Appendix 14A

CAFÉ DIRECTIVE

Limit values of CAFÉ Directive 2008/50/EC

Pollutant	Limit Value Objective	Averaging Period	Limit Value ug/m^3	Basis of Application of the Limit Value
SO_2	Protection of human health	1 hour	350	Not to be exceeded more than 24 times in a calendar year
SO_2	Protection of human health	24 hours	125	Not to be exceeded more than 3 times in a calendar year
SO_2	Protection of vegetation	calendar year	20	Annual mean
SO_2	Protection of vegetation	1 Oct to 31 Mar	20	Winter mean
NO_2	Protection of human health	1 hour	200	Not to be exceeded more than 18 times in a calendar year
NO_2	Protection of human health	calendar year	40	Annual mean
$NO + NO_2$	Protection of ecosystems	calendar year	30	Annual mean
PM_{10}	Protection of human health	24 hours	50	Not to be exceeded more than 35 times in a calendar year
PM_{10}	Protection of human health	calendar year	40	Annual mean
$PM_{2.5}$	Protection of human health	calendar year	25	Annual mean
$PM_{2.5}$	Protection of human health	calendar year	20	Annual mean
Lead	Protection of human health	calendar year	0.5	Annual mean
Carbon Monoxide	Protection of human health	8 hours	10,000	Not to be exceeded
Benzene	Protection of human health	calendar year	5	Annual mean

Appendix 14B

CALCULATED CARBON SAVINGS AND LOSSES

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.

Click here to move to Payback Time Click here
Click here to return to Instructions Click here

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						
No. of turbines	10	Fixed	10		10	
Lifetime of windfarm (years)	35	Fixed	35		35	
Performance						
Power rating of turbines (turbine capacity) (MW)	5.7	Assumed	5.7		5.7	
Capacity factor	Direct input of capacity fa		Direct input of capacity fa		Direct input of capacity fa	
Enter estimated capacity factor (percentage efficiency)	30.0	Long term average capacity factor (IWEA)	30.0		30.0	
Backup						
Extra capacity required for backup (%)	5	Value from SNH guidance	5		5	
Additional emissions due to reduced thermal efficiency of the reserve generation (%)	10	Value from SNH guidance. Over 20% of national electricity is from renewables.	10		10	
Carbon dioxide emissions from turbine life - (eg. manufacture, construction, decommissioning)	Calculate wrt installed ca		Calculate wrt installed ca		Calculate wrt installed ca	
Characteristics of peatland before windfarm development						
Type of peatland	Acid b	Site is heavily modified and drained. Not an undisturbed bog.	Acid b		Acid b	
Average annual air temperature at site (^oC)	9		9		9	
Average depth of peat at site (m)	0.00	Avegage depth of peat during survey. Appendix E1 Peat Stability Risk Assessment.	0.00		0.00	
C Content of dry peat (% by weight)	55	The carbon content of dry peat is assumed to be 55% (the carbon content of dry peat ranges fro 49 to 62% (MLURI et al., 1991 cited by Nayak et al, 2008)	55		55	
Average extent of drainage around drainage features at site (m)	15.00	assumption	15.00		15.00	
Average water table depth at site (m)	0.20	assumption	0.20		0.20	
Dry soil bulk density (g cm^{-3})	0.20	assumption	0.20		0.20	
Characteristics of bog plants						
Time required for regeneration of bog plants after restoration (years)	10	Assumption	10		10	
Carbon accumulation due to C fixation by bog plants in undrained peats (tC ha^{-1} yr^{-1})	0.25	Value from SNH guidance	0.25		0.25	
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)	4.13	Section 2.2 Chapter 2.	4.13		4.13	
Average rate of carbon sequestration in timber (tC ha-1 yr-1)	3.60	Value from SNH guidance	3.60		3.60	
Counterfactual emission factors						
To update counterfactual emission factors from the web Click here (not yet operational)						
Coal-fired plant emission factor (t CO_2 MWh^{-1})						
Grid-mix emission factor (t CO_2 MWh^{-1})	0.375	Energy Related Co2 emissions I Ireland 2005 to 2018. SEAI.	0.375		0.375	
Fossil fuel-mix emission factor (t CO_2 MWh^{-1})						
Borrow pits						
Number of borrow pits	0	No borrow pits. Only peat desosition areas	0		0	
Average length of pits (m)	0		0		0	
Average width of pits (m)	0		0		0	
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		Rectangular with vertical		Rectangular with vertical	
Average length of turbine foundations (m)	0	Section 2.5.3 Chapter 2 Circular hardstand.	0		0	
Average width of turbine foundations (m)	0	Section 2.5.3 Chapter 2. Circular hardstand	0		0	
Average depth of peat removed from turbine foundations (m)	0.00	Average of Table 3-1 Chapter 3	0.00		0.00	
Average length of hard-standing (m)	0	Table 2.2 Chapter 2. Dimensions estimated	0		0	

Note: Capacity factor. The capacity factor of any power plant is the proportion of energy produced during a given period with respect to the energy that would have been produced had the wind farm been running continually and at maximum output (DECC (2004); see also www.bwea.com/ref/capacityfactors.html).
Capacity Factor = Electricity generated during the period [kWh]/ (Installed capacity [kW] x number of hours in the period [h])
We recommend that a site-specific capacity factor ~~site~~ should be used (as measured during planning stage), and should represent the average emission factor expected over the lifetime of the windfarm, accounting for decline in efficiency with age (Hughes, 2012). The 5 year average capacity factor (or "load factor") for UK onshore wind between 2010 and 2014, based on average beginning and end of year capacity, was 29.2% (DUKES, 2015).

Note: Extra capacity required for backup. If 20% of national electricity is generated by wind energy, the extra capacity required for backup is 5% of the rated capacity of the wind plant (Dale et al 2004). We suggest this should be 5% of the actual output. If it is assumed that less than 20% of national electricity is generated by wind energy, a lower percentage should be entered (0%). The House of Lords Economic Affairs Committee report on The Economics of Renewable Energy (Parliamentary Business, 2008) notes that to cover peak demand a '20% margin of extra capacity has been sufficient to keep the risk of a power cut due to insufficient generation at a very low level.' The estimate provided by BERR was a range of 10% to 20% of installed capacity of wind energy. E.ON is reported as proposing that the capacity credit of wind power should be 8%, and The Renewable Energy Foundation proposed the use of the square root of the wind capacity (in GW) as conventional capacity (e.g. 36 GW of wind plant to match 6 GW of conventional plant).

Note: Extra emissions due to reduced thermal efficiency of the reserve power generation ≈ 10% (Dale et al 2004).

Note: Emissions from turbine life. If total emissions for the windfarm are unknown, emissions should be calculated according to turbine capacity. The normal range of CO_2 emissions is 394 to 8147 t CO_2 MW (White & Kulcinski, 2000; White, 2007).

Note: Type of peatland An 'acid bog' is fed primarily by rainwater and often inhabited by sphagnum moss, thus making it acidic (Stoneman & Brooks,1997).
A 'fen' is a type of wetland fed by surface and/or groundwater (McBride et al., 2011).

Note: Time required for regeneration of previous habitat. Loss of fixation should be assumed to be over lifetime of windfarm only. This time could be longer if plants do not regenerate. The requirements for after-use planning include the provision of suitable refugia for peat-forming vegetation, the removal of structures, or an assessment of the impact of leaving them in situ. Methods used to reinstate the site will affect the likely time for regeneration of the previous habitat. This time could also be shorter if plants regenerate during lifetime of windfarm. If so, enter number of years estimated for regeneration.

