits (m ³)	0	0	0

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	Rectangular with vertical walls																	
Calculation method code		1																
No. of turbines	23	23	23	23	23	23	0	0	0	0	0	0	0	0	0	0	0	0
Diameter at surface (m)				25	25	25	0	0	0	0	0	0	0	0	0	0	0	0
Diameter at bottom (m)				25	25	25	0	0	0	0	0	0	0	0	0	0	0	0
Depth of foundations (m)				25	25	25	0	0	0	0	0	0	0	0	0	0	0	0
"Area" of land lost in hard-standing (m ²)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Volume of peat removed from foundation area (m ³)	0	0	0	0	0	0	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	Rectangular with vertical walls																	
Calculation method code		1																
No. of turbines	23	23	23	23	23	23	0	0	0	0	0	0	0	0	0	0	0	0
Diameter at surface (m)				79	79	79	0	0	0	0	0	0	0	0	0	0	0	0
Diameter at bottom (m)				35	35	35	0	0	0	0	0	0	0	0	0	0	0	0
Depth of hardstanding (m)				79	79	79	0	0	0	0	0	0	0	0	0	0	0	0
Area of land lost in hard-standing (m ²)	63595	63595	63595	63595	63595	63595	0	0	0	0	0	0	0	0	0	0	0	0
Volume of peat removed from hardstandingarea (m ³)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Peat removed from access tracks	Exp	Total Min	Max
Floating roads			
Length of access track that is floating road (m)	0	0	0
Floating road width (m)	0	0	0

Floating road depth (m)	0	0	0
Area of land lost in floating roads (m ²)	0	0	0
Volume of peat removed for floating roads	0	0	0
Excavated roads			
Length of access track that is excavated road (m)	13500	13500	13500
Excavated road width (m)	5	5	5
Average depth of peat excavated for road (m)	0	0	0
Area of land lost in excavated roads (m ²)	67500	67500	67500
Volume of peat removed for excavated roads	0	0	0
Rock-filled roads			
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
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)	67500	67500	67500
Total volume of peat removed due to access tracks (m ³)	0	0	0

Additional peat excavated - (not already accounted for above)			
Volume of additional peat excavated (m ³)	0	0	0
Area of additional peat excavated (m ²)	0	0	0

RESULTS			
	Exp	Total Min	Max
Total volume of peat removed (m ³) due to windfarm construction	0	0	0
Total area of land lost due to windfarm construction (m ²)	198327	198327	198327

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

Click here

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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.

CO₂ 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
CO₂ loss from removed peat			
C Content of dry peat (% by weight)	53.23	19.57	64.28
Dry soil bulk density (g cm ⁻³)	0.13	0.07	0.29
% 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	0	0	0
CO ₂ loss from removed peat (t CO ₂)	0	0	0

Assumption: If peat is not restored, 100% of the carbon contained in the removed peat is lost as CO₂

CO₂ loss from undrained peat left in situ			
Total area of land lost due to windfarm construction (ha)	20	20	20
CO ₂ loss from undrained peat left in situ (t CO ₂ ha ⁻¹)	840	887	464
CO ₂ loss from undrained peat left in situ (t CO ₂)	16654	17582	9203

CO₂ loss attributable to peat removal only			
CO ₂ loss from removed peat (t CO ₂)	0	0	0
CO ₂ loss from undrained peat left in situ (t CO ₂)	16654	17582	9203
RESULTS			
CO₂ loss attributable to peat removal only (t CO₂)	-16654	-17582	-9203

Click here to move to 5. Loss of soil CO₂

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CO₂ 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)	15	15	15

Peat affected by drainage around borrow pits	Exp	Total Min	Max
Number of borrow pits	5	5	5
Average length of pits (m)	125	125	125
Average width of pits (m)	107	107	107
Average depth of peat removed from pit (m)	0.0	0.0	0.0
Area affected by drainage per borrow pit (m ²)	7878	7878	7878
Total area affected by drainage around borrowpits (m ²)	39390	39390	39390
Total volume affected by drainage around borrowpits (m ³)	0	0	0

[illegible]

Total area affected by drainage of foundation and hardstanding area (m ²)	133860	133860	133860	133860	133860	133860	0	0	0	0	0	0	0	0	0	0	0	0
Total volume affected by drainage of foundation and hardstanding area (m ³)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Peat affected by drainage of access tracks	Exp	Total Min	Max
<u>Floating roads</u>			
Length of floating road that is drained (m)	0	0	0
Floating road width (m)	0.0	0.0	0.0
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	0
Volume affected by drainage of floating roads (m ³)	0	0	0
<u>Excavated Road</u>			
Length of access track that is excavated road (m)	13500	13500	13500
Excavated road width (m)	5	5	5
Average depth of peat excavated for road (m)	0.0	0.0	0.0
Area affected by drainage of excavated roads (m ²)	405000	405000	405000
Volume affected by drainage of excavated roads (m ³)	0	0	0
<u>Rock-filled roads</u>			
Length of rock filled road that is drained (m)	0	0	0
Rock filled road width (m)	0	0	0
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 ³)	0	0	0
Total area affected by drainage of access track (m ²)	405000	405000	405000
Total volume affected by drainage of access track (m ³)	0	0	0

