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APPENDIX 11-1

CARBON CALCULATIONS

Payback Time

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

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1. Windfarm CO2 emission saving over...	Exp.	Min.	Max.
...coal-fired electricity generation (t CO2 / yr)	1,262	1,205	1,320
...grid-mix of electricity generation (t CO2 / yr)	276	264	289
...fossil fuel-mix of electricity generation (t CO2 / yr)	566	541	592
Energy output from windfarm over lifetime (MWh)	46,744	38,264	55,875

Total CO2 losses due to wind farm (tCO2 eq.)	Exp.	Min.	Max.
2. Losses due to turbine life (eg. manufacture, construction, decomissioning)	39,894	39,240	40,548
3. Losses due to backup	30,030	25,350	34,840
4. Lossess due to reduced carbon fixing potential	645	289	1,234
5. Losses from soil organic matter	2,410	2,196	5,753
6. Losses due to DOC & POC leaching	0	0	0
7. Losses due to felling forestry	8,778	7,277	10,365
Total losses of carbon dioxide	81,757	74,351	92,740

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.)	81,757	74,351	92,740
Carbon Payback Time			
...coal-fired electricity generation (years)	64.8	56.3	76.9
...grid-mix of electricity generation (years)	295.7	257.1	351.3
...fossil fuel-mix of electricity generation (years)	144.4	125.5	171.5
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)	1749.04	1330.67	2423.70

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Carbon Calculator v1.8.1
Seskin Wind Farm Location: 52.762904 -7.057325
EDF Renewables Ireland

Core input data

Input data	Expected value	Minimum value	Maximum value	Source of data
Windfarm characteristics				
Dimensions				
No. of turbines	7	7	7	Ch 4 Description
Duration of consent (years)	35	30	40	Ch 4 Description
Performance				
Power rating of 1 turbine (MW)	6.6	6.5	6.7	Ch 4 Description
Capacity factor	0.33	0.32	0.34	Enduring Connection Policy 2.3 Constraints Report for Solar and Wind - Area H2
Backup				
Fraction of output to backup (%)	5	5	5	SNH Carbon Calculator Guidance
Additional emissions due to reduced thermal efficiency of the reserve generation (%)	10	10	10	Fixed
Total CO2 emission from turbine life (tCO2 MW^{-1}) (eg. manufacture, construction, decommissioning)	Calculate wrt installed capacity	Calculate wrt installed capacity	Calculate wrt installed capacity	
Characteristics of peatland before windfarm development				
Type of peatland	Acid bog	Acid bog	Acid bog	N/A
Average annual air temperature at site (°C)	9.9	4.9	15	Ch 11 Climate
Average depth of peat at site (m)	0.23	0.22	0.24	Peat and Spoil 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	0.13	0.134	Default Value Used
Characteristics of bog plants				
Time required for regeneration of bog plants after restoration (years)	10	5	15	Best Practice in Raised Bog Restoration Ireland
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 Default Value
Forestry Plantation Characteristics				
Area of forestry plantation to be felled (ha)	19	18.9	19.1	Ch 4 Description
Average rate of carbon sequestration in timber (tC ha^{-1} yr^{-1})	3.6	3.5	3.7	SNH Guidance Default Value
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	0	0	0	N/A
Average length of pits (m)	0	0	0	N/A
Average width of pits (m)	0	0	0	N/A
Average depth of peat removed from pit (m)	0	0	0	N/A

1. CO2 emission saving

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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 (%)	0.3	0.3	0.3

	Exp.	Min.	Max.
Annual energy output from windfarm (MW/yr)			
RESULTS			
Emissions saving over coal-fired electricity generatio...	1,262	1,205	1,320
Emissions saving over grid-mix of electricity generati...	276	264	289
Emissions saving over fossil fuel - mix of electricity g...	566	541	592

2. CO2 loss turbine life

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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)	5699	5606	5793
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)	39894	39240	40548
Additional CO2 payback time of windfarm due to turbine life			
...coal-fired electricity generation (months)	379	391	369
...grid-mix of electricity generation (months)	1732	1784	1683
...fossil fuel - mix of electricity generation (months)	845	871	822

3. CO2 loss backup

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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)	20,236	19,929	20,542
Annual emissions due to backup from fossil fuel-mix of electricity generation (tCO2/yr)	858	845	871
RESULTS			
Total emissions due to backup from fossil fuel-mix of electricity generation (tCO2)	30,030	25,350	34,840

4. Loss CO2 fixing pot.

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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)	15.64	11.24	20.39
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)	645	289	1234
Additional CO2 payback time of windfarm due to loss of CO2 fixing potential			
...coal-fired electricity generation (months)	6	3	11
...grid-mix of electricity generation (months)	28	13	51
...fossil fuel - mix of electricity generation (months)	14	6	25