Note: Carbon fixation by bog plants
Apparent C accumulation rate in peatland is 0.12 to 0.31 t C ha^{-1} yr^{-1} (Turunen et al., 2001; Botch et al., 1995). The SNH guidance uses a value of 0.25 t C ha^{-1} yr^{-1}.

Note: Area of forestry plantation to be felled. If the forestry was planned to be removed, with no further rotations planted, before the windfarm development, the area to be felled should be entered as zero.

Note: Plantation carbon sequestration. This is dependent on the yield class of the forestry. The SNH technical guidance assumed yield class of 16 m^3 ha^{-1} yr^{-1}, compared to the value of 14 m^3 ha^{-1} yr^{-1} provided by the Forestry Commission. Carbon sequestered for yield class 16 m^3 ha^{-1} y^{-1} = 3.6 tC ha^{-1} yr^{-1} (Cannell, 1999).

Note: Coal-Fired Plant and Grid Mix Emission Factors. Coal-fired plant emission factor (EF) from electricity supplied in 2014 = 0.093 t CO_2 MWh^{-1}; Grid-Mix EF for 2014 = 0.394 t CO_2 MWh^{-1}. Source = DUKES, 2015b.

Note: Fossil Fuel-Mix Emission Factor. The emission factor from electricity supplied in 2014 from all fossil fuels = 0.642 t CO_2 MWh^{-1}. Source = DUKES, 2015b.

Average width of hard-standing (m)	0	Table 2-2 Chapter 2. Dimensions estimated to reflect total handstand area of 1901.	0		0	
Average depth of peat removed from hard-standing (m)	0.00	Section 3.5.1 (The peat depths vary considerably from hardstand to hardstand ranging from 0.3m to over 7m)	0.00		0.00	
Access tracks						
Total length of access track (m)	0	Lengths and Areas 2020-12-09	0		0	
Existing track length (m)	0	Lengths and Areas 2020-12-09	0		0	
Length of access track that is floating road (m)	0	Combination of floated and excavated. Lengths and Areas 2020-12-09. Split evenly.	0		0	
Floating road width (m)	0	Chapter 2 Section 2.5.7	0		0	
Floating road depth (m)	0.00	Estimate from previous projects	0.00		0.00	
Length of floating road that is drained (m)	0	Combination of floated and excavated. Lengths and Areas 2020-12-09. Split evenly.	0		0	
Average depth of drains associated with floating roads (m)	0.00		0.00		0.00	
Length of access track that is excavated road (m)	0	Combination of floated and excavated. No figure in chapter 2. Split evenly.	0		0	
Excavated road width (m)	0	Chapter 2 Section 2.5.7	0		0	
Average depth of peat excavated for road (m)	0.00	Section 3.3.2 Chapter 3	0.00		0.00	
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	
Length of rock filled road that is drained (m)	0		0		0	
Average depth of drains associated with rock filled roads (m)	0.00		0.00		0.00	
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)	0	From spine road cross country to substation. Lengths and Areas 2020-12-09	0		0	
Average depth of peat cut for cable trenches (m)	0.00	Avegage depth of peat during survey. Appendix E1 Peat Stability Risk Assessment.	0.00		0.00	
Additional peat excavated (not already accounted for above)						
Volume of additional peat excavated (m^3)	2505	Paddy Email. Substation and Met Mast.	2505		2505	
Area of additional peat excavated (m^2)	0.0	Lengths and Areas 2020-12-09	0.0		0.0	
Peat Landslide Hazard						
Weblink: Peat Landslide Hazard and Risk Assessments: Best Practice Guide for Proposed Electricity Generation Developments	0	Peat stability report	0		0	
Improvement of C sequestration at site by blocking drains, restoration of habitat etc						
Improvement of degraded bog		Assumed to be nil				
Area of degraded bog to be improved (ha)	0		0		0	
Water table depth in degraded bog before improvement (m)	0		0		0	
Water table depth in degraded bog after improvement (m)	0		0		0	
Time required for hydrology and habitat of bog to return to its previous state on improvement (years)	0		0		0	
Period of time when effectiveness of the improvement in degraded bog can be guaranteed (years)	0		0		0	
Improvement of felled plantation land	0	Assumed to be nil	0		0	
Area of felled plantation to be improved (ha)	0		0		0	
Water table depth in felled area before improvement (m)	0.00		0.00		0.00	
Water table depth in felled area after improvement (m)	0.00		0.00		0.00	
Time required for hydrology and habitat of felled plantation to return to its previous state on improvement (years)	0		0		0	
Period of time when effectiveness of the improvement in felled plantation can be guaranteed (years)	0		0		0	
Restoration of peat removed from borrow pits	0	No borrow pits	0		0	
Area of borrow pits to be restored (ha)	0		0		0	
Depth of water table in borrow pit before restoration with respect to the restored surface (m)	0.00		0.00		0.00	
Depth of water table in borrow pit after restoration with respect to the restored surface (m)	0.00		0.00		0.00	
Time required for hydrology and habitat of borrow pit to return to its previous state on restoration (years)	15		15		15	
Period of time when effectiveness of the restoration of peat removed from borrow pits can be guaranteed (years)	35		35		35	
Early removal of drainage from foundations and hardstanding						
Water table depth around foundations and hardstanding before restoration (m)	0.20	Estimate from previous projects on peat	0.20		0.20	
Water table depth around foundations and hardstanding after restoration (m)	0.20	Estimate from previous projects on peat	0.20		0.20	

Note: Total length of access track. If areas of access track overlap with hardstanding area, exclude these from the total length of access track to avoid double counting of land area lost.

Note: Floating road depth. Accounts for sinking of floating road. Should be entered as the average depth of the road expected over the lifetime of the windfarm. If no sinking is expected, enter as zero.

Note: Length of floating road that is drained. Refers to any drains running along the length of the road.

Note: Rock filled roads. Rock filled roads are assumed to be roads where no peat has been removed and rock has been placed on the surface and allowed to settle.

Note: Depth of peat cut for cable trenches. In shallow peats, the cable trenches may be cut below the peat. To avoid overestimating the depth of peat affected by the cable trenches, only enter the depth of the peat that is cut.

Note: Peat Landslide Hazard. It is assumed that measures have been taken to limit damage (Scottish Executive, 2006, Peat Landslide Hazard and Risk Assessments. Best Practice Guide for Proposed Electricity Generation Developments. Scottish Executive, Edinburgh. pp. 34-35) so that C losses due to peat landslide can be assumed to be negligible. Link: http://www.scotland.gov.uk/Publications/2006/12/21162303/1.

Note: Period of time when improvement can be guaranteed. This gurantee should be absolute. Therefore, if you enter a value beyond the lifetime of the windfarm you should provide strong supporting evidence that this improvement can be guaranteed for the full period given. This includes the time requirement for the improvement to become effective. For example if time required for hydrology and habitat to return to its previous state is 10 years and the restoration can be guaranteed over the lifetime of the windfarm (25 years), the period of time when the improvement can be guaranteed should be entered as 25 years, and the improvement will be effective for (25 -10) = 15 years.

Note: Period of time when improvement can be guaranteed. This gurantee should be absolute. Therefore, if you enter a value beyond the lifetime of the windfarm you should provide strong supporting evidence that this improvement can be guaranteed for the full period given. This includes the time requirement for the improvement to become effective. For example if time required for hydrology and habitat to return to its previous state is 10 years and the restoration can be guaranteed over the lifetime of the windfarm (25 years), the period of time when the improvement can be guaranteed should be entered as 25 years, and the improvement will be effective for (25 -10) = 15 years.