Peat affected by drainage of cable trenches	Exp	Total 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)	0	0	0
Average depth of peat cut for cable trenches (m)	0.0	0.0	0.0
Total area affected by drainage of cable trenches (m ²)	0	0	0
Total volume affected by drainage of cable trenches (m ³)	0.00	0.00	0.00

Drainage around additional peat excavated	Exp	Total Min	Max
Volume of additional peat excavated (m ³)	0.0	0.0	0.0
Area of additional peat excavated (m ²)	0.0	0.0	0.0
Average depth of excavated peat (m)	0	0	0
Radius of area excavated (m)	0	0	0
Radius of excavated and drained area (m)	0	0	0
Total area affected by drainage (m ²)	0	0	0
Total volume affected by drainage (m ³)	0.00	0.00	0.00

Assumption: Area excavated is assumed to be a circle

RESULTS	Exp	Total Min	Max
Total area affected by drainage due to windfarm (m²)	578250	578250	578250
Total volume affected by drainage due to windfarm (m³)	0	0	0

Click here to move to 5d. CO2 loss from drained peat [Click here](#)

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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.

CO₂ loss due to drainage

Note: 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).

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	Expected	Minimum	Maximum
Drained Land			
Total area affected by drainage due to wind farm construction (ha)	58	58	58
Will the hydrology of the site be restored on decommissioning?	No	No	No
Will the habitat of the site be restored on decommissioning?	No	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)	0	0	0
	C Content of dry peat (% by weight)	53	20	64
	Dry soil bulk density (g cm ⁻³)	0.13	0.07	0.29
	Total GHG emissions from Drained Land (t CO₂ equiv.)	0	0	0
	Total GHG Emissions from Undrained Land (t CO₂ equiv.)	0	0	0

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)	35	35	35
	Time required for regeneration of bog plants after restoration (years)	10	5	15
	Methane Emissions from Drained Land			
Check	Rate of methane emission in drained soil ((t CH ₄ -C) ha ⁻¹ yr ⁻¹)	0.000	-0.017	0.163
	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.)	-27	-1174	14411
	Carbon Dioxide Emissions from Drained Land			
Check	Rate of carbon dioxide emission in drained soil (t CO ₂ ha ⁻¹ yr ⁻¹)	18.67	22.67	4.30
	CO ₂ emissions from drained land (t CO ₂)	48583	52437	12423
	Total GHG emissions from Drained Land (t CO₂ equiv.)	48556	51263	26834

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

Note: Conversion = (23 x 16/12) = 30.67 CO₂ equiv. (CH₄-C)⁻¹

2. Losses if Land is Undrained

	Flooded period (days year ⁻¹)	178	178	178
	Lifetime of windfarm (years)	35	35	35
	Time required for regeneration of bog plants after restoration (years)	10	5	15
	Methane Emissions from Undrained Land			
Check	Rate of methane emission in undrained soil ((t CH ₄ -C) ha ⁻¹ yr ⁻¹)	0.00	-0.02	0.16
	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.)	-27	-1174	14411
	Carbon Dioxide Emissions from Undrained Land			
Check	Rate of carbon dioxide emission in undrained soil (t CO ₂ ha ⁻¹ yr ⁻¹)	18.67	22.67	4.30

Note: Conversion = (23 x 16/12) = 30.67 CO₂ equiv. (CH₄-C)⁻¹

CO ₂ emissions from undrained land (t CO ₂)	48583	52437	12423
Total GHG Emissions from Undrained Land (t CO₂ equiv.)	48556	51263	26834

3. CO₂ Losses due to Drainage

Total GHG emissions from drained land (t CO ₂ equiv.)	0	0	0
Total GHG emissions from undrained land (t CO ₂ equiv.)	0	0	0
RESULTS			
Total GHG emissions due to drainage (t CO₂ equiv.)	0	0	0

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CO₂ loss due to drainage

Note: 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).

Emission rates from soils

Note: 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).

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

Calculations following IPCC default methodology
Emission characteristics of acid bogs (IPCC, 1997)

	Expected	Minimum	Maximum
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)	58	58	58
Total volume affected by drainage due to wind farm construction (m ³)	0	0	0

Soil Characteristics that Determine Emission Rates

Average annual air temperature at the site (°C)	10	5.7	15.2
Average water table depth at site (m)	0.50	1.00	0.10
Average water table depth of drained land (m)	0.50	1.00	0.10

Annual Emission Rates following site specific methodology

Acid bogs

Rate of carbon dioxide emission in drained soil (t CO ₂ ha ⁻¹ yr ⁻¹)	18.67	22.67	4.30
Rate of carbon dioxide emission in undrained soil (t CO ₂ ha ⁻¹ yr ⁻¹)	18.67	22.67	4.30
Rate of methane emission in drained soil ((t CH ₄ -C) ha ⁻¹ yr ⁻¹)	0.000	-0.017	0.163
Rate of methane emission in undrained soil ((t CH ₄ -C) ha ⁻¹ yr ⁻¹)	0.00	-0.02	0.16

