Scottish Government’s Carbon Calculator - Macauley Institute Model

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

1. Windfarm CO2 emission saving over...	Exp.	Min.	Max.
...coal-fired electricity generation (t CO2 / yr)	6,083	5,778	6,396
...grid-mix of electricity generation (t CO2 / yr)	1,174	1,115	1,234
...fossil fuel-mix of electricity generation (t CO2 / yr)	2,623	2,491	2,757
Energy output from windfarm over lifetime (MWh)	212,474	172,985	255,315

Total CO2 losses due to wind farm (tCO2 eq.)	Exp.	Min.	Max.
2. Losses due to turbine life (eg. manufacture, construction, decomissioning)	174,715	170,604	178,826
3. Losses due to backup	131,127	109,897	153,189
4. Lossess due to reduced carbon fixing potential	3,086	1,351	6,005
5. Losses from soil organic matter	45,910	20,739	114,880
6. Losses due to DOC & POC leaching	0	0	0
7. Losses due to felling forestry	53,592	44,275	63,493
Total losses of carbon dioxide	408,431	346,866	516,394

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.)	408,431	346,866	516,394
Carbon Payback Time			
...coal-fired electricity generation (years)	67.1	54.2	89.4
...grid-mix of electricity generation (years)	347.9	281.0	463.1
...fossil fuel-mix of electricity generation (years)	155.7	125.8	207.3
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)	1922.26	1358.58	2985.18