Note: Period of time when improvement can be guaranteed. This gurantee should be absolute. Therefore, if you enter a value beyond the lifetime of the windfarm you should provide strong supporting evidence that this improvement can be guaranteed for the full period given. This includes the time requirement for the improvement to become effective. For example if time required for hydrology and habitat to return to its previous state is 10 years and the restoration can be guaranteed over the lifetime of the windfarm (25 years), the period of time when the improvement can be guaranteed should be entered as 25 years, and the improvement will be effective for (25 -10) = 15 years.

Note: Period of time when improvement can be guaranteed. This is assumed to be the lifetime of the windfarm as restoration after windfarm decommissioning is already accounted for in restoration of the site

Time to completion of backfilling, removal of any surface drains, and full restoration of the hydrology (years)	35		35		35	
Restoration of site after decomissioning						
Will the hydrology of the site be restored on decommissioning?	Yes		Yes		Yes	
Will you attempt to block any gullies that have formed due to the windfarm?	Yes		Yes		Yes	
Will you attempt to block all artificial ditches and facilitate rewetting?	Yes		Yes		Yes	
Will the habitat of the site be restored on decommissioning?	Yes		Yes		Yes	
Will you control grazing on degraded areas?	Not appli		Yes		Yes	
Will you manage areas to favour reintroduction of species	Not appli		Yes		Yes	

Note: Restoration of site. If the water table at the site is returned to its original level or higher on decommissioning, and habitat at the site is restored, it is assumed that C losses continue only over the lifetime of the windfarm. Otherwise, C losses from drained peat are assumed to be 100%.

Choice of methodology for calculating emission factors	IPCC default

Note: Choice of methodology for calculating emission factors. The IPCC default methodology is the internationally accepted standard (IPCC, 1997). However, it is stated in IPCC (1997) that these are rough estimates, and "these rates and production periods can be used if countries do not have more appropriate estimates". Therefore, we have developed more site specific estimates for use here based on work from the Scottish Government funded ECOSSE project (Smith et al, 2007. ECOSSE: Estimating Carbon in Organic Soils - Sequestration and Emissions. Final Report. SEERAD Report. ISBN 978 0 7559 1498 2. 166pp.).

Core input data

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Click here to move to Payback Time Click here
Click here to return to Instructions Click here

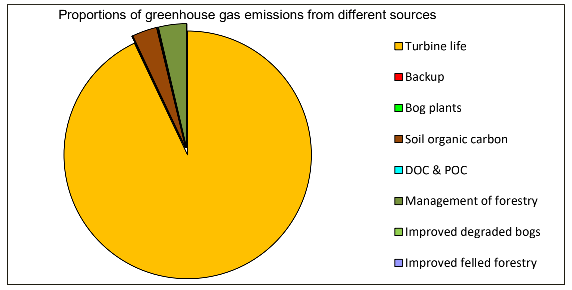
Results
PAYBACK TIME AND CO_2 EMISSIONS

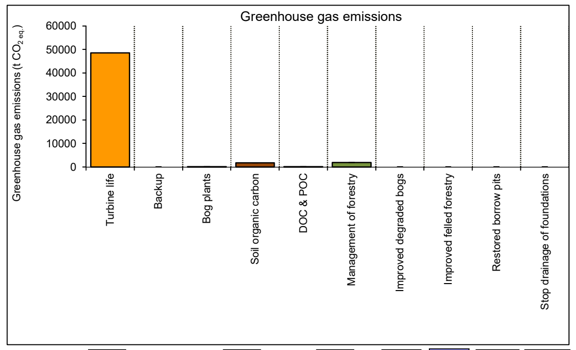
Note: The carbon payback time of the windfarm is calculated by comparing the loss of C from the site due to windfarm development with the carbon-savings achieved by the windfarm while displacing electricity generated from coal-fired capacity or grid-mix.

Click here to return to Input data — Click here
Click here to return to Instructions — Click here

	Exp.	*Min.*	*Max.*
1. Windfarm CO_2 emission saving over…			
…coal-fired electricity generation ($tCO_2\ yr^{-1}$)	0	0	0
…grid-mix of electricity generation ($tCO_2\ yr^{-1}$)	56174	56174	56174
…fossil fuel - mix of electricity generation ($tCO_2\ yr^{-1}$)	0	0	0
Energy output from windfarm over lifetime (MWh)	5242860	5242860	5242860
Total CO_2 losses due to wind farm ($t\ CO_2$ eq.)			
2. Losses due to turbine life (eg. manufacture, construction, decomissioning)	48582	48582	48582
3. Losses due to backup	0	0	0
4. Losses due to reduced carbon fixing potential	37	37	37
5. Losses from soil organic matter	1681	1681	1681
6. Losses due to DOC & POC leaching	76	76	76
7. Losses due to felling forestry	1908	1908	1908
Total losses of carbon dioxide	52286	52286	52286
8. Total CO_2 gains 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 ($t\ CO_{2\ eq.}$)	**52286**	**52286**	**52286**
Carbon Payback Time			
…grid-mix of electricity generation (years)	0.9	0.9	0.9
Ratio of CO_2 eq. emissions to power generation (g / kWh) (TARGET ratio by 2030 (electricity generation) < 50 g /kWh)	**10**	**10**	**10**





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Results
PAYBACK TIME AND CO_2 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.

Click here to return to Input data — Click here
Click here to return to Instructions — Click here

Proportions of greenhouse gas emissions from different sources

	Exp.	*Min*	*Max*
Turbine life	48582	0	0
Backup	0	0	0
Bog plants	37	0	0
Soil organic carbon	1681	0	0
DOC & POC	76	0	0
Management of forestry	1908	0	0
Improved degraded bogs	0	0	0
Restored borrow pits	0	0	0

	Exp.	*Min.*	*Max.*
Turbine life	48582	0	0
Backup	0	0	0
Bog plants	37	0	0
Soil organic carbon	1681	0	0
DOC & POC	76	0	0
Management of forestry	1908	0	0
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
	52286		

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.