Fens

Rate of carbon dioxide emission in drained soil (t CO ₂ ha ⁻¹ yr ⁻¹)	55.58	62.50	10.69
Rate of carbon dioxide emission in undrained soil (t CO ₂ ha ⁻¹ yr ⁻¹)	55.58	62.50	10.69
Rate of methane emission in drained soil ((t CH ₄ -C) ha ⁻¹ yr ⁻¹)	0.001	-0.006	0.214
Rate of methane emission in undrained soil ((t CH ₄ -C) ha ⁻¹ yr ⁻¹)	0.00	-0.01	0.21

Selected emission characteristics following site specific methodology

Rate of carbon dioxide emission in drained soil (t CO ₂ ha ⁻¹ yr ⁻¹)	18.67	22.67	4.30
Rate of carbon dioxide emission in undrained soil (t CO ₂ ha ⁻¹ yr ⁻¹)	18.67	22.67	4.30
Rate of methane emission in drained soil ((t CH ₄ -C) ha ⁻¹ yr ⁻¹)	0.000	-0.017	0.163
Rate of methane emission in undrained soil ((t CH ₄ -C) ha ⁻¹ yr ⁻¹)	0.00	-0.02	0.16

RESULTS

Selected Emission Rates

Rate of carbon dioxide emission in drained soil (t CO ₂ ha ⁻¹ yr ⁻¹)	18.67	22.67	4.30
Rate of carbon dioxide emission in undrained soil (t CO ₂ ha ⁻¹ yr ⁻¹)	18.67	22.67	4.30
Rate of methane emission in drained soil ((t CH ₄ -C) ha ⁻¹ yr ⁻¹)	0.000	-0.017	0.163
Rate of methane emission in undrained soil ((t CH ₄ -C) ha ⁻¹ yr ⁻¹)	0.00	-0.02	0.16

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

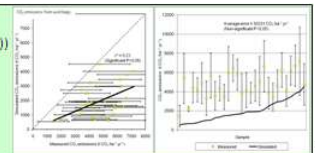
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Assumption: The period of flooding is taken to be 178 days yr⁻¹ for acid bogs and 169 days yr⁻¹ based on the monthly mean temperature and the lengths of inundation (IPCC, 1997, Revised 1996 IPCC guidelines for national greenhouse gas inventories, Vol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

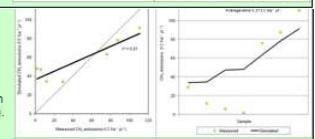
Assumption: The CH₄ emission rate provided for acid bogs is 11 (1-38) mg CH₄-C m⁻² day⁻¹ x 365 days; and for fens is 60 (21-162) mg CH₄-C m⁻² day⁻¹ x 365 days (Asefmann & Crutzen, 1989, J.Atmos.Chem. 8, 307-358)

Assumption: CO₂ emissions on drainage of organic soils for upland crops (e.g. grain, vegetables) are 3.667x9.6 (7.9-11.3) t CO₂ ha⁻¹ yr⁻¹ in temperate climates (Armentano and Menges, 1986, J. Ecol. 74, 755-774).

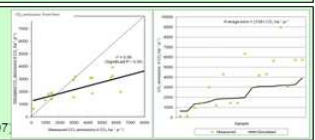
Note: Carbon dioxide emissions from acid bogs. Equation derived by regression analysis against 60 measurements (Nayak et al, 2009). The equation derived was
 $R_{CO_2} = (3.667/1000) \times ((6700 \times \exp(-0.26 \times \exp(-0.0515 \times ((W \times 100) - 50)))) + ((72.54 \times T) - 800))$
 where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



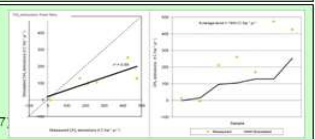
measurements (Nayak et al, 2009). The equation derived was
 $R_{CH_4} = (1/1000) \times (500 \times \exp(-0.1234 \times (W \times 100))) + ((3.529 \times T) - 36.67)$
 where R_{CH_4} is the annual rate of CH₄ emissions (t CH₄-C (ha)⁻¹ yr⁻¹),
 T = average annual air temperature (°C) and
 W is the water 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 CH₄-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
 $R_{CO_2} = (3.667/1000) \times (16244 \times \exp(-0.175 \times \exp(-0.073 \times ((W \times 100) - 50)))) + (153.23 \times T)$
 where R_{CO_2} is the annual rate of CO₂ emissions (t CO₂ (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 ($r^2 = 0.42$, $P > 0.05$).
 Evaluation against 18 independent experiments shows a significant association ($r^2 = 0.66$; $P > 0.05$) and an average error of 2108 t CO₂ 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 35 measurements (Nayak et al, 2009). The equation derived was
 $R_{CH_4} = (1/1000) \times (-10 + 653.62 \times \exp(-0.097 \times (W \times 100))) + (0.862 \times T)$
 where R_{CH_4} is the annual rate of CH₄ emissions (t CH₄-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 CH₄-C ha⁻¹ yr⁻¹ (significance not defined due to lack of replicates - Smith et al, 1997).



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Emission rates from soils

Note: 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).

