61253

Environmental Impact Assessment Report

Cummeennabuddoge Wind Farm

Technical Appendix 12-1: Carbon Calculator

Cummeennabuddoge Wind (DAC)

September 2024

Cummeennabuddoge Wind Farm

Technical Appendix 12-1 – Carbon Calculator: Scenario One

CoreInput

Core input data
1. Windfarm characteristics 2. Peatland 3. Bog plants 4. Forestry Plantation 5. Emission factors 6. Borrow pits 7. Foundations and hard-standing 8. Access tracks 9. Cable trenches 10. Additional peat 11. Improvement actions 12. Restoration after decomissioning 13. Methodology & application details
Forestry input data
Construction input data

Save Signed off for submission

Note: Results are only available once ALL data are correct and complete, and a new version will be created.

New app...

Ref: VYXV-DX5B-23SY v

MENU≡

Help

Core input data | Forestry input data | Construction input data

Windfarm characteristics Page 1 of 12

Expected values	Minimum	Maximum
Dimensions		
Number of Turbines: 17	17	17
Chapter 4: Description of Development		
Duration of consent (years): 35	35	35
Chapter 4: Description of Development		
Performance		
Power rating of 1 turbine (MW): 6	6	7.2
Chapter 4: Description of Development		
Capacity factor: Direct input (% estimated capacity factor)	Direct input (% estimated capacity factor)	Direct input (% estimated capacity factor)
35	34.999999	35.000001
Chapter 4: Description of Development which		
Backup		
Fraction of output to backup (%): 5	5	5
The extra electricity generation capacity		
Additional emissions due to reduced thermal efficiency of the reserve generation (%): 10	10	10
Fixed		
CO_2 emissions from turbine life (tCO_2/MW) (eg. manufacture, construction, decommissioning): Calculate wrt installed capacity	Calculate wrt installed capacity	Calculate wrt installed capacity

Next

Introduction

Core input data comprises 12 pages that must be completed by the user in order to be considered a complete application. Depending on the user input it may be required to fill the fields included in the tabs *"Forestry input data"* and *"Construction input data"*. Results will only be available when the application is COMPLETE and free of errors.

All the fields that are not fixed by the tool are validated before being saved to the database. Any validation message that may occur will appear in red right below the failing field. These validations can be about wrong type of data entered, missing fields, wrong range of data, etc.

Some fields have notes, protocols, and/or assumptions associated to them. Those will be shown clicking in the tabs appearing on the top right corner of the screen, next to the Help tab which, in turn, can be toggled on/off by clicking on it.
Please note that the source of data is required along with the chapter and section of the environmental statement where this information is presented. Use the green boxes placed next to the *Expected* value input boxes. These boxes have a limit of 512 characters.

Please, use the menu on the right top corner to navigate through the pages of the application. You will also find a button to **save** the application. If it is a new application it will generate a code that will appear at the top of the screen (it will be also added to the history of your browser, which can be useful in order to retrieve a forgotten code); it is recommended that you copy that code and store it on your computer for later use.

Number of Turbines: The error ≠ turbines in forestry areas is triggered when the number of turbines specified in this page does not match the number of turbines entered in the forestry areas from the *"Forestry input data"* page.[Analogously when the "Construction input data" is compulsory and values do not match the message ≠ turbines in construction areas will appear.]

Capacity factor: If you select the option *Calculate from "Forestry input data"* you must fill the fields in the "Forestry input data" tab. You may do it at any time but the tool won't allow you to save a complete application (and see the results) until you do so.

Payback Time and CO_2 emissions • VYXV-DX5B-23SY v5

1. Windfarm CO2 emission saving over...	Exp.	Min.	Max.
...coal-fired electricity generation (t CO2 / yr)	295,532	295,532	354,638
...grid-mix of electricity generation (t CO2 / yr)	64,736	64,736	77,683
...fossil fuel-mix of electricity generation (t CO2 / yr)	132,598	132,598	159,118
Energy output from windfarm over lifetime (MWh)	10,945,620	10,945,620	13,134,744

Total CO2 losses due to wind farm (tCO2 eq.)	Exp.	Min.	Max.
2. Losses due to turbine life (eg. manufacture, construction, decomissioning)	92,609	92,609	111,670
3. Losses due to backup	66,299	66,299	79,559
4. Lossess due to reduced carbon fixing potential	4,114	1,273	19,022
5. Losses from soil organic matter	121,875	31,370	536,074
6. Losses due to DOC & POC leaching	0	0	152
7. Losses due to felling forestry	117,041	19,507	214,575
Total losses of carbon dioxide	401,938	211,057	961,051

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	-7,443
8d. Change in emissions due to removal of drainage from foundations & hardstanding	0	0	0
Total change in emissions due to improvements	0	0	-7,443