Click here to move to Payback Time Click here

Click here to return to Instructions Click here

Input data	Expected values: Enter expected value here	Expected values: Record source of data	Possible range of values: Enter minimum value here	Record source of data	Possible range of values: Enter maximum value here	Record source of data
Windfarm characteristics						
Dimensions						
No. of turbines	10	Fixed	10		10	
Lifetime of windfarm (years)	35	Fixed	35		35	
Performance						
Power rating of turbines (turbine capacity) (MW)	6	Assumed	6		6	
Capacity factor	Direct input of capacity fa		Direct input of capacity fa		Direct input of capacity fa	
Enter estimated capacity factor (percentage efficiency)	30.0	Long term average capacity factor (IWEA)	30.0		30.0	
Backup						
Extra capacity required for backup (%)	5	Value from SNH guidance	5		5	
Additional emissions due to reduced thermal efficiency of the reserve generation (%)	10	Value from SNH guidance. Over 20% of national electricity is from renewables.	10		10	
Carbon dioxide emissions from turbine life - (eg. manufacture, construction, decommissioning)	Calculate wrt installed ca		Calculate wrt installed ca		Calculate wrt installed ca	
Characteristics of peatland before windfarm development						
Type of peatland	Acid b	Site is heavily modified and drained. Not an undisturbed bog.	Acid b		Acid b	
Average annual air temperature at site (^oC)	9		9		9	
Average depth of peat at site (m)	0.00	Avegage depth of peat during survey. Appendix E1 Peat Stability Risk Assessment.	0.00		0.00	
C Content of dry peat (% by weight)	55	The carbon content of dry peat is assumed to be 55% (the carbon content of dry peat ranges fro 49 to 62% (MLURI et al., 1991 cited by Nayak et al, 2008)	55		55	
Average extent of drainage around drainage features at site (m)	15.00	assumption	15.00		15.00	
Average water table depth at site (m)	0.20	assumption	0.20		0.20	
Dry soil bulk density (g cm^{-3})	0.20	assumption	0.20		0.20	
Characteristics of bog plants						
Time required for regeneration of bog plants after restoration (years)	10	Assumption	10		10	
Carbon accumulation due to C fixation by bog plants in undrained peats (tC ha^{-1} yr^{-1})	0.25	Value from SNH guidance	0.25		0.25	
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)	4.13	Section 2.2 Chapter 2.	4.13		4.13	
Average rate of carbon sequestration in timber (tC ha-1 yr-1)	3.60	Value from SNH guidance	3.60		3.60	
Counterfactual emission factors						
To update counterfactual emission factors from the web [Click here (not yet operational)]						
Coal-fired plant emission factor (t CO_2 MWh^{-1})						
Grid-mix emission factor (t CO_2 MWh^{-1})	0.375	Energy Related Co2 emissions I Ireland 2005 to 2018. SEAI.	0.375		0.375	
Fossil fuel-mix emission factor (t CO_2 MWh^{-1})						
Borrow pits						
Number of borrow pits	0	No borrow pits. Only peat desosition areas	0		0	
Average length of pits (m)	0		0		0	
Average width of pits (m)	0		0		0	
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		Rectangular with vertical		Rectangular with vertical	
Average length of turbine foundations (m)	0	Section 2.5.3 Chapter 2 Circular hardstand.	0		0	
Average width of turbine foundations (m)	0	Section 2.5.3 Chapter 2. Circular hardstand	0		0	
Average depth of peat removed from turbine foundations (m)	0.00	Average of Table 3-1 Chapter 3	0.00		0.00	
Average length of hard-standing (m)	0	Table 2.2 Chapter 2. Dimensions estimated	0		0	

Note: Capacity factor. The capacity factor of any power plant is the proportion of energy produced during a given period with respect to the energy that would have been produced had the wind farm been running continually and at maximum output (DECC (2004); see also www.bwea.com/ref/capacityfactors.html).
Capacity Factor = Electricity generated during the period [kWh]/ (Installed capacity [kW] x number of hours in the period [h])
We recommend that a site-specific capacity factor ~~site~~ should be used (as measured during planning stage), and should represent the average emission factor expected over the lifetime of the windfarm, accounting for decline in efficiency with age (Hughes, 2012). The 5 year average capacity factor (or "load factor") for UK onshore wind between 2010 and 2014, based on average beginning and end of year capacity, was 29.2% (DUKES, 2015).

Note: Extra capacity required for backup. If 20% of national electricity is generated by wind energy, the extra capacity required for backup is 5% of the rated capacity of the wind plant (Dale et al 2004). We suggest this should be 5% of the actual output. If it is assumed that less than 20% of national electricity is generated by wind energy, a lower percentage should be entered (0%). The House of Lords Economic Affairs Committee report on The Economics of Renewable Energy (Parliamentary Business, 2008) notes that to cover peak demand a '20% margin of extra capacity has been sufficient to keep the risk of a power cut due to insufficient generation at a very low level.' The estimate provided by BERR was a range of 10% to 20% of installed capacity of wind energy. E.ON is reported as proposing that the capacity credit of wind power should be 8%, and The Renewable Energy Foundation proposed the use of the square root of the wind capacity (in GW) as conventional capacity (e.g. 36 GW of wind plant to match 6 GW of conventional plant).

Note: Extra emissions due to reduced thermal efficiency of the reserve power generation ≈ 10% (Dale et al 2004).

Note: Emissions from turbine life. If total emissions for the windfarm are unknown, emissions should be calculated according to turbine capacity. The normal range of CO_2 emissions is 394 to 8147 t CO_2 MW (White & Kulcinski, 2000; White, 2007).

Note: Type of peatland An 'acid bog' is fed primarily by rainwater and often inhabited by sphagnum moss, thus making it acidic (Stoneman & Brooks,1997).
A 'fen' is a type of wetland fed by surface and/or groundwater (McBride et al., 2011).

Note: Time required for regeneration of previous habitat. Loss of fixation should be assumed to be over lifetime of windfarm only. This time could be longer if plants do not regenerate. The requirements for after-use planning include the provision of suitable refugia for peat-forming vegetation, the removal of structures, or an assessment of the impact of leaving them in situ. Methods used to reinstate the site will affect the likely time for regeneration of the previous habitat. This time could also be shorter if plants regenerate during lifetime of windfarm. If so, enter number of years estimated for regeneration.

Note: Carbon fixation by bog plants
Apparent C accumulation rate in peatland is 0.12 to 0.31 t C ha^{-1} yr^{-1} (Turunen et al., 2001; Botch et al., 1995). The SNH guidance uses a value of 0.25 t C ha^{-1} yr^{-1}.

Note: Area of forestry plantation to be felled. If the forestry was planned to be removed, with no further rotations planted, before the windfarm development, the area to be felled should be entered as zero.

Note: Plantation carbon sequestration. This is dependent on the yield class of the forestry. The SNH technical guidance assumed yield class of 16 m^3 ha^{-1} yr^{-1}, compared to the value of 14 m^3 ha^{-1} yr^{-1} provided by the Forestry Commission. Carbon sequestered for yield class 16 m^3 ha^{-1} y^{-1} = 3.6 tC ha^{-1} yr^{-1} (Cannell, 1999).

Note: Coal-Fired Plant and Grid Mix Emission Factors. Coal-fired plant emission factor (EF) from electricity supplied in 2014 = 0.093 t CO_2 MWh^{-1}. Grid-Mix EF for 2014 = 0.394 t CO_2 MWh^{-1}.
Source = DUKES, 2015b.

Note: Fossil Fuel-Mix Emission Factor. The emission factor from electricity supplied in 2014 from all fossil fuels = 0.642 t CO_2 MWh^{-1}. Source = DUKES, 2015b.