5. Loss of soil CO2 (a, b)

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

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.)	2410.46	2196.11	3668.05
CO2 loss from drained peat (t CO2 equiv.)	0	0	2084.94
RESULTS			
Total CO2 loss from peat (removed + drained) (t CO2 equiv.)	2410.46	2196.11	5752.99
Additional CO2 payback time of windfarm due to loss of soil C...			
...coal-fired electricity generation (months)	22.92	21.86	52.3
...grid-mix of electricity generation (months)	104.63	99.82	238.75
...fossil fuel - mix of electricity generation (months)	51.08	48.73	116.56

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)	5481.69	4962.21	6020.93
CO2 loss from undrained peat left in situ (t CO2)	3071.24	2766.10	2352.87
RESULTS			
CO2 loss atributable to peat removal only (t CO2)	2410.46	2196.11	3668.05

5a. Volume of peat removed

	Exp.	Min.	Max.
Peat removed from borrow pits			
Area of land lost in borrow pits (m2)	0	0	0
Volume of peat removed from borrow pits (m3)	0	0	0
Peat removed from turbine foundations			
Area of land lost in foundation (m2)	4551.75	4551.75	4551.75
Volume of peat removed from foundation area (m3)	5006.93	4551.75	5462.1
Peat removed from hard-standing			
Area of land lost in hard-standing (m2)	8750	8750	8750
Volume of peat removed from hard-standing area (m3)	9625	8750	10500
Peat removed from access tracks			
Area of land lost in floating roads (m2)	0	0	0
Volume of peat removed from floating roads (m3)	0	0	0
Area of land lost in excavated roads (m2)	13500	13000	14000
Volume of peat removed from excavated roads (m3)	4725	4420	5040
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)	13500	13000	14000
Total volume of peat removed due to access tracks (m3)	4725	4420	5040
RESULTS			
Total area of land lost due to windfarm construction (m2)	36651.75	36151.75	37151.75
Total volume of peat removed due to windfarm construction (m3)	21276.93	19641.75	22922.1

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

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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)	0	0	0
Total volume affected by drainage around borrow pits (m3)	0	0	0
Peat affected by drainage around turbine foundation and hardstanding			
Total area affected by drainage of foundation and hardstanding area (m2)	32760	20440	46480
Total volume affected by drainage of foundation and hardstanding area (m3)	18018	10220	27888
Peat affected by drainage of access tracks			
Total area affected by drainage of access track(m2)	81000	52000	112000
Total volume affected by drainage of access track(m3)	14175	8840	20160
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)	5984.19	3832.38	8293.08
Total volume affected by drainage (m3)	1166.46	747.02	1616.52
RESULTS			
Total area affected by drainage due to windfarm (m2)	119744.19	76272.38	166773.08
Total volume affected by drainage due to windfarm (m3)	33359.46	19807.02	49664.52

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.)	8594.58	5003.96	13045.34
Total GHG emissions from Undrained Land (t CO2 equiv.)	8594.58	5003.96	10960.4
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.)	-11.36	-158.62	814.11
CO2 emissions from drained land (t CO2)	10045.33	5994.49	11757.02
Total GHG emissions from Drained Land (t CO2 equiv.)	8594.58	5003.96	13045.34
Losses if Land is Undrained			
CH4 emissions from undrained land (t CO2 equiv.)	-11.36	-158.62	2637.01
CO2 emissions from undrained land (t CO2)	10045.33	5994.49	7924.97
Total GHG emissions from Undrained Land (t CO2 equiv.)	8594.58	5003.96	10960.4
RESULTS			
Total GHG emissions due to drainage (t CO2 equiv.)	0	0	2084.94

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)	11.97	7.63	16.68

6. CO2 loss DOC & POC

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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

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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)	19	18.9	19.1
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)	8778.08	7276.57	10365.03
Additional CO2 payback time of windfarm due to management of forestry			
...coal-fired electricity generation (months)	83.46	72.45	94.22
...grid-mix of electricity generation (months)	381.02	330.73	430.16
...fossil fuel - mix of electricity generation (months)	186.02	161.46	210.01

8. CO2 gain - site improvement

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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)	0.508	-0.822	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)	0.508	-0.822	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

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)	0.508	-0.822	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)	0.508	-0.822	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

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)	0.508	-0.822	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)	0.508	-0.822	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

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)	0.508	-0.822	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)	0.508	-0.822	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