Payback Time - Charts

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Payback Time - ChartsInput Data
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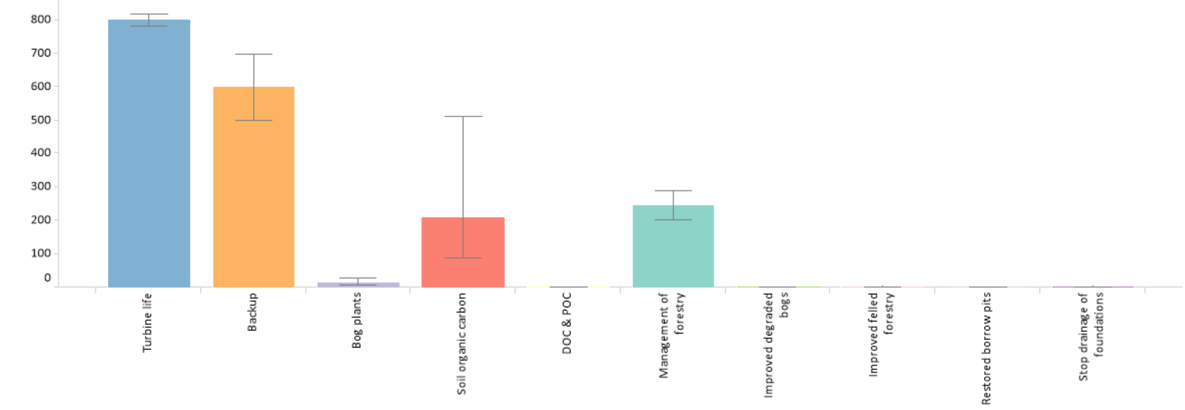
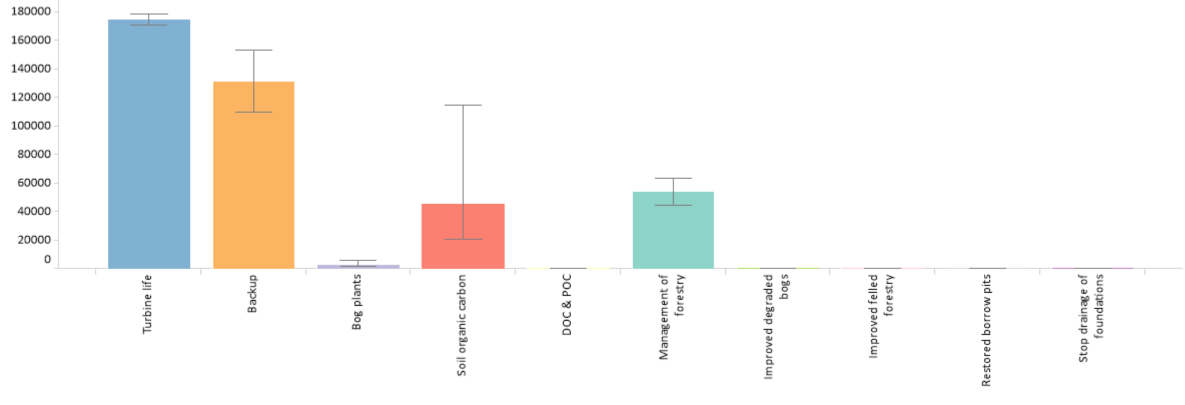
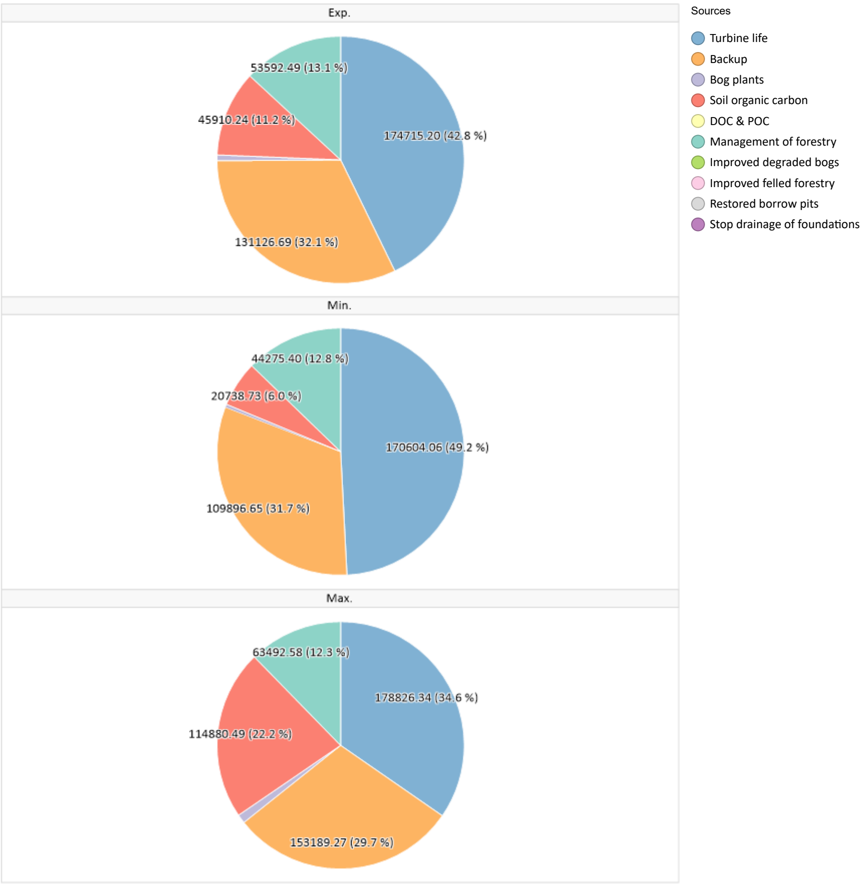
Carbon payback time (months) using fossil-fuel mix as conterfactual



Greenhouse gas emissions (t CO2 eq.)