Average width of hard-standing (m)	0	Table 2-2 Chapter 2. Dimensions estimated to reflect total handstand area of 1901.	0		0	
Average depth of peat removed from hard-standing (m)	0.00	Section 3.5.1 (The peat depths vary considerably from hardstand to hardstand ranging from 0.3m to over 7m)	0.00		0.00	
Access tracks						
Total length of access track (m)	0	Lengths and Areas 2020-12-09	0		0	
Existing track length (m)	0	Lengths and Areas 2020-12-09	0		0	
Length of access track that is floating road (m)	0	Combination of floated and excavated. Lengths and Areas 2020-12-09. Split evenly.	0		0	
Floating road width (m)	0	Chapter 2 Section 2.5.7	0		0	
Floating road depth (m)	0.00	Estimate from previous projects	0.00		0.00	
Length of floating road that is drained (m)	0	Combination of floated and excavated. Lengths and Areas 2020-12-09. Split evenly.	0		0	
Average depth of drains associated with floating roads (m)	0.00		0.00		0.00	
Length of access track that is excavated road (m)	0	Combination of floated and excavated. No figure in chapter 2. Split evenly.	0		0	
Excavated road width (m)	0	Chapter 2 Section 2.5.7	0		0	
Average depth of peat excavated for road (m)	0.00	Section 3.3.2 Chapter 3	0.00		0.00	
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	
Length of rock filled road that is drained (m)	0		0		0	
Average depth of drains associated with rock filled roads (m)	0.00		0.00		0.00	
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)	0	From spine road cross country to substation. Lengths and Areas 2020-12-09	0		0	
Average depth of peat cut for cable trenches (m)	0.00	Avegage depth of peat during survey. Appendix E1 Peat Stability Risk Assessment.	0.00		0.00	
Additional peat excavated (not already accounted for above)						
Volume of additional peat excavated (m^3)	2505	Paddy Email. Substation and Met Mast.	2505		2505	
Area of additional peat excavated (m^2)	0.0	Lengths and Areas 2020-12-09	0.0		0.0	
Peat Landslide Hazard						
Weblink: Peat Landslide Hazard and Risk Assessments: Best Practice Guide for Proposed Electricity Generation Developments	0	Peat stability report	0		0	
Improvement of C sequestration at site by blocking drains, restoration of habitat etc						
Improvement of degraded bog		Assumed to be nil				
Area of degraded bog to be improved (ha)	0		0		0	
Water table depth in degraded bog before improvement (m)	0		0		0	
Water table depth in degraded bog after improvement (m)	0		0		0	
Time required for hydrology and habitat of bog to return to its previous state on improvement (years)	0		0		0	
Period of time when effectiveness of the improvement in degraded bog can be guaranteed (years)	0		0		0	
Improvement of felled plantation land	0	Assumed to be nil	0		0	
Area of felled plantation to be improved (ha)	0		0		0	
Water table depth in felled area before improvement (m)	0.00		0.00		0.00	
Water table depth in felled area after improvement (m)	0.00		0.00		0.00	
Time required for hydrology and habitat of felled plantation to return to its previous state on improvement (years)	0		0		0	
Period of time when effectiveness of the improvement in felled plantation can be guaranteed (years)	0		0		0	
Restoration of peat removed from borrow pits	0	No borrow pits	0		0	
Area of borrow pits to be restored (ha)	0		0		0	
Depth of water table in borrow pit before restoration with respect to the restored surface (m)	0.00		0.00		0.00	
Depth of water table in borrow pit after restoration with respect to the restored surface (m)	0.00		0.00		0.00	
Time required for hydrology and habitat of borrow pit to return to its previous state on restoration (years)	15		15		15	
Period of time when effectiveness of the restoration of peat removed from borrow pits can be guaranteed (years)	35		35		35	
Early removal of drainage from foundations and hardstanding						
Water table depth around foundations and hardstanding before restoration (m)	0.20	Estimate from previous projects on peat	0.20		0.20	
Water table depth around foundations and hardstanding after restoration (m)	0.20	Estimate from previous projects on peat	0.20		0.20	

Note: Total length of access track. If areas of access track overlap with hardstanding area, exclude these from the total length of access track to avoid double counting of land area lost.

Note: Floating road depth. Accounts for sinking of floating road. Should be entered as the average depth of the road expected over the lifetime of the windfarm. If no sinking is expected, enter as zero.

Note: Length of floating road that is drained. Refers to any drains running along the length of the road.

Note: Rock filled roads. Rock filled roads are assumed to be roads where no peat has been removed and rock has been placed on the surface and allowed to settle.

Note: Depth of peat cut for cable trenches. In shallow peats, the cable trenches may be cut below the peat. To avoid overestimating the depth of peat affected by the cable trenches, only enter the depth of the peat that is cut.

Note: Peat Landslide Hazard. It is assumed that measures have been taken to limit damage (Scottish Executive, 2006, Peat Landslide Hazard and Risk Assessments. Best Practice Guide for Proposed Electricity Generation Developments. Scottish Executive, Edinburgh. pp. 34-35) so that C losses due to peat landslide can be assumed to be negligible. Link: http://www.scotland.gov.uk/Publications/2006/12/21162303/1.

Note: Period of time when improvement can be guaranteed. This guarantee should be absolute. Therefore, if you enter a value beyond the lifetime of the windfarm you should provide strong supporting evidence that this improvement can be guaranteed for the full period given. This includes the time requirement for the improvement to become effective. For example if time required for hydrology and habitat to return to its previous state is 10 years and the restoration can be guaranteed over the lifetime of the windfarm (25 years), the period of time when the improvement can be guaranteed should be entered as 25 years, and the improvement will be effective for (25 -10) = 15 years.

Note: Period of time when improvement can be guaranteed. This guarantee should be absolute. Therefore, if you enter a value beyond the lifetime of the windfarm you should provide strong supporting evidence that this improvement can be guaranteed for the full period given. This includes the time requirement for the improvement to become effective. For example if time required for hydrology and habitat to return to its previous state is 10 years and the restoration can be guaranteed over the lifetime of the windfarm (25 years), the period of time when the improvement can be guaranteed should be entered as 25 years, and the improvement will be effective for (25 -10) = 15 years.

Note: Period of time when improvement can be guaranteed. This guarantee should be absolute. Therefore, if you enter a value beyond the lifetime of the windfarm you should provide strong supporting evidence that this improvement can be guaranteed for the full period given. This includes the time requirement for the improvement to become effective. For example if time required for hydrology and habitat to return to its previous state is 10 years and the restoration can be guaranteed over the lifetime of the windfarm (25 years), the period of time when the improvement can be guaranteed should be entered as 25 years, and the improvement will be effective for (25 -10) = 15 years.

Note: Period of time when improvement can be guaranteed. This is assumed to be the lifetime of the windfarm as restoration after windfarm decommissioning is already accounted for in restoration of the site

Time to completion of backfilling, removal of any surface drains, and full restoration of the hydrology (years)	35		35		35		
Restoration of site after decomissioning							
Will the hydrology of the site be restored on decommissioning?	Yes		Yes		Yes		
Will you attempt to block any gullies that have formed due to the windfarm?	Yes		Yes		Yes		
Will you attempt to block all artificial ditches and facilitate rewetting?	Yes		Yes		Yes		
Will the habitat of the site be restored on decommissioning?	Yes		Yes		Yes		
Will you control grazing on degraded areas?	Not appli		Yes		Yes		
Will you manage areas to favour reintroduction of species	Not appli		Yes		Yes		

Note: Restoration of site. If the water table at the site is returned to its original level or higher on decommissioning, and habitat at the site is restored, it is assumed that C losses continue only over the lifetime of the windfarm. Otherwise, C losses from drained peat are assumed to be 100%.

Choice of methodology for calculating emission factors	IPCC default

Note: Choice of methodology for calculating emission factors. The IPCC default methodology is the internationally accepted standard (IPCC, 1997). However, it is stated in IPCC (1997) that these are rough estimates, and "these rates and production periods can be used if countries do not have more appropriate estimates". Therefore, we have developed more site specific estimates for use here based on work from the Scottish Government funded ECOSSE project (Smith et al, 2007. ECOSSE: Estimating Carbon in Organic Soils - Sequestration and Emissions. Final Report. SEERAD Report. ISBN 978 0 7559 1498 2. 166pp.).

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.