TII Carbon Assessment Tool

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Ch 15: Material Assets, Section 15.1, Table 15-9					Distance Assumptions	TII Embodied Carbon Tool Inputs (https://web.tii.ie/index.html)						TII Transport Inputs (https://web.tii.ie/index.html)		
Material	Total no. Truck Loads	Truck Types	TII Embodied Carbon	TII Traffic	Distance (km)	Category	Sub-Category	Material	Quantity	Unit	Embodied tCO2e	Transport Type	Distance (km)	Transport TCO2e
Concrete (turbine foundations)	560	Concrete mixers	✓	✓	11.1	Series 1700 - Structural Concrete	Concrete - Construction General	Concrete Average	4,480	m3	1,181.62	HGV - Rigid - All	6,216.00	6.2
Concrete (other Proposed Project Infrastructure)	128	Concrete mixers	✓	✓	11.1	Series 1700 - Structural Concrete	Concrete - Construction General	Concrete Average	1,024	m3	270.08	HGV - Rigid - All	1,420.80	1.42
Delivery of plant	27	Large artic		✓	11.1				540			HGV-All-Average	299.70	0.32
Fencing & gates	3	Large artic		✓	11.1				60			HGV-All-Average	33.30	0.04
Compound setup	28	Large artic		✓	11.1				560			HGV-All-Average	310.80	0.33
Steel	19	Large artic	✓	✓	11.1	Series 1800- Structural Steel Work	General	Anchorages and holding down bolt assemblies	380	tonnes	1,022.07	HGV-All-Average	210.90	0.23
Sand / binding	197	Trucks	✓	✓	11.1	Series 800 - Road Pavements - Unbound and Cement Bound Mixtures	Sand	Sand	3,940	tonnes	27.58	HGV - Articulated - All	2,186.70	2.47
Ducting and cabling (internal)	205	Large artic		✓	11.1				4,100			HGV-All-Average	2,275.50	2.44
Tree felling	190	Large artic		✓	11.1				3,800			HGV-All-Average	2,109.00	2.26
Crane (to lift steel)	1	Large artic		✓	135.5				20			HGV-All-Average	135.50	0.17
Stone for wind farm	5,040	Trucks	✓	✓	135.5	Series 2400 - Brickwork, Blockwork and Stonework	Brickwork and Blockwork	General Stone	100,800	tonne	7,963.20	HGV - Articulated - All	682,920.00	771.77
All materials for cable grid connection	2,814	Large artic		✓	11.1				56,280			HGV-All-Average	31,235.40	33.61
Substation and mast	120	Large artic		✓	135.5				2,400			HGV-All-Average	16,260.00	17.45
BESS	100	Large artic		✓	135.5				2,000			HGV-All-Average	13,550.00	14.54
Cranes for turbines	12	Large artic		✓	135.5				240			HGV-All-Average	1,626.00	1.74
Refueling for plant	145	Large artic		✓	11.1				2,900			HGV-All-Average	1,609.50	1.73
Site maintenance	105	Large artic		✓	11.1				2,100			HGV-All-Average	1,165.50	1.25
Miscellaneous	70	Large artic		✓	11.1				1,400			HGV-All-Average	777.00	0.83
Total											10,464.55			858.8

List of Assumptions

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Embodied Carbon Assumptions		
Item	Description	Assumption
Volume of Concrete Mixer	Calculation completed based on the average concrete mixer holding 8m3 of concrete	8
Volume of Average Artic Truck	Calculation completed based on the average artic truck having a carrying capacity of 20 tonnes	20
Ducting and cabling (internal)	Embodied carbon of electrical equipment not included as an option in TII Carbon Tool	-
Grid connection cable laying	Embodied carbon of electrical equipment not included as an option in TII Carbon Tool	-
Tree Felling	Embodied carbon of tree felling is included in the Macauley Institute Carbon Calculator for Wind Farms on Peatland	-
Turbine Lifecycle	Embodied carbon of the overall turbine lifecycle is included in the Macauley Institute Carbon Calculator for Wind Farms on Peatland	-

Traffic Assumptions		
Item	Description	Assumption
Import (P) Distance	For modelling purposes, the average distance from Sthe Port of Waterford, Waterford City and Dublin Port, Dublin City for transport of all other materials for the site	135.5
Quarry (Q) Distance	Identified Quarries in Section 4.4.2. Deliveries of Stone and Ready-Mix Concrete from Quarries in this EIAR	11.1
Concrete Mixer Emission factor	Calculated from an HGV - Rigid - All emission factor as provided in the TII Carbon Tool	0.99784
Large Artic Emission Factor	Calculated from an HGV - All - Average emission factor as provided in the TII Carbon Tool	1.07296
Truck Emissions Factor	Calculated from an HGV - Articulated - Average emission factor as provided in the TII Carbon Tool	1.1301