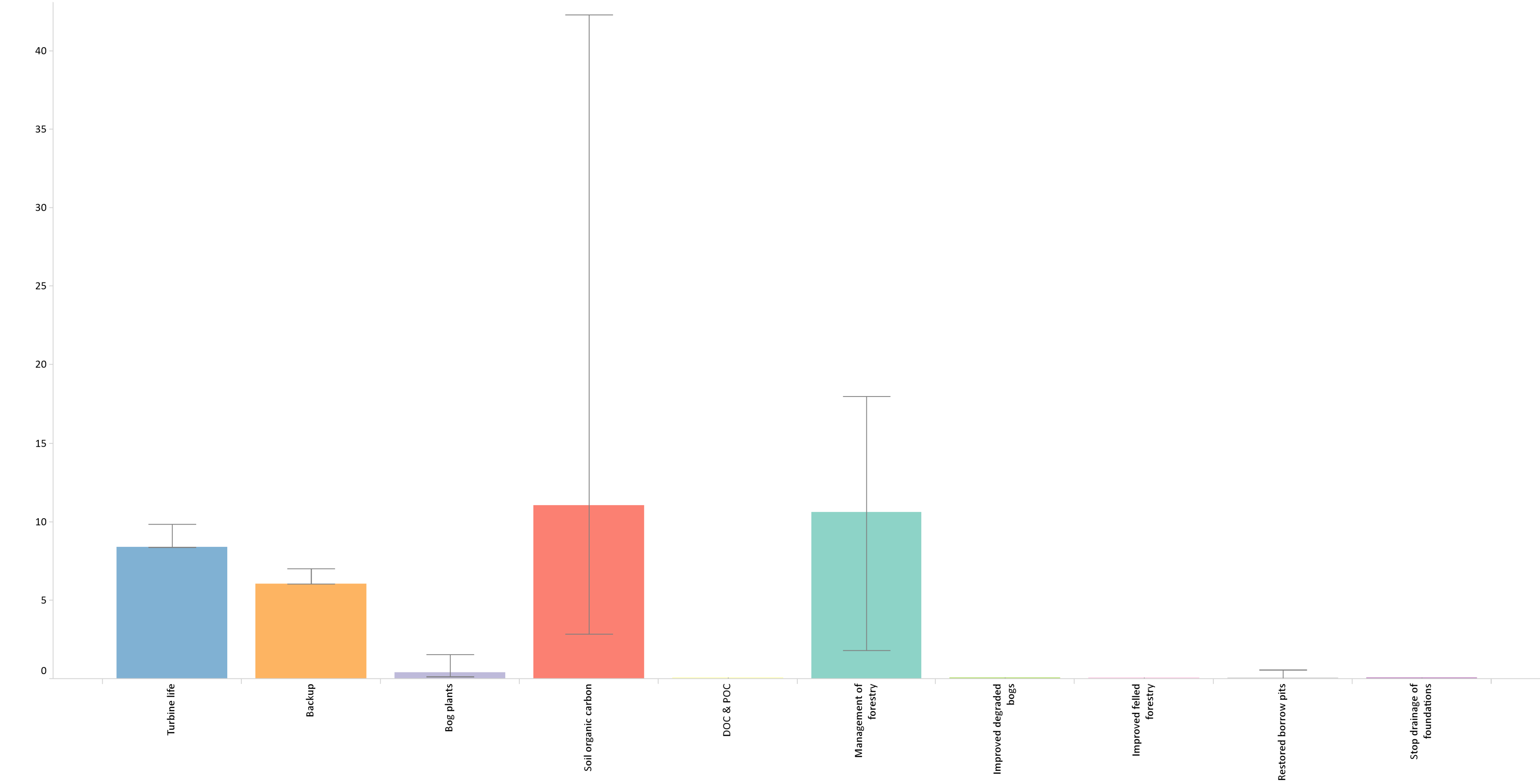
RESULTS	Exp.	Min.	Max.
Net emissions of carbon dioxide (t CO2 eq.)	401,938	203,614	961,051
Carbon Payback Time			
...coal-fired electricity generation (years)	1.4	0.6	3.3
...grid-mix of electricity generation (years)	6.2	2.6	14.8
...fossil fuel-mix of electricity generation (years)	3.0	1.3	7.2
Ratio of soil carbon loss to gain by restoration (not used in Scottish applications)	No gains!	4.21	No gains!
Ratio of CO2 eq. emissions to power generation (g/kWh) (for info. only)	36.72	15.50	87.80

Payback Time - Charts

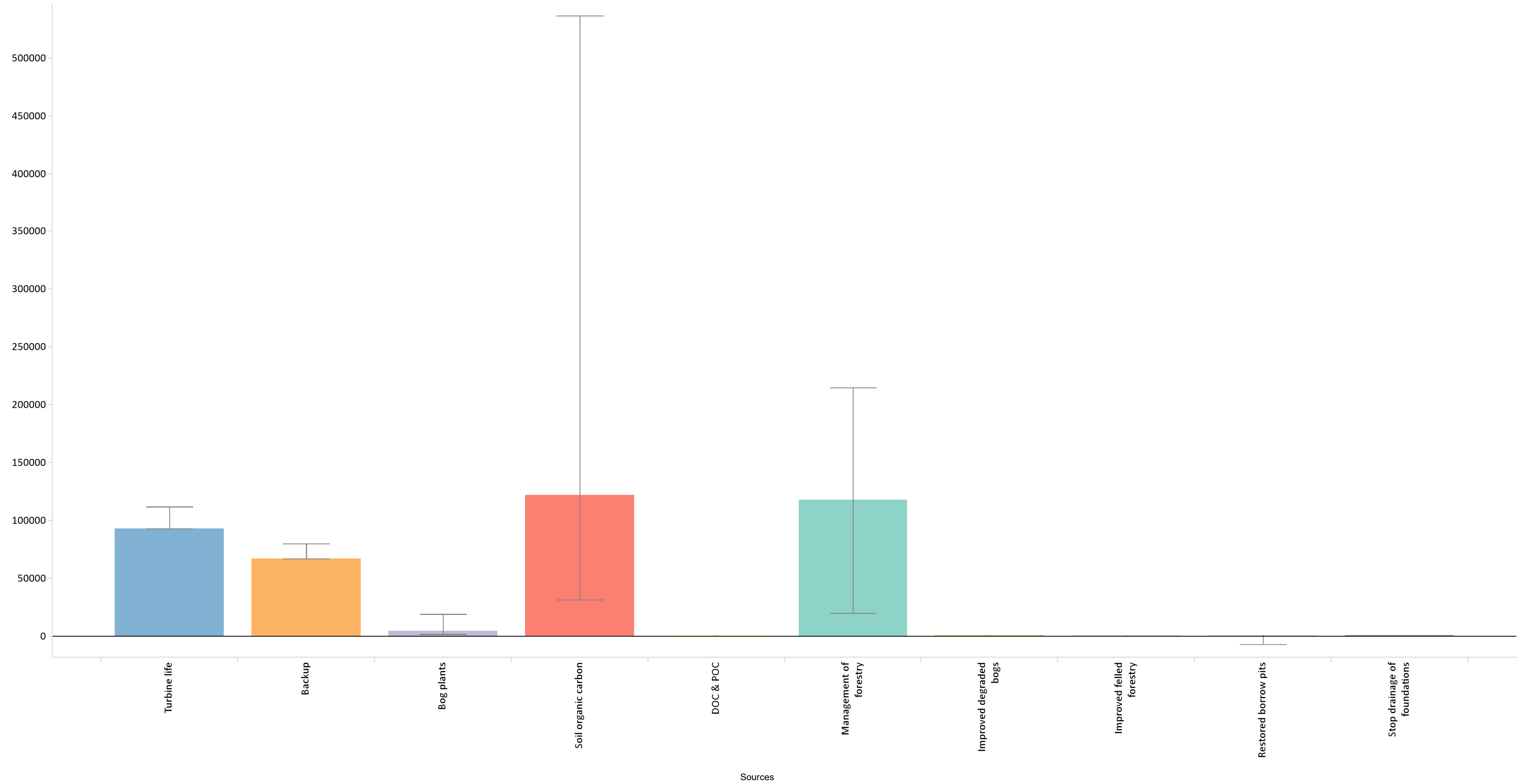
Payback Time
Payback Time - ChartsInput Data
1. Windfarm CO2 emission saving 2. CO2 loss due to turbine life 3. CO2 loss due to backup 4. Loss of CO2 fixing potential 5. Loss of soil CO2 (a,b) 5. Loss of soil CO2 (c,d,e) 6. CO2 loss by DOC & POC loss 7. Forestry CO2 loss 8. CO2 gain - site improvement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