Click here to move to Payback Time Click here
Click here to return to Instructions Click here

Results

PAYBACK TIME AND CO_2 EMISSIONS

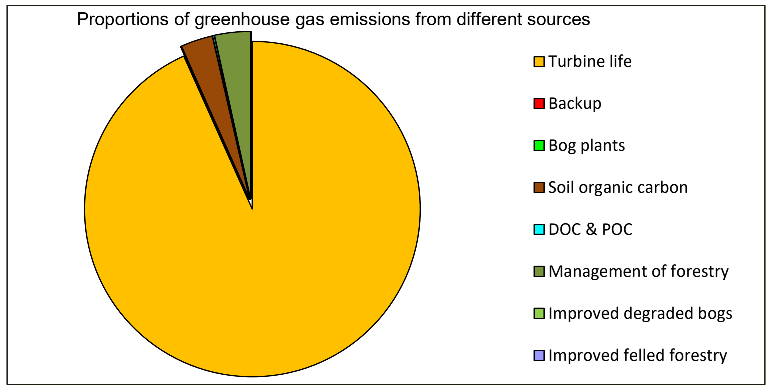
Note: The carbon payback time of the windfarm is calculated by comparing the loss of C from the site due to windfarm development with the carbon-savings achieved by the windfarm while displacing electricity generated from coal-fired capacity or grid-mix.

Click here to return to Input data | Click here

Click here to return to Instructions | Click here

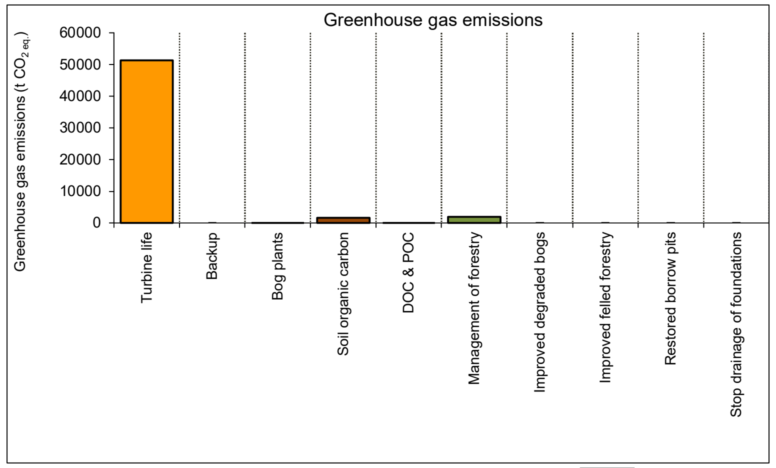
	Exp.	Min.	Max.
1. Windfarm CO_2 emission saving over…			
…coal-fired electricity generation (tCO_2 yr^{-1})	0	0	0
…grid-mix of electricity generation (tCO_2 yr^{-1})	59130	59130	59130
…fossil fuel - mix of electricity generation (tCO_2 yr^{-1})	0	0	0
Energy output from windfarm over lifetime (MWh)	5518800	5518800	5518800
Total CO_2 losses due to wind farm (t CO_2 eq.)			
2. Losses due to turbine life (eg. manufacture, construction, decomissioning)	51386	51386	51386
3. Losses due to backup	0	0	0
4. Losses due to reduced carbon fixing potential	37	37	37
5. Losses from soil organic matter	1681	1681	1681
6. Losses due to DOC & POC leaching	76	76	76
7. Losses due to felling forestry	1908	1908	1908
Total losses of carbon dioxide	55089	55089	55089
8. Total CO_2 gains 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 $CO_{2\ eq.}$)	**55089**	**55089**	**55089**
Carbon Payback Time …grid-mix of electricity generation (years)	0.9	0.9	0.9
Ratio of CO_2 eq. emissions to power generation (g / kWh) (TARGET ratio by 2030 (electricity generation) < 50 g /kWh)	**10**	**10**	**10**



Proportions of greenhouse gas emissions from different sources

	Exp.	Min	Max
Turbine life	51386	0	0
Backup	0	0	0
Bog plants	37	0	0
Soil organic carbon	1681	0	0
DOC & POC	76	0	0
Management of forestry	1908	0	0
Improved degraded bogs	0	0	0
Restored borrow pits	0	0	0



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	Exp.	Min.	Max.
Turbine life	51386	0	0
Backup	0	0	0
Bog plants	37	0	0
Soil organic carbon	1681	0	0
DOC & POC	76	0	0
Management of forestry	1908	0	0
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
	55089		

Results

PAYBACK TIME AND CO_2 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.

Click here to return to Input data | Click here

Click here to return to Instructions | Click here

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.

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Click here to move to Payback Time [Click here]

Click here to return to Instructions [Click here]

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						
No. of turbines	10	Fixed	10		10	
Lifetime of windfarm (years)	35	Fixed	35		35	
Performance						
Power rating of turbines (turbine capacity) (MW)	6.6	Assumed	6.6		6.6	
Capacity factor	Direct input of capacity fa		Direct input of capacity fa		Direct input of capacity fa	
Enter estimated capacity factor (percentage efficiency)	30.0	Long term average capacity factor (IWEA)	30.0		30.0	
Backup						
Extra capacity required for backup (%)	5	Value from SNH guidance	5		5	
Additional emissions due to reduced thermal efficiency of the reserve generation (%)	10	Value from SNH guidance. Over 20% of national electricity is from renewables.	10		10	
Carbon dioxide emissions from turbine life - (eg. manufacture, construction, decommissioning)	Calculate wrt installed ca		Calculate wrt installed ca		Calculate wrt installed ca	
Characteristics of peatland before windfarm development						
Type of peatland	Acid b	Site is heavily modified and drained. Not an undisturbed bog.	Acid b		Acid b	
Average annual air temperature at site (^oC)	9		9		9	
Average depth of peat at site (m)	0.00	Avegage depth of peat during survey. Appendix E1 Peat Stability Risk Assessment.	0.00		0.00	
C Content of dry peat (% by weight)	55	The carbon content of dry peat is assumed to be 55% (the carbon content of dry peat ranges fro 49 to 62% (MLURI et al., 1991 cited by Nayak et al, 2008)	55		55	
Average extent of drainage around drainage features at site (m)	15.00	assumption	15.00		15.00	
Average water table depth at site (m)	0.20	assumption	0.20		0.20	
Dry soil bulk density (g cm^{-3})	0.20	assumption	0.20		0.20	
Characteristics of bog plants						
Time required for regeneration of bog plants after restoration (years)	10	Assumption	10		10	
Carbon accumulation due to C fixation by bog plants in undrained peats (tC ha^{-1} yr^{-1})	0.25	Value from SNH guidance	0.25		0.25	
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)	4.13	Section 2.2 Chapter 2.	4.13		4.13	
Average rate of carbon sequestration in timber (tC ha-1 yr-1)	3.60	Value from SNH guidance	3.60		3.60	
Counterfactual emission factors						
To update counterfactual emission factors from the web [Click here (not yet operational)]						
Coal-fired plant emission factor (t CO_2 MWh^{-1})						
Grid-mix emission factor (t CO_2 MWh^{-1})	0.375	Energy Related Co2 emissions I Ireland 2005 to 2018. SEAI.	0.375		0.375	
Fossil fuel-mix emission factor (t CO_2 MWh^{-1})						
Borrow pits						
Number of borrow pits	0		0		0	
Average length of pits (m)	0	No borrow pits. Only peat desosition areas	0		0	
Average width of pits (m)	0		0		0	
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		Rectangular with vertical		Rectangular with vertical	
Average length of turbine foundations (m)	0	Section 2.5.3 Chapter 2 Circular hardstand.	0		0	
Average width of turbine foundations (m)	0	Section 2.5.3 Chapter 2. Circular hardstand	0		0	
Average depth of peat removed from turbine foundations (m)	0.00	Average of Table 3-1 Chapter 3	0.00		0.00	
Average length of hard-standing (m)	0	Table 2.2 Chapter 2. Dimensions estimated	0		0	

Note: Capacity factor. The capacity factor of any power plant is the proportion of energy produced during a given period with respect to the energy that would have been produced had the wind farm been running continually and at maximum output (DECC (2004); see also www.bwea.com/ref/capacityfactors.html).
Capacity Factor = Electricity generated during the period [kWh]/ (Installed capacity [kW] x number of hours in the period [h])
We recommend that a site-specific capacity factor ~~site~~ should be used (as measured during planning stage), and should represent the average emission factor expected over the lifetime of the windfarm, accounting for decline in efficiency with age (Hughes, 2012). The 5 year average capacity factor (or "load factor") for UK onshore wind between 2010 and 2014, based on average beginning and end of year capacity, was 29.2% (DUKES, 2015).