Emissions due to loss of DOC and POC

Note: 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 (Birmie 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	0	0	0
Felled Forestry	0	0	0
Borrow Pits	0	0	0
Foundations & Hardstanding	0	0	0
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)	0	0	0
Total C loss as DOC (t C)	0	0	0
Total C loss as POC (t C)	0	0	0
RESULTS			
Total CO₂ loss due to DOC leaching (t CO₂)	0	0	0
Total CO₂ loss due to POC leaching (t CO₂)	0	0	0
Total CO₂ loss due to DOC & POC leaching (t CO₂)	0	0	0
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

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/KM²/yr) and not on flux at catchment outlet (i.e. 10.3 - 21.8 MgC/KM²/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 CO₂

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/KM²/yr) (Worrall et al, 2009).

Assumption: In the long term, 100% of leached POC is assumed to be lost as CO₂

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Emissions due to loss of DOC and POC

Note: 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 (Birmie et al, 1991)

Emissions due to forest felling - calculation using simple management data

Note: 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.

	Expected	Minimum	Maximum
Emissions due to forestry felling			
Area of forestry plantation to be felled (ha)	69.27	69.27	69.27
Carbon sequestered ($\text{tC ha}^{-1} \text{ yr}^{-1}$)	3.5	3.45	3.55
Lifetime of windfarm (years)	35	35	35
Carbon sequestered over the lifetime of the windfarm (t C ha^{-1})	122.5	120.75	124.25
RESULTS			
Total carbon loss due to felling of forestry (t CO_2)	31117	30672	31561
Additional CO_2 payback time of windfarm due to management of forestry			
...coal-fired electricity generation (months)	91	95	81
...grid-mix of electricity generation (months)	475	491	421
...fossil fuel - mix of electricity generation (months)	188	194	167

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Emissions due to forest felling - calculation using simple management data

Note: 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.

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Forestry Area 2		Forestry Area 3			Forestry Area 4			Forestry Area 5		
Min	Max	Exp	Min	Max	Exp	Min	Max	Exp	Min	Max
0	0	0	0	0	0	0	0	0	0	0
6	7.2	6.3	6	7.2	6.3	6	7.2	6.3	6	7.2
0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0
0.919	0.919	0.919	0.919	0.919	0.919	0.919	0.919	0.919	0.919	0.919
0.177	0.177	0.177	0.177	0.177	0.177	0.177	0.177	0.177	0.177	0.177
0.448	0.448	0.448	0.448	0.448	0.448	0.448	0.448	0.448	0.448	0.448

Forestry Area 2		Forestry Area 3			Forestry Area 4			Forestry Area 5		
Min	Max	Exp	Min	Max	Exp	Min	Max	Exp	Min	Max
0	0	0	0	0	0	0	0	0	0	0
52560	63072	55188	52560	63072	55188	52560	63072	55188	52560	63072
Partial power curves for different turbines	Partial power curves for different turbines	Partial power curves for different turbines	Partial power curves for different turbines	Partial power curves for different turbines	Partial power curves for different turbines	Partial power curves for different turbines	Partial power curves for different turbines	Partial power curves for different turbines	Partial power curves for different turbines	Partial power curves for different turbines
0	0	0	0	0	0	0	0	0	0	0
Min	Max	Exp	Min	Max	Exp	Min	Max	Exp	Min	Max
Min	Max	Exp	Min	Max	Exp	Min	Max	Exp	Min	Max

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Forestry Area 2		Forestry Area 3			Forestry Area 4			Forestry Area 5		
0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0

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Gains due to site improvement

Note: 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).