Payback Time and CO_2 emissions • VYXV-DX5B-23SY v5

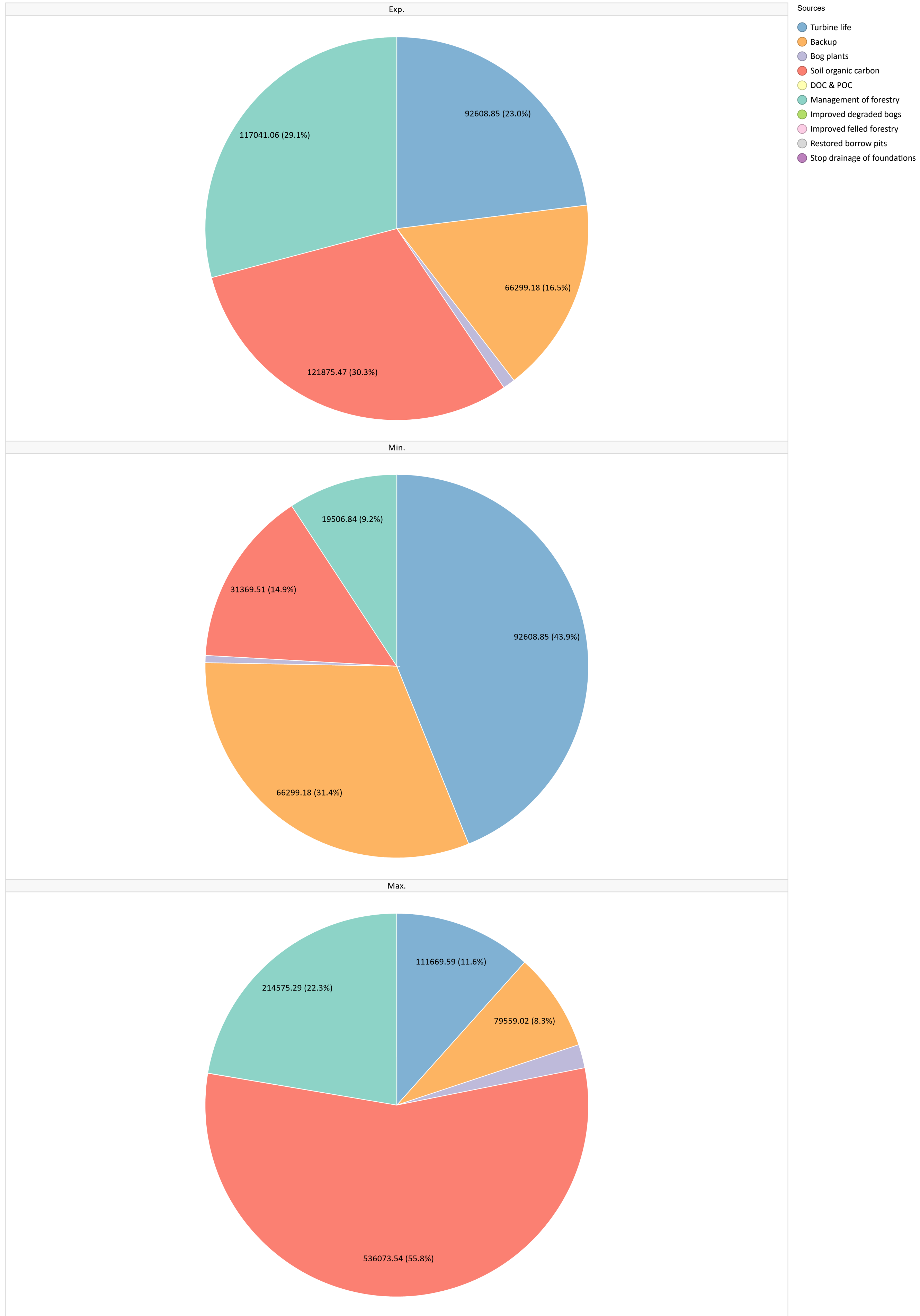
Carbon payback time (months) using fossil-fuel mix as conterfactual



Greenhouse gas emissions (t CO2 eq.)



Proportions of greenhouse gas emissions from different sources



View Input Data • VYXV-DX5B-23SY v5

Print this page

Carbon Calculator v1.8.1

Cummeennabuddoge Wind Farm   Location: 51.99492 -9.167813

Cummeennabuddoge Wind (DAC)