Proportions of greenhouse gas emissions from different sources



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Carbon Calculator v1.7.0
Glenora Wind Farm   Location: 54.242873 -9.472858
SSE Renewables

Core input data

Input data	**Expected value**	**Minimum value**	**Maximum value**	**Source of data**
Windfarm characteristics				
Dimensions				
No. of turbines	22	22	22	Ch 4 Description
Duration of consent (years)	35	30	40	Ch 4 Description
Performance				
Power rating of 1 turbine (MW)	9	8.8	9.2	Ch 4 Description
Capacity factor	0.35	0.34	0.36	Enduring Connection Policy 2.2 Constraints Report for Solar and Wind Area B
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)	10.4	6.4	14.9	Ch 11 Climate
Average depth of peat at site (m)	1.85	1.8	1.95	Geotechnical & Peat Stability Assessment
C Content of dry peat (% by weight)	55	50	60	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})	0.1	0.09	0.11	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 in 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)	116	115	117	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})	1.002	1.002	1.002	
Grid-mix emission factor (t CO2 MWh^{-1})	0.19338	0.19338	0.19338	
Fossil fuel-mix emission factor (t CO2 MWh^{-1})	0.432	0.432	0.432	
Borrow pits				
Number of borrow pits	3	2	4	Ch 4 Description
Average length of pits (m)	172	170	174	Direct Borrow Pit Measurements
Average width of pits (m)	181	179	183	Direct Borrow Pit Measurements
Average depth of peat removed from pit (m)	1.5	1	2	Peat and Spoil Management Plan

5. Loss of soil CO2 (a, b)

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

5. Loss of soil C02

	Exp.	Min.	Max.
CO2 loss from removed peat (t CO2 equiv.)	45910.24	20738.73	92654.79
CO2 loss from drained peat (t CO2 equiv.)	0	0	22225.7
RESULTS			
Total CO2 loss from peat (removed + drained) (t CO2 equiv.)	45910.24	20738.73	114880....
Additional CO2 payback time of windfarm due to loss of soil C...			
...coal-fired electricity generation (months)	90.57	43.07	215.55
...grid-mix of electricity generation (months)	469.29	223.18	1116.86
...fossil fuel - mix of electricity generation (months)	210.07	99.91	499.95

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)	68811.67	38570.68	118789....
CO2 loss from undrained peat left in situ (t CO2)	22901.43	17831.96	26134.31
RESULTS			
CO2 loss atributable to peat removal only (t CO2)	45910.24	20738.73	92654.79

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

5a. Volume of peat removed

	Exp.	Min.	Max.
Peat removed from borrow pits			
Area of land lost in borrow pits (m2)	93396	60860	127368
Volume of peat removed from borrow pits (m3)	140094	60860	254736
Peat removed from turbine foundations			
Area of land lost in foundation (m2)	16038	14872	17248
Volume of peat removed from foundation area (m3)	29670.3	26769.6	33633.6
Peat removed from hard-standing			
Area of land lost in hard-standing (m2)	42350	33000	52800
Volume of peat removed from hard-standing area (m3)	78347.5	59400	102960
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)	63000	62700	63300
Volume of peat removed from excavated roads (m3)	18900	12540	25320
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)	63000	62700	63300
Total volume of peat removed due to access tracks (m3)	18900	12540	25320
RESULTS			
Total area of land lost due to windfarm construction (m2)	270584	227222	316526
Total volume of peat removed due to windfarm construction (m3)	341211.8	233759.6	490859.6

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

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

5c. Volume of peat drained

	Exp.	Min.	Max.
Total area affected by drainage around borrow pits (m2)	34470	14760	63520
Total volume affected by drainage around borrow pits (m3)	25852.5	7380	63520
Peat affected by drainage around turbine foundation and hardstanding			
Total area affected by drainage of foundation and hardstanding area (m2)	114840	66880	172480
Total volume affected by drainage of foundation and hardstanding area (m3)	106227	60192	168168
Peat affected by drainage of access tracks			
Total area affected by drainage of access track(m2)	315000	209000	422000
Total volume affected by drainage of access track(m3)	47250	20900	84400
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)	13267.54	8687.2	18005.72
Total volume affected by drainage (m3)	17642.5	11548.17	23950.6
RESULTS			
Total area affected by drainage due to windfarm (m2)	477577.54	299327.2	676005.72
Total volume affected by drainage due to windfarm (m3)	196972	100020.17	340038.6

CO_2 loss due to drainage
Note, CO2 losses are calculated using two approaches: IPCC default methodology and more site specific equations derived for this project. The IPCC methodology is included because it is the established approach, although it contains no site detail. The new equations have been derived directly from experimental data for acid bogs and fens (see Nayak et al, 2008 - Final report).