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

Reduction in GHG emissions due to improvement of site	Expected result				Minimum result				Maximum result			
	Degraded Bog	Felled Forestry	Borrow Pits	Foundations & Hardstanding	Degraded Bog	Felled Forestry	Borrow Pits	Foundations & Hardstanding	Degraded Bog	Felled Forestry	Borrow Pits	Foundations & Hardstanding
1. Description of site												
Period of time when effectiveness of the improvement can be guaranteed (years)	25	25	25	35	25	25	25	35	25	25	25	35
Area to be improved (ha)	0	0	0	0	0	0	0	0	0	0	0	0
Average air temperature at site (°C)	10	10	10	10	5.7	5.7	5.7	5.7	15.2	15.2	15.2	15.2
Depth of peat drained (m)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Depth of peat above water table before improvement (m)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Depth of peat above water table after improvement (m)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2. Losses with improvement												
Flooded period (days year ⁻¹)	178	178	178	178	178	178	178	178	178	178	178	178
Time required for hydrology and habitat to return to its previous state on restoration (years)	0	0	0	0	0	0	0	0	0	0	0	0
Improved period (years)	25	25	25	35	25	25	25	35	25	25	25	35
Methane emissions from improved land												
Site specific methane emission from improved soil on acid bogs (t CH ₄ -C ha ⁻¹ yr ⁻¹)	0.499	0.499	0.499	0.499	0.483	0.483	0.483	0.483	0.517	0.517	0.517	0.517
Site specific methane emission from improved soil on fens (t CH ₄ -C ha ⁻¹ yr ⁻¹)	0.560	0.560	0.560	0.560	0.557	0.557	0.557	0.557	0.564	0.564	0.564	0.564
IPCC annual rate of methane emission on acid bogs (t CH ₄ -C ha ⁻¹ yr ⁻¹)	0.040	0.040	0.040	0.040	0.040	0.040	0.040	0.040	0.040	0.040	0.040	0.040
IPCC annual rate of methane emission on fens (t CH ₄ -C ha ⁻¹ yr ⁻¹)	0.219	0.219	0.219	0.219	0.219	0.219	0.219	0.219	0.219	0.219	0.219	0.219
Selected annual rate of methane emission (t CH ₄ -C ha ⁻¹ yr ⁻¹)	0.499	0.499	0.499	0.499	0.483	0.483	0.483	0.483	0.517	0.517	0.517	0.517
CH ₄ emissions from improved land (t CO ₂ equiv.)	0	0	0	0	0	0	0	0	0	0	0	0
Carbon dioxide emissions from improved land												
Site specific CO ₂ emission from improved soil on acid bogs (t CO ₂ ha ⁻¹ yr ⁻¹)	0.53	0.53	0.53	0.53	-0.61	-0.61	-0.61	-0.61	1.91	1.91	1.91	1.91
Site specific CO ₂ emissions from improved soil on fens (t CO ₂ ha ⁻¹ yr ⁻¹)	5.68	5.68	5.68	5.68	3.26	3.26	3.26	3.26	8.60	8.60	8.60	8.60
IPCC annual rate of carbon dioxide emission on acid bogs (t CO ₂ ha ⁻¹ yr ⁻¹)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
IPCC annual rate of carbon dioxide emission on fens (t CO ₂ ha ⁻¹ yr ⁻¹)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Selected annual rate of carbon dioxide emission (t CO ₂ ha ⁻¹ yr ⁻¹)	0.53	0.53	0.53	0.53	-0.61	-0.61	-0.61	-0.61	1.91	1.91	1.91	1.91
CO ₂ emissions from improved land (t CO ₂)	0	0	0	0	0	0	0	0	0	0	0	0
Total GHG emissions from improved land (t CO ₂ equiv.)	0	0	0	0	0	0	0	0	0	0	0	0
3. Losses without improvement												
Flooded period (days year ⁻¹)	0	0	0	0	0	0	0	0	0	0	0	0
Time required for hydrology and habitat to return to its previous state on restoration (years)	0	0	0	0	0	0	0	0	0	0	0	0
Improved period (years)	25	25	25	35	25	25	25	35	25	25	25	35
Methane emissions from unimproved land												
Site specific methane emission from unimproved soil on acid bogs (t CH ₄ -C ha ⁻¹ yr ⁻¹)	0.499	0.499	0.499	0.499	0.483	0.483	0.483	0.483	0.517	0.517	0.517	0.517
Site specific methane emission from unimproved soil on fens (t CH ₄ -C ha ⁻¹ yr ⁻¹)	0.560	0.560	0.560	0.560	0.557	0.557	0.557	0.557	0.564	0.564	0.564	0.564
IPCC annual rate of methane emission on acid bogs (t CH ₄ -C ha ⁻¹ yr ⁻¹)	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
IPCC annual rate of methane emission on fens (t CH ₄ -C ha ⁻¹ yr ⁻¹)	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Selected annual rate of methane emission (t CH ₄ -C ha ⁻¹ yr ⁻¹)	0.499	0.499	0.499	0.499	0.483	0.483	0.483	0.483	0.517	0.517	0.517	0.517
CH ₄ emissions from unimproved land (t CO ₂ equiv.)	0	0	0	0	0	0	0	0	0	0	0	0
Carbon dioxide emissions from unimproved land												
Site specific CO ₂ emission from unimproved soil on acid bogs (t CO ₂ ha ⁻¹ yr ⁻¹)	0.53	0.53	0.53	0.53	-0.61	-0.61	-0.61	-0.61	1.91	1.91	1.91	1.91
Site specific CO ₂ emissions from unimproved soil on fens (t CO ₂ ha ⁻¹ yr ⁻¹)	5.68	5.68	5.68	5.68	3.26	3.26	3.26	3.26	8.60	8.60	8.60	8.60
IPCC annual rate of carbon dioxide emission on acid bogs (t CO ₂ ha ⁻¹ yr ⁻¹)	35.20	35.20	35.20	35.20	35.20	35.20	35.20	35.20	35.20	35.20	35.20	35.20
IPCC annual rate of carbon dioxide emission on fens (t CO ₂ ha ⁻¹ yr ⁻¹)	35.20	35.20	35.20	35.20	35.20	35.20	35.20	35.20	35.20	35.20	35.20	35.20
Selected annual rate of carbon dioxide emission (t CO ₂ ha ⁻¹ yr ⁻¹)	0.53	0.53	0.53	0.53	-0.61	-0.61	-0.61	-0.61	1.91	1.91	1.91	1.91
CO ₂ emissions from unimproved land (t CO ₂)	0	0	0	0	0	0	0	0	0	0	0	0
Total GHG emissions from unimproved land (t CO ₂ equiv.)	0	0	0	0	0	0	0	0	0	0	0	0
RESULTS												
4. Reduction in GHG emissions due to improvement of site												
Total GHG emissions from improved land (t CO ₂ equiv.)	0	0	0	0	0	0	0	0	0	0	0	0
Total GHG emissions from unimproved land (t CO ₂ equiv.)	0	0	0	0	0	0	0	0	0	0	0	0
Reduction in GHG emissions due to improvement (t CO ₂ equiv.)	0	0	0	0	0	0	0	0	0	0	0	0
Additional CO ₂ payback time of windfarm due to site improvement												
...coal-fired electricity generation (months)	0	0	0	0	0	0	0	0	0	0	0	0
...grid-mix of electricity generation (months)	0	0	0	0	0	0	0	0	0	0	0	0
...fossil fuel - mix of electricity generation (months)	0	0	0	0	0	0	0	0	0	0	0	0