Core input data

Input data	Expected value	Minimum value	Maximum value	Source of data
Windfarm characteristics				
Dimensions				
No. of turbines	17	17	17	Chapter 4: Description of Development
Duration of consent (years)	35	35	35	Chapter 4: Description of Development
Performance				
Power rating of 1 turbine (MW)	6	6	7.2	Chapter 4: Description of Development
Capacity factor	35	34.999999	35.000001	Chapter 4: Description of Development which sourced its figure from: Baringa (2018). A 70% Renewable Electricity Vision for Ireland in 2030. [Online] Available at https://windenergyireland.com/images/files/70by30-report-final.pdf Accessed 18 July 2022
Backup				
Fraction of output to backup (%)	5	5	5	The extra electricity generation capacity required to maintain electricity supply during times of low wind generation. It 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).
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	Chapter 10 - Soils, Geology and Hydrogeology
Average annual air temperature at site (°C)	10.44	10.439999	10.440001	Chapter 12 - Air and Climate
Average depth of peat at site (m)	1.3	1.299999	1.300001	Appendix 10-3 PMP
C Content of dry peat (% by weight)	55.5	49	62	Default value: An estimate of the range of %C in peat of between 49% and 62% is provided by Birnie et al. (1991). Estimated value is the median of the range.
Average extent of drainage around drainage features at site (m)	10	5	50	Carbon Calculator Estimated Value
Average water table depth at site (m)	0	0	1	Technical Appendix 10-1 Geotechnical Interpretive Report
Dry soil bulk density (g cm^{-3})	0.132	0.072	0.293	Carbon Calculator Estimated Value
Characteristics of bog plants				
Time required for regeneration of bog plants after restoration (years)	10	5	15	Carbon Calculator Value: "The physical and hydrological restoration of the site post construction, even if no wider site improvements and restoration are undertaken, should allow the vegetation to recover more rapidly than within 15 years."
Carbon accumulation due to C fixation by bog plants in undrained peats (tC ha^{-1} yr^{-1})	0.25	0.12	0.31	Carbon Calculator default value: Apparent C accumulation rate in peatland is 0.12 to 0.31 tC ha-1 yr-1 (Turunen et al., 2001; Botch et al., 1995). The SNH guidance uses a value of 0.25 tC ha-1 yr-1 .
Forestry Plantation Characteristics				
Area of forestry plantation to be felled (ha)	152	151.999999	152.000001	Technical Appendix 4-2 Forestry Management Plan and Chapter 4: Project Description
Average rate of carbon sequestration in timber (tC ha^{-1} yr^{-1})	6	1	11	Values of 13.2 , 11.8, 14.5 for expected, minimum and maximum respectively taken from "Calculating potential carbon losses and savings from wind farms on Scottish peatlands Technical Note – Version 2.10.0" However the carbon calculator allowed values between 0 and 11 only. Full range given with the expected value as the median 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	4	4	4	Chapter 4: Description of Development
Average length of pits (m)	342.5175	342.5175	342.5175	Each borrow pit is irregular, the average area of all four borrow pits is 34,251.75 m2 based on Chapter 4: Description of Development Table 4-1. As such the value has been entered which provides the total area when length x width is performed.
Average width of pits (m)	100	100	100	Each borrow pit is irregular, the average area of all four borrow pits is 34,251.75 m2 based on Chapter 4: Description of Development Table 4-1. As such the value has been entered which provides the total area when length x width is performed.
Average depth of peat removed from pit (m)	1.25	1.25	1.25	Appendix 10-3 PMP. Value is the average of the averages of all Borrow Pits
Foundations and hard-standing area associated with each turbine				
Average length of turbine foundations (m)	38	38	38	The foundations are irregular in shape, as such a value has been entered which provides the total area of one turbine foundation when width x length is performed. Total area of all 17 foundations can be found in Chapter 4: Description of Development
Average width of turbine foundations (m)	10	10	10	The foundations are irregular in shape, as such a value has been entered which provides the total area of one turbine foundation when width x length is performed. Total area of all 17 foundations can be found in Chapter 4: Description of Development
Average depth of peat removed from turbine foundations(m)	1.3	1.3	1.3	Appendix 10-3 PMP
Average length of hard-standing (m)	109.319	109.319	109.319	This is used to find area of the turbine hardstanding. The hardstandings are irregular in shape, as such a value has been entered which provides the average area of one hardstanding when width x length is performed. Total area of all 17 hardstandings can be found in Chapter 4: Description of Development.
Average width of hard-standing (m)	100	100	100	This is used to find area of the turbine hardstanding. The hardstandings are irregular in shape, as such a value has been entered which provides the average area of one hardstanding when width x length is performed. Total area of all 17 hardstandings can be found in Chapter 4: Description of Development.
Average depth of peat removed from hard-standing (m)	1.3	1.3	1.3	Appendix 10-3 PMP
Volume of concrete used in construction of the ENTIRE windfarm				
Volume of concrete (m^3)	16625	16625	16625	Chapter 4: Description of Development
Access tracks				
Total length of access track (m)	26039	26038.999999	26039.000001	Chapter 4: Description of Development.
Existing track length (m)	6999	6999	6999	Chapter 4: Description of Development
Length of access track that is floating road (m)	0	0	0	
Floating road width (m)	0	0	0	
Floating road depth (m)	0	0	0	
Length of floating road that is drained (m)	0	0	0	
Average depth of drains associated with floating roads (m)	0	0	0	
Length of access track that is excavated road (m)	0	0	0	
Excavated road width (m)	0	0	0	
Average depth of peat excavated for road (m)	0	0	0	
Length of access track that is rock filled road (m)	19040	19039.999999	19040.000001	Chapter 4: Description of Development. All access track is rock filled road.
Rock filled road width (m)	5	5	5	Chapter 4: Description of Development
Rock filled road depth (m)	1.3	1.299999	1.300001	Planning Application Drawings
Length of rock filled road that is drained (m)	19040	19039.999999	19040.000001	Chapter 11: Hydrology, Water Quality and Flood Risk. All rock filled road will be drained
Average depth of drains associated with rock filled roads (m)	0.5	0.5	1.5	Chapter 11: Hydrology
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)	1270	1270	1270	Chapter 4: Description of Development
Average depth of peat cut for cable trenches (m)	1.3	1.3	1.3	Chapter 4: Description of Development
Additional peat excavated (not already accounted for above)				
Volume of additional peat excavated (m^3)	33049.3	33049.3	33049.3	Appendix 10-3 PMP. Includes: Substation, Met Mast Hardstand, Contractor Compound.
Area of additional peat excavated (m^2)	28914	28914	28914	Chapter 4: Description of Development. Includes: Substation, Met Mast Hardstand, Contractor Compound.
Peat Landslide Hazard				
Peat Landslide Hazard and Risk Assessments: Best Practice Guide for Proposed Electricity Generation Developments	negligible	negligible	negligible	Fixed
Improvement of C sequestration at site by blocking drains, restoration of habitat etc				
Improvement of degraded bog				
Area of degraded bog to be improved (ha)	0	0	0	n/a as no degraded bog will be improved
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				
Area of felled plantation to be improved (ha)	40.03	40.03	40.03	GIS generated, See Figure 4-7a. The areas to be improved are the green felling area circles around the turbines, minus the hardstands and access tracks.
Water table depth in felled area before improvement (m)	0	0	2.5	No borehole data available at this preliminary stage. Trial pits show 0-2.5m water depth (Appendix 10-1).
Water table depth in felled area after improvement (m)	0	0	1	No borehole data available at this preliminary stage. Trial pits show 0-2.5m water depth (Appendix 10-1). A maximum value of 1 was selected due to input constaints on the carbon calculator
Time required for hydrology and habitat of felled plantation to return to its previous state on				The habitats we are restoring are wet heath and to a lesser extent, blanket bog. Time to target condition for wet heath to reach good condition is 30 years. This is based on information in Table TS3-1 which assumes 'Heathland and shrub - Upland Heathland' as a correlate for wet heath as there is not a wet heath category https://www.n-