5d. CO2 loss from drained peat

	Exp.	Min.	Max.
Calculations of C Loss from Drained Land if Site is NOT Restored after Decomissioning			
Total GHG emissions from Drained Land (t CO2 equiv.)	39723.05	16503.48	82290.09
Total GHG emissions from Undrained Land (t CO2 equiv.)	39723.05	16503.48	60064.39
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.)	70.99	-452.43	1929.17
CO2 emissions from drained land (t CO2)	40349.76	23943.07	74539.32
Total GHG emissions from Drained Land (t CO2 equiv.)	39723.05	16503.48	82290.09
Losses if Land is Undrained			
CH4 emissions from undrained land (t CO2 equiv.)	70.99	-452.43	9967.05
CO2 emissions from undrained land (t CO2)	40349.76	23943.07	45848.1
Total GHG emissions from Undrained Land (t CO2 equiv.)	39723.05	16503.48	60064.39
RESULTS			
Total GHG emissions due to drainage (t CO2 equiv.)	0	0	22225.7

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)	47.76	29.93	67.6
[illegible]	[illegible]	[illegible]	[illegible]

7. Forestry CO2 loss

CO_2 loss from forests - calculation using detailed management information
Forest carbon calculator (Perks et al, 2009)

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

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

	Exp.	Min.	Max.
Area of forestry plantation to be felled (ha)	116	115	117
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)	53592.49	44275.4	63492.58
Additional CO2 payback time of windfarm due to management of forestry			
...coal-fired electricity generation (months)	105.73	91.96	119.13
...grid-mix of electricity generation (months)	547.82	476.48	617.27
...fossil fuel - mix of electricity generation (months)	245.22	213.29	276.31

8. CO2 gain - site improvement

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

Degraded Bog

	Exp.	Min.	Max.
1. Description of site			
Area to be improved (ha)	0	0	0
Depth of peat above water table before improvement (m)	0	0	0
Depth of peat above water table after improvement (m)	0	0	0
2. Losses with improvement			
Improved period (years)	0	0	0
Selected annual rate of methane emissions (t CH4-C ha-1 yr-1)	0.5	0.486	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)	0.641	-0.423	1.838
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)	0.5	0.486	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)	0.641	-0.423	1.838
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)	0.5	0.486	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)	0.641	-0.423	1.838
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)	0.5	0.486	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)	0.641	-0.423	1.838
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)	1	1	1
Selected annual rate of methane emissions (t CH4-C ha-1 yr-1)	0.5	0.486	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)	0.641	-0.423	1.838
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)	1	1	1
Selected annual rate of methane emissions (t CH4-C ha-1 yr-1)	0.5	0.486	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)	0.641	-0.423	1.838
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)	34.9	29.9	39.9
Selected annual rate of methane emissions (t CH4-C ha-1 yr-1)	0.5	0.486	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)	0.641	-0.423	1.838
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)	34.9	29.9	39.9
Selected annual rate of methane emissions (t CH4-C ha-1 yr-1)	0.5	0.486	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)	0.641	-0.423	1.838
CO2 emissions from unimproved land (t CO2 equiv.)	0	0	0
Total GHG emissions from unimproved land (t CO2 eqiv.)	0	0	0

3. CO2 loss backup

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

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

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

	Exp.	Min.	Max.
Reserve energy (MWh/yr)	86,724	84,797	88,651
Annual emissions due to backup from fossil fuel-mix of electricity generation (tCO2/yr)	3,746	3,663	3,830
RESULTS			
Total emissions due to backup from fossil fuel-mix of electricity generation (tCO2)	131,127	109,897	153,189