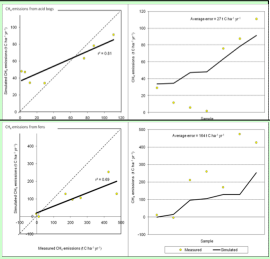
Click here to move to Payback Time [Click here](#)

Gains due to site improvement

Note: 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).

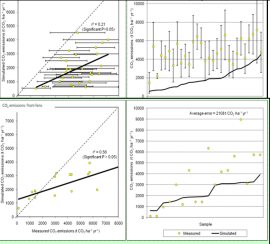
Note: Methane emissions from acid bogs. Equation derived by regression analysis against 57 measurements (Nayak et al. 2009). The equation derived was $R_{CH_4} = (1/1000) \times (500 \times \exp(-0.1234 \times (W \times 100))) + ((3.529 \times T) - 36.67)$ where R_{CH_4} is the annual rate of CH₄ emissions (t CH₄-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 CH₄-C 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 35 measurements (Nayak et al. 2008). The equation derived was $R_{CH_4} = (1/1000) \times (-10+563.62 \times \exp(-0.097 \times (W \times 100)))+(0.662 \times T)$ where R_{CH_4} is the annual rate of CH₄ emissions (t CH₄-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 CH₄-C ha⁻¹ yr⁻¹ (significance not defined due to lack of replicate-Smith et al. 1997).



$R_{CO_2} = (3.667/1000) \times ((6700 \times \exp(-0.26 \times \exp(-0.0515 \times ((W \times 100) - 50)))) + ((72.54 \times T) - 800))$ where R_{CO_2} is the annual rate of CO₂ emissions (t CO₂ (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 CO₂ ha⁻¹ yr⁻¹ which is non-significant ($P < 0.05$) (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 $R_{CO_2} = (3.667/1000) \times (16244 \times \exp(-0.175 \times \exp(-0.073 \times ((W \times 100) - 50)))) + (153.23 \times T)$ where R_{CO_2} is the annual rate of CO₂ emissions (t CO₂ (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 CO₂ ha⁻¹ yr⁻¹ (significance not defined due to lack of replicates-Smith et al. 1997).



Note: Methane emissions from acid bogs. As above
Note: Methane emissions from fens. As above

Note: CO₂ emissions from acid bogs. As above
Note: CO₂ emissions from fens. As above

Results

PAYBACK TIME AND CO₂ EMISSIONS

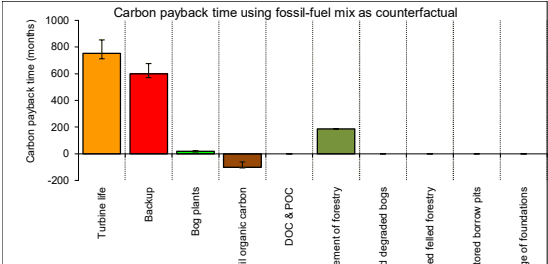
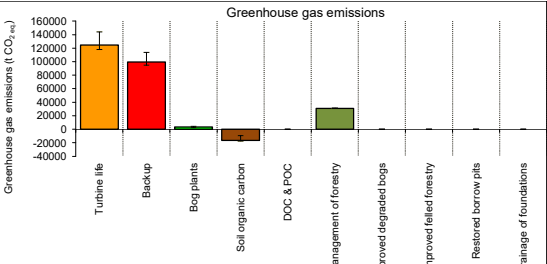
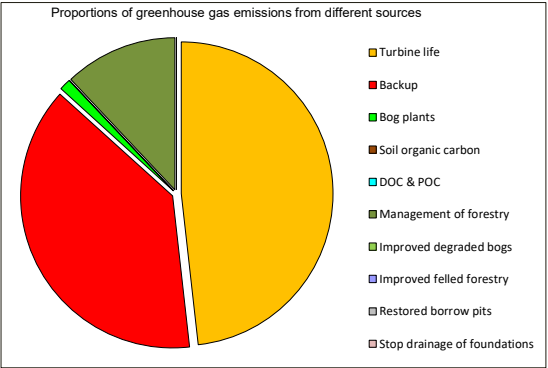
Note: The carbon payback time of the windfarm is calculated by comparing the loss of C from the site due to windfarm development with the carbon-savings achieved by the windfarm while displacing electricity generated from coal-fired capacity or grid-mix.