5. Loss of soil CO2 (a, b)

Payback Time
Payback Time - ChartsInput Data
1. Windfarm CO2 emission saving 2. CO2 loss due to turbine life 3. CO2 loss due to backup 4. Loss of CO2 fixing potential 5. Loss of soil CO2 (a,b) 5. Loss of soil CO2 (c,d,e) 6. CO2 loss by DOC & POC loss 7. Forestry CO2 loss 8. CO2 gain - site improvement
Edit input... New app...
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5. Loss of soil CO_2 (a, b) • VYXV-DX5B-23SY v5

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.)	123754....	31369.51	341289....
CO2 loss from drained peat (t CO2 equiv.)	-1878.68	0	194784....
RESULTS			
Total CO2 loss from peat (removed + drained) (t CO2 equiv.)	121875....	31369.51	536073....
Additional CO2 payback time of windfarm due to loss of soil C...			
...coal-fired electricity generation (months)	4.95	1.27	18.14
...grid-mix of electricity generation (months)	22.59	5.81	82.81
...fossil fuel - mix of electricity generation (months)	11.03	2.84	40.43

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)	155280....	74778.64	385042....
CO2 loss from undrained peat left in situ (t CO2)	31526.02	43409.13	43753.17
RESULTS			
CO2 loss atributable to peat removal only (t CO2)	123754....	31369.51	341289....

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)	137007	137007	137007
Volume of peat removed from borrow pits (m3)	171258.75	171258.75	171258.75
Peat removed from turbine foundations			
Area of land lost in foundation (m2)	6460	6460	6460
Volume of peat removed from foundation area (m3)	8398	8398	8398
Peat removed from hard-standing			
Area of land lost in hard-standing (m2)	185842.3	185842.3	185842.3
Volume of peat removed from hard-standing area (m3)	241594.99	241594.99	241594.99
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)	0	0	0
Volume of peat removed from excavated roads (m3)	0	0	0
Area of land lost in rock-filled roads (m2)	95200	95200	95200
Volume of peat removed from rock-filled roads (m3)	123760	123759.9	123760.1
Total area of land lost in access tracks (m2)	95200	95200	95200
Total volume of peat removed due to access tracks (m3)	123760	123759.9	123760.1
RESULTS			
Total area of land lost due to windfarm construction (m2)	453423.3	453423.3	453423.3
Total volume of peat removed due to windfarm construction (m3)	578061.04	578060.94	578061.14

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

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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5. Loss of soil CO_2 (c, d, e) • VYXV-DX5B-23SY v5

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)	37001.4	18100.7	217007
Total volume affected by drainage around borrow pits (m3)	23125.88	11312.94	135629.38
Peat affected by drainage around turbine foundation and hardstanding			
Total area affected by drainage of foundation and hardstanding area (m2)	94288.46	45444.23	607442.3
Total volume affected by drainage of foundation and hardstanding area (m3)	61287.5	29538.75	394837.5
Peat affected by drainage of access tracks			
Total area affected by drainage of access track(m2)	380800	190400	1904000
Total volume affected by drainage of access track(m3)	95200	47600	1428000
Peat affected by drainage of cable trenches			
Total area affected by drainage of cable trenches(m2)	25400	12700	127000
Total volume affected by drainage of cable trneches(m3)	16510	8255	82550
Drainage around additional peat excavated			
Total area affected by drainage (m2)	6341.96	3092.44	37992.99
Total volume affected by drainage (m3)	7248.99	3534.72	43426.78
RESULTS			
Total area affected by drainage due to windfarm (m2)	543831.82	269737.37	2893442.29
Total volume affected by drainage due to windfarm (m3)	203372.37	100241.41	2084443.65

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.)	54630.38	12967.35	1388432....
Total GHG emissions from Undrained Land (t CO2 equiv.)	56509.06	12967.35	1193648....
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.)	384.65	5.79	107.21
CO2 emissions from drained land (t CO2)	36170.28	25817.91	324657.58
Total GHG emissions from Drained Land (t CO2 equiv.)	54630.38	12967.35	1388432....
Losses if Land is Undrained			
CH4 emissions from undrained land (t CO2 equiv.)	18502.98	5.79	108272.82
CO2 emissions from undrained land (t CO2)	19309.04	25817.91	170930.45
Total GHG emissions from Undrained Land (t CO2 equiv.)	56509.06	12967.35	1193648....
RESULTS			
Total GHG emissions due to drainage (t CO2 equiv.)	-1878.68	0	194784.39

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)	54.38	26.97	289.34
Average water table depth of drained land (m)	0.37	1	0.72
Selected emission characteristics following site specific methodology			
Rate of carbon dioxide emission in drained soil (t CO2/ha year)	14.78	23.93	22.44
Rate of carbon dioxide emission in undrained soil (t CO2/ha year)	0.65	23.93	0.65
Rate of methane emission in drained soil (t CH4-C/ha year)	0.01	0	0
Rate of methane emission in undrained soil (t CH4-C/ha year)	0.5	0	0.5
RESULTS			
Selected rate of carbon dioxide emission in drained soil (t CO2/ha year)	14.78	23.93	22.44
Selected rate of carbon dioxide emission in undrained soil (t CO2/ha year)	0.65	23.93	0.65
Selected rate of methane emission in drained soil (t CH4-C/ha year)	0.01	0	0

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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7. Forestry CO_2 loss • VYXV-DX5B-23SY v5

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)	152	152	152
Carbon sequestered (t C ha-1 yr-1)	6	1	11
Lifetime of windfarm (years)	35	35	35
Carbon sequestered over the lifetime of the windfarm (t C ha-1)	210	35	385
RESULTS			
Total carbon loss due to felling of forestry (t CO2)	117041.06	19506.84	214575.29
Additional CO2 payback time of windfarm due to management of forestry			
...coal-fired electricity generation (months)	4.75	0.79	7.26
...grid-mix of electricity generation (months)	21.7	3.62	33.15
...fossil fuel - mix of electricity generation (months)	10.59	1.77	16.18

8. CO2 gain - site improvement

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

8. CO_2 gain - site improvement • VYXV-DX5B-23SY v5

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	0.5	0.5
CH4 emissions from improved land (t CO2 equiv.)	0	0	0
Selected annual rate of carbone dioxide emissions (t CO2 ha-1 yr-1)	0.652	0.652	0.652
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	0.5	0.5
CH4 emissions from improved land (t CO2 equiv.)	0	0	0
Selected annual rate of carbone dioxide emissions (t CO2 ha-1 yr-1)	0.652	0.652	0.652
CO2 emissions from unimproved land (t CO2 equiv.)	0	0	0
Total GHG emissions from unimproved land (t CO2 eqiv.)	0	0	0
RESULTS			
4. Reduction in GHG emissions due to improvement of site			
Reduction in GHG emissions due to improvement (t CO2 equiv.)	0	0	0