1. CO2 emission saving

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

Capacity factor calculated from forestry data

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

Capacity factor - Direct input

	Exp.	Min.	Max.
Capacity factor (%)	0.4	0.3	0.4

	Exp.	Min.	Max.
Annual energy output from windfarm (MW/yr)			
RESULTS			
Emissions saving over coal-fired electricity generatio...	6,083	5,778	6,396
Emissions saving over grid-mix of electricity generati...	1,174	1,115	1,234
Emissions saving over fossil fuel - mix of electricity g...	2,623	2,491	2,757

2. CO2 loss turbine life

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

Calculation of emissions with relation to installed capacity

	Exp.	Min.	Max.
Emissions due to turbine frome energy output (t CO2)	7942	7755	8128
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)	174715	170604	178826
Additional CO2 payback time of windfarm due to turbine life			
...coal-fired electricity generation (months)	345	354	336
...grid-mix of electricity generation (months)	1786	1836	1739
...fossil fuel - mix of electricity generation (months)	799	822	778

4. Loss CO2 fixing pot.

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

	Exp.	Min.	Max.
Area where carbon accumulation by bog plants is lost (ha)	74.82	52.65	99.25
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)	3086	1351	6005
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)	32	15	58
...fossil fuel - mix of electricity generation (months)	14	7	26

6. CO2 loss DOC & POC

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

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

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

TII Carbon Assessment Tool

Ch 15: Material Assets, Section 15.1.4.1.1, Table 15-7					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	1650	Trucks	ü	ü	40	Series 1700 - Structural Concrete	Concrete - Construction General	Concrete Average	12540	m3	3307.47	HGV - Rigid - Average	66206.25	66.06
Concrete blinding and steel	257	Large artic	ü	ü	40	Series 1700 - Structural Concrete	Concrete - Construction General	Concrete Average	3212.5	m3	847.31	HGV- All - Average	10312.125	11.06
Plant / fencing / compound set-up	56	Large artic	ü	ü	40	Series 300 - Fencing and Environmental Noise Barriers	Gate	Steel Single Field Gate 3m Width	2	no units	0.49	HGV- All - Average	2247	2.41
Forestry felling	1181	Large artic		ü	40							HGV- All - Average	47387.625	50.85
Crushed rock and stone	100	Trucks	ü	ü	40	Series 800 - Road Pavements - Unbound and Cement Bound Mixtures	Granular Material Type A	Granular material Type 1 depth 400-500mm	16990.10796	m2	96.57	HGV - Rigid - Average	4012.5	4
Ducting / cabling	691	Large artic		ü	40							HGV- All - Average	27726.375	29.75
Grid cable laying	59	Large artic		ü	40							HGV- All - Average	2367.375	2.54
Cranes	11	Large artic		ü	144							HGV- All - Average	1584	17.04
Substation components	150	Large artic		ü	144							HGV- All - Average	21600	23.18
Refuelling / maintenance / misc. (incl. waste)	51	Large artic		ü	40							HGV- All - Average	2046.375	2.2
Total											4251			209

List of Assumptions

Embodied Carbon Assumptions		
Item	Description	Assumption
Volume of Concrete Mixer	Calculation completed based on the average concrete mixer holding 7.6m3 of concrete	7.6
Volume of Average Artic Truck	Calculation completed based on the average artic truck having a carrying capacity of 30 tonnes	30
Volume Assumption	To determine the volume of crushed rock and stone, the following calculations were completed: -Volume of Crushed Rock and Stone brought to site = 3000 tonnes -3,000 tonnes = 8,495m3 -8,495m3 = 16,990m2	16,990
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 distance from Galway Harbour, Galway City for transport of all turbine infrastructure to site	144
Quarry (Q) Distance	For modelling purposes, the average distance from Ballina, Crossmolina, Bangor Erris, and Belmullet to the site entrance of the Proposed Development for transport of all other materials to site	40
Truck Emission factor	Calculated from an HGV - Rigid - Average 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