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Note: Emissions from turbine life. If total emissions for the windfarm are unknown, emissions should be calculated according to turbine capacity. The normal range of CO_2 emissions is 394 to 8147 t CO_2 MW (White & Kulcinski, 2000; White, 2007).

Note: Type of peatland An 'acid bog' is fed primarily by rainwater and often inhabited by sphagnum moss, thus making it acidic (Stoneman & Brooks,1997).
A 'fen' is a type of wetland fed by surface and/or groundwater (McBride et al., 2011).

Note: Time required for regeneration of previous habitat. Loss of fixation should be assumed to be over lifetime of windfarm only. This time could be longer if plants do not regenerate. The requirements for after-use planning include the provision of suitable refugia for peat-forming vegetation, the removal of structures, or an assessment of the impact of leaving them in situ. Methods used to reinstate the site will affect the likely time for regeneration of the previous habitat. This time could also be shorter if plants regenerate during lifetime of windfarm. If so, enter number of years estimated for regeneration.

Note: Carbon fixation by bog plants
Apparent C accumulation rate in peatland is 0.12 to 0.31 t C ha^{-1} yr^{-1} (Turunen et al., 2001; Botch et al., 1995). The SNH guidance uses a value of 0.25 t C ha^{-1} yr^{-1}.

Note: Area of forestry plantation to be felled. If the forestry was planned to be removed, with no further rotations planted, before the windfarm development, the area to be felled should be entered as zero.

Note: Plantation carbon sequestration. This is dependent on the yield class of the forestry. The SNH technical guidance assumed yield class of 16 m^3 ha^{-1} yr^{-1}, compared to the value of 14 m^3 ha^{-1} yr^{-1} provided by the Forestry Commission. Carbon sequestered for yield class 16 m^3 ha^{-1} y^{-1} = 3.6 tC ha^{-1} yr^{-1} (Cannell, 1999).

Note: Coal-Fired Plant and Grid Mix Emission Factors. Coal-fired plant emission factor (EF) from electricity supplied in 2014 = 0.093 t CO_2 MWh^{-1}; Grid-Mix EF for 2014 = 0.394 t CO_2 MWh^{-1}. Source = DUKES, 2015b.

Note: Fossil Fuel-Mix Emission Factor. The emission factor from electricity supplied in 2014 from all fossil fuels = 0.642 t CO_2 MWh^{-1}. Source = DUKES, 2015b.

Average width of hard-standing (m)	0	Table 2-2 Chapter 2. Dimensions estimated to reflect total handstand area of 1901.	0		0	
Average depth of peat removed from hard-standing (m)	0.00	Section 3.5.1 (The peat depths vary considerably from hardstand to hardstand ranging from 0.3m to over 7m)	0.00		0.00	
Access tracks						
Total length of access track (m)	0	Lengths and Areas 2020-12-09	0		0	
Existing track length (m)	0	Lengths and Areas 2020-12-09	0		0	
Length of access track that is floating road (m)	0	Combination of floated and excavated. Lengths and Areas 2020-12-09. Split evenly.	0		0	
Floating road width (m)	0	Chapter 2 Section 2.5.7	0		0	
Floating road depth (m)	0.00	Estimate from previous projects	0.00		0.00	
Length of floating road that is drained (m)	0	Combination of floated and excavated. Lengths and Areas 2020-12-09. Split evenly.	0		0	
Average depth of drains associated with floating roads (m)	0.00		0.00		0.00	
Length of access track that is excavated road (m)	0	Combination of floated and excavated. No figure in chapter 2. Split evenly.	0		0	
Excavated road width (m)	0	Chapter 2 Section 2.5.7	0		0	
Average depth of peat excavated for road (m)	0.00	Section 3.3.2 Chapter 3	0.00		0.00	
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	
Length of rock filled road that is drained (m)	0		0		0	
Average depth of drains associated with rock filled roads (m)	0.00		0.00		0.00	
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)	0	From spine road cross country to substation. Lengths and Areas 2020-12-09	0		0	
Average depth of peat cut for cable trenches (m)	0.00	Avegage depth of peat during survey. Appendix E1 Peat Stability Risk Assessment.	0.00		0.00	
Additional peat excavated (not already accounted for above)						
Volume of additional peat excavated (m^3)	2505	Paddy Email. Substation and Met Mast.	2505		2505	
Area of additional peat excavated (m^2)	0.0	Lengths and Areas 2020-12-09	0.0		0.0	
Peat Landslide Hazard						
Weblink: Peat Landslide Hazard and Risk Assessments: Best Practice Guide for Proposed Electricity Generation Developments	0	Peat stability report	0		0	
Improvement of C sequestration at site by blocking drains, restoration of habitat etc						
Improvement of degraded bog		Assumed to be nil				
Area of degraded bog to be improved (ha)	0		0		0	
Water table depth in degraded bog before improvement (m)	0		0		0	
Water table depth in degraded bog after improvement (m)	0		0		0	
Time required for hydrology and habitat of bog to return to its previous state on improvement (years)	0		0		0	
Period of time when effectiveness of the improvement in degraded bog can be guaranteed (years)	0		0		0	
Improvement of felled plantation land	0	Assumed to be nil	0		0	
Area of felled plantation to be improved (ha)	0		0		0	
Water table depth in felled area before improvement (m)	0.00		0.00		0.00	
Water table depth in felled area after improvement (m)	0.00		0.00		0.00	
Time required for hydrology and habitat of felled plantation to return to its previous state on improvement (years)	0		0		0	
Period of time when effectiveness of the improvement in felled plantation can be guaranteed (years)	0		0		0	
Restoration of peat removed from borrow pits	0	No borrow pits	0		0	
Area of borrow pits to be restored (ha)	0		0		0	
Depth of water table in borrow pit before restoration with respect to the restored surface (m)	0.00		0.00		0.00	
Depth of water table in borrow pit after restoration with respect to the restored surface (m)	0.00		0.00		0.00	
Time required for hydrology and habitat of borrow pit to return to its previous state on restoration (years)	15		15		15	
Period of time when effectiveness of the restoration of peat removed from borrow pits can be guaranteed (years)	35		35		35	
Early removal of drainage from foundations and hardstanding						
Water table depth around foundations and hardstanding before restoration (m)	0.20	Estimate from previous projects on peat	0.20		0.20	
Water table depth around foundations and hardstanding after restoration (m)	0.20	Estimate from previous projects on peat	0.20		0.20	

Note: Total length of access track. If areas of access track overlap with hardstanding area, exclude these from the total length of access track to avoid double counting of land area lost.