Felled Forestry

	Exp.	Min.	Max.
1. Description of site			
Area to be improved (ha)	0	0	40.03
Depth of peat above water table before improvement (m)	0	0	1.3
Depth of peat above water table after improvement (m)	0	1	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	0.5
CH4 emissions from improved land (t CO2 equiv.)	0	0	0
Selected annual rate of carbone dioxide emissions (t CO2 ha-1 yr-1)	0.652	23.929	0.652
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	0.5	0
CH4 emissions from improved land (t CO2 equiv.)	0	0	0
Selected annual rate of carbone dioxide emissions (t CO2 ha-1 yr-1)	0.652	0.652	24.307
CO2 emissions from unimproved land (t CO2 equiv.)	0	0	0
Total GHG emissions from unimproved land (t CO2 eqiv.)	0	0	0
RESULTS			
4. Reduction in GHG emissions due to improvement of site			
Reduction in GHG emissions due to improvement (t CO2 equiv.)	0	0	0

Borrow Pits

	Exp.	Min.	Max.
1. Description of site			
Area to be improved (ha)	0	0	13.701
Depth of peat above water table before improvement (m)	0	0	1.25
Depth of peat above water table after improvement (m)	0	1	0
2. Losses with improvement			
Improved period (years)	33	33	33
Selected annual rate of methane emissions (t CH4-C ha-1 yr-1)	0.5	0	0.5
CH4 emissions from improved land (t CO2 equiv.)	0	0	3381.979
Selected annual rate of carbone dioxide emissions (t CO2 ha-1 yr-1)	0.652	23.929	0.652
CO2 emissions from improved land (t CO2 equiv.)	0	0	150.994
Total GHG emissions from improved land (t CO2 eqiv.)	0	0	3532.973
3. Losses without improvement			
Improved period (years)	33	33	33
Selected annual rate of methane emissions (t CH4-C ha-1 yr-1)	0.5	0.5	0
CH4 emissions from improved land (t CO2 equiv.)	0	0	0
Selected annual rate of carbone dioxide emissions (t CO2 ha-1 yr-1)	0.652	0.652	24.277
CO2 emissions from unimproved land (t CO2 equiv.)	0	0	10975.975
Total GHG emissions from unimproved land (t CO2 eqiv.)	0	0	10975.975
RESULTS			
4. Reduction in GHG emissions due to improvement of site			
Reduction in GHG emissions due to improvement (t CO2 equiv.)	0	0	7443.002

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	34	34
Selected annual rate of methane emissions (t CH4-C ha-1 yr-1)	0.5	0.5	0.5
CH4 emissions from improved land (t CO2 equiv.)	0	0	0
Selected annual rate of carbone dioxide emissions (t CO2 ha-1 yr-1)	0.652	0.652	0.652
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	34	34
Selected annual rate of methane emissions (t CH4-C ha-1 yr-1)	0.5	0.5	0.5
CH4 emissions from improved land (t CO2 equiv.)	0	0	0
Selected annual rate of carbone dioxide emissions (t CO2 ha-1 yr-1)	0.652	0.652	0.652
CO2 emissions from unimproved land (t CO2 equiv.)	0	0	0
Total GHG emissions from unimproved land (t CO2 eqiv.)	0	0	0
RESULTS			
4. Reduction in GHG emissions due to improvement of site			
Reduction in GHG emissions due to improvement (t CO2 equiv.)	0	0	0

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

3. CO_2 loss due to backup • VYXV-DX5B-23SY v5

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)	44,676	44,676	53,611
Annual emissions due to backup from fossil fuel-mix of electricity generation (tCO2/yr)	1,894	1,894	2,273
RESULTS			
Total emissions due to backup from fossil fuel-mix of electricity generation (tCO2)	66,299	66,299	79,559

1. CO2 emission saving

1. Windfarm CO_2 emission saving • VYXV-DX5B-23SY v5

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 (%)	35.0	35.0	35.0

	Exp.	Min.	Max.
Annual energy output from windfarm (MW/yr)			
RESULTS			
Emissions saving over coal-fired electricity generatio...	295,532	295,532	354,638
Emissions saving over grid-mix of electricity generati...	64,736	64,736	77,683
Emissions saving over fossil fuel - mix of electricity g...	132,598	132,598	159,118

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

2. CO_2 loss due to turbine life • VYXV-DX5B-23SY v5

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)	5139	5139	6260
Emissions due to cement used in construction (t CO2)	5254	5254	5254

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)	92609	92609	111670
Additional CO2 payback time of windfarm due to turbine life			
...coal-fired electricity generation (months)	4	4	4
...grid-mix of electricity generation (months)	17	17	17
...fossil fuel - mix of electricity generation (months)	8	8	8

4. Loss CO2 fixing pot.

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

4. Loss of CO_2 fixing potential • VYXV-DX5B-23SY v5

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)	99.73	72.32	334.69
Total loss of carbon accumulation up to time of restoration (tCO2 eq./ha)	41	18	57
RESULTS			
Total loss of carbon fixation by plants at the site (t CO2)	4114	1273	19022
Additional CO2 payback time of windfarm due to loss of CO2 fixing potential			
...coal-fired electricity generation (months)	0	0	1
...grid-mix of electricity generation (months)	1	0	3
...fossil fuel - mix of electricity generation (months)	0	0	1

6. CO_2 loss by DOC & POC loss • VYXV-DX5B-23SY v5

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	3381.98
Total gaseous loss of C (t C)	0.00	0.00	82.71
Total C loss as DOC (t C)	0.00	0.00	33.08
Total C loss as POC (t C)	0.00	0.00	8.27
RESULTS			
Total CO2 loss due to DOC leaching (t CO2)	0.00	0.00	121.31
Total CO2 loss due to POC leaching (t CO2)	0.00	0.00	30.33
Total CO2 loss due to DOC & POC leaching (t CO2)	0.00	0.00	151.64
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

Cummeennabuddoge Wind Farm

Technical Appendix 12-1 – Carbon Calculator: Scenario Two

CoreInput

Core input data
1. Windfarm characteristics 2. Peatland 3. Bog plants 4. Forestry Plantation 5. Emission factors 6. Borrow pits 7. Foundations and hard-standing 8. Access tracks 9. Cable trenches 10. Additional peat 11. Improvement actions 12. Restoration after decomissioning 13. Methodology & application details
Forestry input data
Construction input data

Save ☐ Signed off for submission

Note: Results are only available once ALL data are correct and complete, and a new version will be created.