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	Exp.	Min.	Max.
1. Windfarm CO ₂ emission saving over...			
...coal-fired electricity generation (tCO ₂ yr ⁻¹)	4083	3888	4666
...grid-mix of electricity generation (tCO ₂ yr ⁻¹)	786	749	899
...fossil fuel - mix of electricity generation (tCO ₂ yr ⁻¹)	1990	1896	2275
Energy output from windfarm over lifetime (MWh)	155492	148088	177705
Total CO ₂ losses due to wind farm (t CO ₂ eq.)			
2. Losses due to turbine life (eg. manufacture, construction, decommissioning)	124634	118187	143975
3. Losses due to backup	99515	94776	113731
4. Losses due to reduced carbon fixing potential	3204	2278	4272
5. Losses from soil organic matter	-16654	-17582	-9203
6. Losses due to DOC & POC leaching	0	0	0
7. Losses due to felling forestry	31117	30672	31561
Total losses of carbon dioxide	241815	228331	284335
8. Total CO ₂ losses due to improvement of site (t CO ₂ eq.)			
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 CO ₂ eq.)			
	241815	228331	284335
Carbon Payback Time			
...coal-fired electricity generation (years)	59.2	48.9	73.1
...grid-mix of electricity generation (years)	307.5	254.1	379.7
...fossil fuel - mix of electricity generation (years)	121.5	100.4	150.0
Ratio of soil carbon loss to gain by restoration (TARGET ratio (Natural Resources Wales) < 1.0)	#DIV/0!	#DIV/0!	#DIV/0!
	No gains!	No gains!	No gains!
Ratio of CO ₂ eq. emissions to power generation (g / kWh) (TARGET ratio by 2030 (electricity generation) < 50 g /kWh)	1555	1285	1920



Data used in barchart of carbon payback time using fossil-fuel mix as counterfactual

Greenhouse gas emissions	Exp.	Min.	Max.
Turbine life	124634	6447	19341
Backup	99515	4739	14216
Bog plants	3204	926	1068
Soil organic carbon	0	928	7450
DOC & POC	0	0	0
Management of forestry	31117	445	445
Improved degraded bogs	0	0	0
Improved felled forestry	0	0	0
Restored borrow pits	0	0	0
Stop drainage of foundations	0	0	0

Data used in barchart of carbon payback time using fossil-fuel mix as counterfactual

Greenhouse gas emissions				Carbon payback time (months)		
	Exp.	Min.	Max.	Exp.	Min.	Max.
Turbine life	124634	6447	19341	751	41	102
Backup	99515	4739	14216	600	30	75
Bog plants	3204	926	1068	19	6	6
Soil organic carbon	-16654	928	7450	-100	6	39
DOC & POC	0	0	0	0	0	0
Management of forestry	31117	445	445	188	3	2
Improved degraded bogs	0	0	0	0	0	0
Improved felled forestry	0	0	0	0	0	0
Restored borrow pits	0	0	0	0	0	0
Stop drainage of foundations	0	0	0	0	0	0
	241815			1458		

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Results

PAYBACK TIME AND CO₂ EMISSIONS

Note: The carbon payback time of the windfarm is calculated by comparing the loss of C from the site due to windfarm development with the carbon-savings achieved by the windfarm while displacing electricity generated from coal-fired capacity or grid-mix.

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List of Assumptions

Embodied Carbon Assumptions			Traffic Assumptions			Carbon Fixing Vegetation Assumptions		
Item	Description	Assumption	Item	Description	Assumption	Item	Description	Assumption
Volume of Concrete Mixer	Calculation completed based on the average concrete mixer holding 8m3 of concrete	8	Import (P) Distance	For modelling purposes, the average distance from Port of Cork, Co. Cork (Ringaskiddy) and Port of Waterford, Co. Kilkenny for transport of all other materials for the site	71	Calculation of Carbon Storage Potential in Enhancement Measures	The carbon storage capacity of restored habitats will vary over time as vegetation matures and land use and the baseline environment change. Therefore, while it can be assumed that native woodland replanting on the site will result in an increased capacity of carbon storage due to the carbon storage potential that exists within these habitats, to ensure the assessment below is identified under a theoretical precautionary scenario the quantification of these potential carbon savings (via an increase in carbon storage potential) associated with these measures has not been included in the carbon savings assessment. Please note, the carbon sequestration potential associated with the replanting of native woodland will be able to be determined in the future via the Teagasc Forest Carbon Tool; currently this is not able to be completed due to Teagasc carrying out further analysis and validation on current data and the sequestration potential not being available in the public domain.	Not considered in assessment or quantified
Volume of Average Artic Truck	Calculation completed based on the average artic truck having a carrying capacity of 20 tonnes	20	Quarry (Q) Distance	Distances from key quarries (Kereen Quarry & Roadstone Cappagh) and towns (Dungarvan & Youghal) for the Deliveries of Stone and Read-Mix Concrete from Quarries to the Proposed	15.325	Calculation of Carbon Loss from removal of carbon fixing vegetation	Carbon losses associated with the removal of other carbon-fixing vegetation will result in additional carbon losses. These have not been quantified as the lack of consistent national level field data and methodologies limits the ability to make	Not considered in assessment or quantified
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 - All emission factor as provided in the TII Carbon Tool. Source: 2024 DEZNZ emission factors - 'Delivery vehicles' tab, All Rigid HGVs and used Average laden weight. 2024 DEZNZ emission factors - 'WTT' - delivery vehs & freight' tab, all Rigid HGVs and used Average laden weight.	1.03			
Grid connection cable laying	Embodied carbon of electrical equipment not included as an option in TII Carbon Tool	-	Large Artic Emission Factor	Calculated from an HGV - All - Average emission factor as provided in the TII Carbon Tool. Source: 2024 DEZNZ emission factors - 'Delivery vehicles' tab, All artic HGVs and used Average laden weight. 2024 DEZNZ emission factors - 'WTT' - delivery vehs & freight' tab, all artic HGVs and used Average laden weight.	1.08			
Tree Felling	Embodied carbon of tree felling is included in the Macauley Institute Carbon Calculator for Wind Farms on Peatland	-	Truck Emissions Factor	Calculated from an HGV - Articulated - Average emission factor as provided in the TII Carbon Tool. Source: 2024 DEZNZ emission factors - 'Delivery vehicles' tab, All artic HGVs and used Average laden weight. 2024 DEZNZ emission factors - 'WTT' - delivery vehs & freight' tab, all artic HGVs and used Average laden weight.	1.12			
Turbine Lifecycle	Embodied carbon of the overall turbine lifecycle is included in the Macauley Institute Carbon Calculator for Wind Farms on Peatland	-						
Volume of Concrete Material	There will be approximately 27,504m3 of concrete required for the Proposed Project., The TII Carbon Tool require this material to be in kg. The density of concrete to be used at the Proposed Wind Farm is assumed to have average density of approximately 2,243m3/kg. Based on an assumed 27,504m3 of concrete being required (based on 3,438 truckloads of concrete with a 8m3 carrying capacity) this would result in approximately 61,691,472kg being used for the Proposed Project	61691472.00						
Volume of Steel	An assumed 1300 tonnes of steel is required (based on 65 truckloads of steel with a 20 tonne carrying capacity) for the Proposed Project	1300						
Volume of Stone for the Proposed Project	Whilst it is anticipated that the proposed borrow pits will source all the required stone for the Proposed Project, an assumed total of 67,280 tonnes of stone is required (based on 3364 truckloads of stone with a 20 tonne carrying capacity) for the Proposed Project	67280						