Note: Floating road depth. Accounts for sinking of floating road. Should be entered as the average depth of the road expected over the lifetime of the windfarm. If no sinking is expected, enter as zero.

Note: Length of floating road that is drained. Refers to any drains running along the length of the road.

Note: Rock filled roads. Rock filled roads are assumed to be roads where no peat has been removed and rock has been placed on the surface and allowed to settle.

Note: Depth of peat cut for cable trenches. In shallow peats, the cable trenches may be cut below the peat. To avoid overestimating the depth of peat affected by the cable trenches, only enter the depth of the peat that is cut.

Note: Peat Landslide Hazard. It is assumed that measures have been taken to limit damage (Scottish Executive, 2006, Peat Landslide Hazard and Risk Assessments. Best Practice Guide for Proposed Electricity Generation Developments. Scottish Executive, Edinburgh. pp. 34-35) so that C losses due to peat landslide can be assumed to be negligible. Link: http://www.scotland.gov.uk/Publications/2006/12/21162303/1.

Note: Period of time when improvement can be guaranteed. This gurantee should be absolute. Therefore, if you enter a value beyond the lifetime of the windfarm you should provide strong supporting evidence that this improvement can be guaranteed for the full period given. This includes the time requirement for the improvement to become effective. For example if time required for hydrology and habitat to return to its previous state is 10 years and the restoration can be guaranteed over the lifetime of the windfarm (25 years), the period of time when the improvement can be guaranteed should be entered as 25 years, and the improvement will be effective for (25 -10) = 15 years.

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Note: Period of time when improvement can be guaranteed. This is assumed to be the lifetime of the windfarm as restoration after windfarm decommissioning is already accounted for in restoration of the site

Time to completion of backfilling, removal of any surface drains, and full restoration of the hydrology (years)	35		35		35	
Restoration of site after decomissioning						
Will the hydrology of the site be restored on decommissioning?	Yes		Yes		Yes	
Will you attempt to block any gullies that have formed due to the windfarm?	Yes		Yes		Yes	
Will you attempt to block all artificial ditches and facilitate rewetting?	Yes		Yes		Yes	
Will the habitat of the site be restored on decommissioning?	Yes		Yes		Yes	
Will you control grazing on degraded areas?	Not appli		Yes		Yes	
Will you manage areas to favour reintroduction of species	Not appli		Yes		Yes	

Note: Restoration of site. If the water table at the site is returned to its original level or higher on decommissioning, and habitat at the site is restored, it is assumed that C losses continue only over the lifetime of the windfarm. Otherwise, C losses from drained peat are assumed to be 100%.

Choice of methodology for calculating emission factors	IPCC default

Note: Choice of methodology for calculating emission factors. The IPCC default methodology is the internationally accepted standard (IPCC, 1997). However, it is stated in IPCC (1997) that these are rough estimates, and "these rates and production periods can be used if countries do not have more appropriate estimates". Therefore, we have developed more site specific estimates for use here based on work from the Scottish Government funded ECOSSE project (Smith et al, 2007. ECOSSE: Estimating Carbon in Organic Soils - Sequestration and Emissions. Final Report. SEERAD Report. ISBN 978 0 7559 1498 2. 166pp.).

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.

Click here to move to Payback Time Click here
Click here to return to Instructions Click here

Results

PAYBACK TIME AND CO_2 EMISSIONS

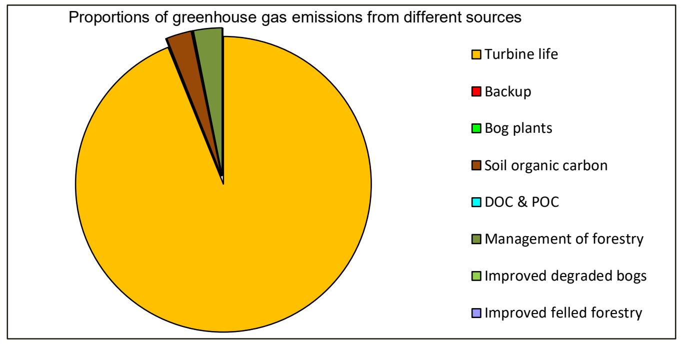
Note: The carbon payback time of the windfarm is calculated by comparing the loss of C from the site due to windfarm development with the carbon-savings achieved by the windfarm while displacing electricity generated from coal-fired capacity or grid-mix.

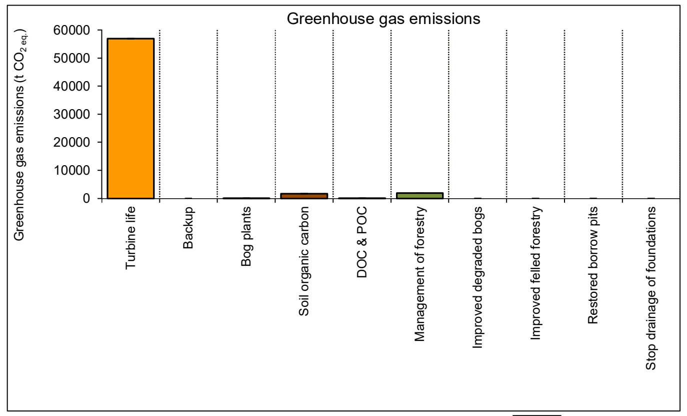
Click here to return to Input data Click here

Click here to return to Instructions Click here

	Exp.	*Min.*	*Max.*
1. Windfarm CO_2 emission saving over…			
…coal-fired electricity generation ($tCO_2\ yr^{-1}$)	0	0	0
…grid-mix of electricity generation ($tCO_2\ yr^{-1}$)	65043	65043	65043
…fossil fuel - mix of electricity generation ($tCO_2\ yr^{-1}$)	0	0	0
Energy output from windfarm over lifetime (MWh)	6070680	6070680	6070680
Total CO_2 losses due to wind farm (t CO_2 eq.)			
2. Losses due to turbine life (eg. manufacture, construction, decomissioning)	56992	56992	56992
3. Losses due to backup	0	0	0
4. Losses due to reduced carbon fixing potential	37	37	37
5. Losses from soil organic matter	1681	1681	1681
6. Losses due to DOC & POC leaching	76	76	76
7. Losses due to felling forestry	1908	1908	1908
Total losses of carbon dioxide	60695	60695	60695
8. Total CO_2 gains 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 $CO_{2\ eq.}$)	**60695**	**60695**	**60695**
Carbon Payback Time			
…grid-mix of electricity generation (years)	0.9	0.9	0.9
Ratio of CO_2 eq. emissions to power generation (g / kWh) (TARGET ratio by 2030 (electricity generation) < 50 g /kWh)	**10**	**10**	**10**





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Proportions of greenhouse gas emissions from different sources

	Exp.	*Min*	*Max*
Turbine life	56992	0	0
Backup	0	0	0
Bog plants	37	0	0
Soil organic carbon	1681	0	0
DOC & POC	76	0	0
Management of forestry	1908	0	0
Improved degraded bogs	0	0	0
Restored borrow pits	0	0	0

	Exp.	*Min.*	*Max.*
Turbine life	56992	0	0
Backup	0	0	0
Bog plants	37	0	0
Soil organic carbon	1681	0	0
DOC & POC	76	0	0
Management of forestry	1908	0	0
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
	60695		

Results

PAYBACK TIME AND CO_2 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.

Click here to return to Input data Click here

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