New app...

Ref: VYXV-DX5B-23SY v

MENU≡

Help

Core input data | Forestry input data | Construction input data

Windfarm characteristics Page 1 of 12

Expected values	Minimum	Maximum
Dimensions		
Number of Turbines		
17		
Chapter 4: Description of Development	17	17
Duration of consent (years)		
35		
Chapter 4: Description of Development	35	35
Performance		
Power rating of 1 turbine (MW)		
7.2		
Chapter 4: Description of Development	6	7.2
Capacity factor		
Direct input (% estimated capacity factor)		
35	Direct input (% estimated capacity factor)	Direct input (% estimated capacity factor)
Chapter 4: Description of Development which	34.999999	35.000001
Backup		
Fraction of output to backup (%)		
5		
The extra electricity generation capacity	5	5
Additional emissions due to reduced thermal efficiency of the reserve generation (%)		
10		
Fixed	10	10
CO_2 emissions from turbine life (tCO_2/MW) (eg. manufacture, construction, decommisioning)		
Calculate wrt installed capacity	Calculate wrt installed capacity	Calculate wrt installed capacity

Next

Introduction

Core input data comprises 12 pages that must be completed by the user in order to be considered a complete application. Depending on the user input it may be required to fill the fields included in the tabs *"Forestry input data"* and *"Construction input data"*. Results will only be available when the application is COMPLETE and free of errors.

All the fields that are not fixed by the tool are validated before being saved to the database. Any validation message that may occur will appear in red right below the failing field. These validations can be about wrong type of data entered, missing fields, wrong range of data, etc.

Some fields have notes, protocols, and/or assumptions associated to them. Those will be shown clicking in the tabs appearing on the top right corner of the screen, next to the Help tab which, in turn, can be toggled on/off by clicking on it.
Please note that the source of data is required along with the chapter and section of the environmental statement where this information is presented. Use the green boxes placed next to the *Expected* value input boxes. These boxes have a limit of 512 characters.

Please, use the menu on the right top corner to navigate through the pages of the application. You will also find a button to **save** the application. If it is a new application it will generate a code that will appear at the top of the screen (it will be also added to the history of your browser, which can be useful in order to retrieve a forgotten code); it is recommended that you copy that code and store it on your computer for later use.

Number of Turbines: The error ≠ turbines in forestry areas is triggered when the number of turbines specified in this page does not match the number of turbines entered in the forestry areas from the *"Forestry input data"* page.[Analogously when the "Construction input data" is compulsory and values do not match the message ≠ turbines in construction areas will appear.]

Capacity factor: If you select the option *Calculate from "Forestry input data"* you must fill the fields in the "Forestry input data" tab. You may do it at any time but the tool won't allow you to save a complete application (and see the results) until you do so.

Payback Time and CO_2 emissions • VYXV-DX5B-23SY v4

1. Windfarm CO2 emission saving over...	Exp.	Min.	Max.
...coal-fired electricity generation (t CO2 / yr)	354,638	295,532	354,638
...grid-mix of electricity generation (t CO2 / yr)	77,683	64,736	77,683
...fossil fuel-mix of electricity generation (t CO2 / yr)	159,118	132,598	159,118
Energy output from windfarm over lifetime (MWh)	13,134,744	10,945,620	13,134,744

Total CO2 losses due to wind farm (tCO2 eq.)	Exp.	Min.	Max.
2. Losses due to turbine life (eg. manufacture, construction, decomissioning)	111,670	92,609	111,670
3. Losses due to backup	79,559	66,299	79,559
4. Lossess due to reduced carbon fixing potential	4,114	1,273	19,022
5. Losses from soil organic matter	121,875	31,370	536,074
6. Losses due to DOC & POC leaching	0	0	152
7. Losses due to felling forestry	117,041	19,507	214,575
Total losses of carbon dioxide	434,259	211,057	961,051

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	-7,443
8d. Change in emissions due to removal of drainage from foundations & hardstanding	0	0	0
Total change in emissions due to improvements	0	0	-7,443

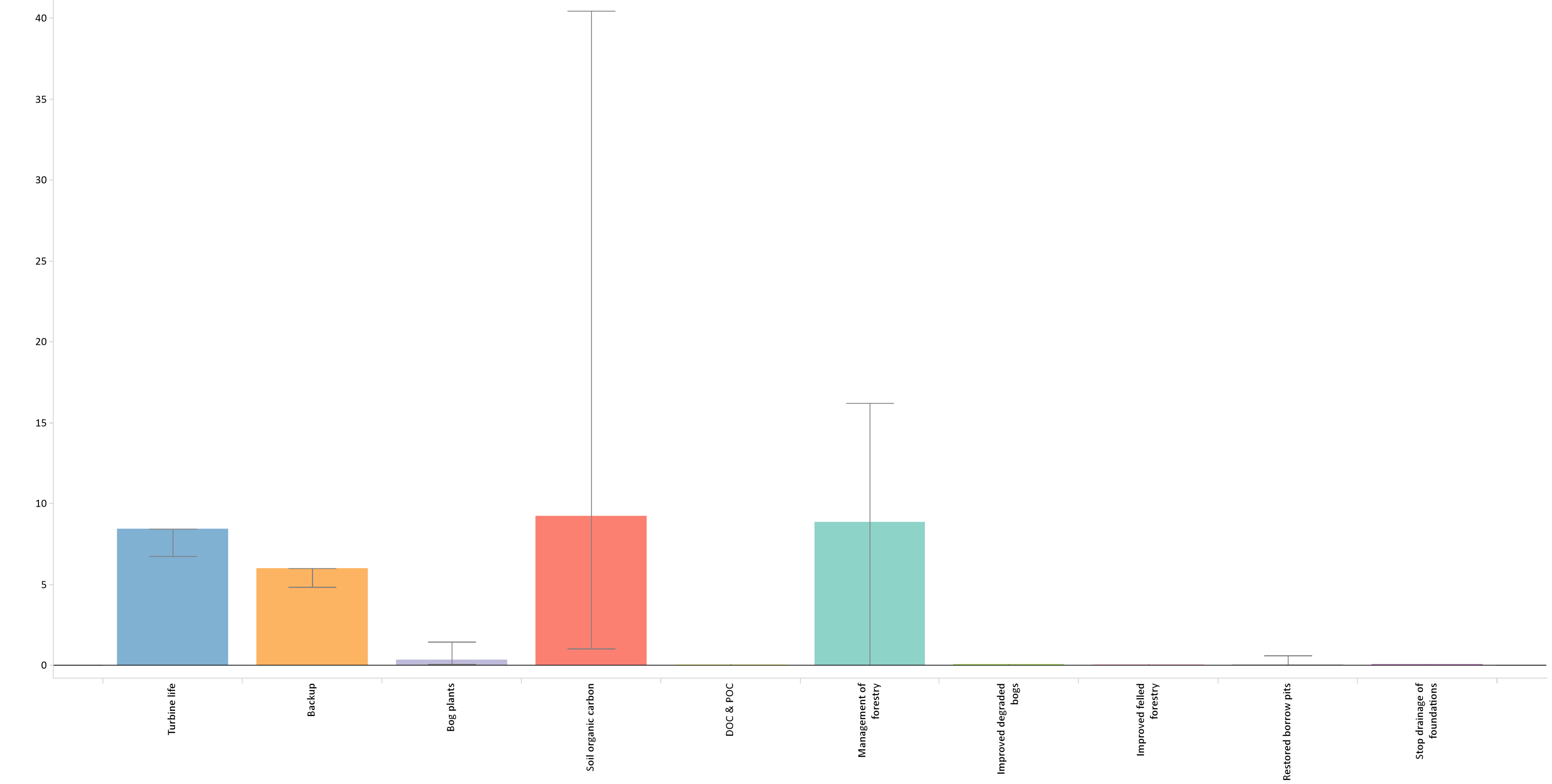
RESULTS	Exp.	Min.	Max.
Net emissions of carbon dioxide (t CO2 eq.)	434,259	203,614	961,051
Carbon Payback Time			
...coal-fired electricity generation (years)	1.2	0.6	3.3
...grid-mix of electricity generation (years)	5.6	2.6	14.8
...fossil fuel-mix of electricity generation (years)	2.7	1.3	7.2
Ratio of soil carbon loss to gain by restoration (not used in Scottish applications)	No gains!	4.21	No gains!
Ratio of CO2 eq. emissions to power generation (g/kWh) (for info. only)	33.06	15.50	87.80