	Categorisation	Route	Distance (km)	Use:
Q	Close to Site	Identified Quarry in EIAR for Stone and Ready Mix Concrete, Identified large scale quarry, 2 no. large settlements which material and personnel may travel from	15.325	For transport calculations for all concrete and infill materials
P	Import	For modelling purposes, the average distance from two of the proximate ports/city locations for transport of all other materials for the site	71.2	For transport calculations for all other materials

Feed In Information:	
Route	Distance KM
Ringaskiddy to Site Entrance	78.4
Port of Waterford to Site Entrance	64
Average:	71.2
Kereen Quarry	14.8
Roadstone Cappagh	14
Dungarvan	9.4
Youghal	23.1
Average:	15.325

Ch 15: Material Assets, Table 15-8					Distance Assumptions	TII Embodied Carbon Tool Inputs						TII Transport Inputs		
Construction Task	Vehicle Type	Approximate No. of Loads	TII Embodied Carbon	TII Traffic	Distance (km)	Category	Sub-Category	Material	Quantity	Unit	Embodied tCO2e	Transport Type	Distance (km)	Transport tCO2e
Site Establishment	Low Loader and Dump Truck	200		✓	15.325							HGV- All - Average	3,065.00	3.399
General site deliveries	Low Loader and Dump Truck	300		✓	15.325							HGV- All - Average	4,597.50	5.098
Forestry removal	Articulated Low Loader	600		✓	15.325							HGV- All - Average	10,574.25	11.727
Imported stone	Dump Truck	3364	✓	✓	15.325	Series 2400 - Brickwork, Blockwork and Stonework	Brickwork and Blockwork	General Stone	67,280.00	tonnes	5315	HGV - Rigid - Average	51,553.30	53.979
Reinforcement	Low Loader	65	✓	✓	71.2	Other	Structural Steelwork	Anchorage and holding down bolt assemblies	1,300.00	tonnes	2331	HGV - Articulated - Average	4,628.00	5.335
Concrete	Concrete Wagon	3438	✓	✓	15.325	Series 1700 Structural Concrete	In Situ Concrete - General	In Situ Concrete , General	61691472.00	kg	30626.477	HGV - Rigid - Average	52,687.35	55.166
Cabling and sand	Low Loader	700		✓	15.325							HGV- All - Average	10,727.50	11.896
Geotextile separators	Low Loader	45		✓	15.325							HGV- All - Average	689.63	0.765
HV electrical items	Dump Truck	75		✓	15.325							HGV- All - Average	1,149.38	1.275
Sub-stations	Various	200		✓	15.325							HGV- All - Average	3,065.00	3.399
Cranes and related lifting equipment	Crane Vehicle	80		✓	71.2							HGV- All - Average	5,696.00	6.317
Turbine components	Abnormal Loads	250		✓	71.2							HGV - Articulated - Average	17,800.00	20.518
Proposed 110kV Grid Connection Cable	Various	1254		✓	71.2							HGV- All - Average	89,284.80	99.014
Site reinstatement and restoration	Various	150		✓	15.325							HGV- All - Average	2,298.75	2.549
Total											38272.477	280.44		