Payback Time - Charts

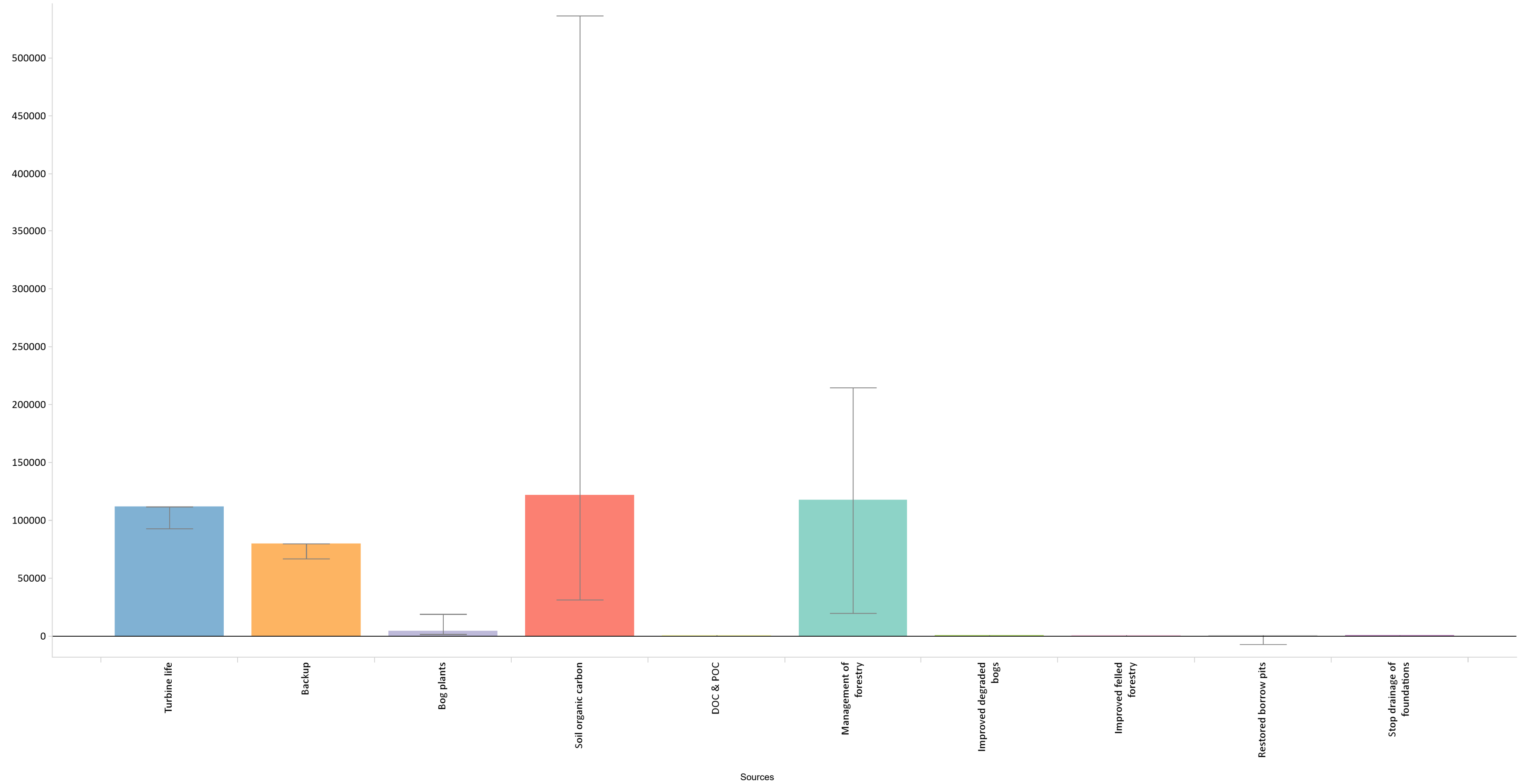
Payback Time
Payback Time - ChartsInput Data
1. Windfarm CO2 emission saving 2. CO2 loss due to turbine life 3. CO2 loss due to backup 4. Loss of CO2 fixing potential 5. Loss of soil CO2 (a,b) 5. Loss of soil CO2 (c,d,e) 6. CO2 loss by DOC & POC loss 7. Forestry CO2 loss 8. CO2 gain - site improvement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

Payback Time and CO_2 emissions • VYXV-DX5B-23SY v4

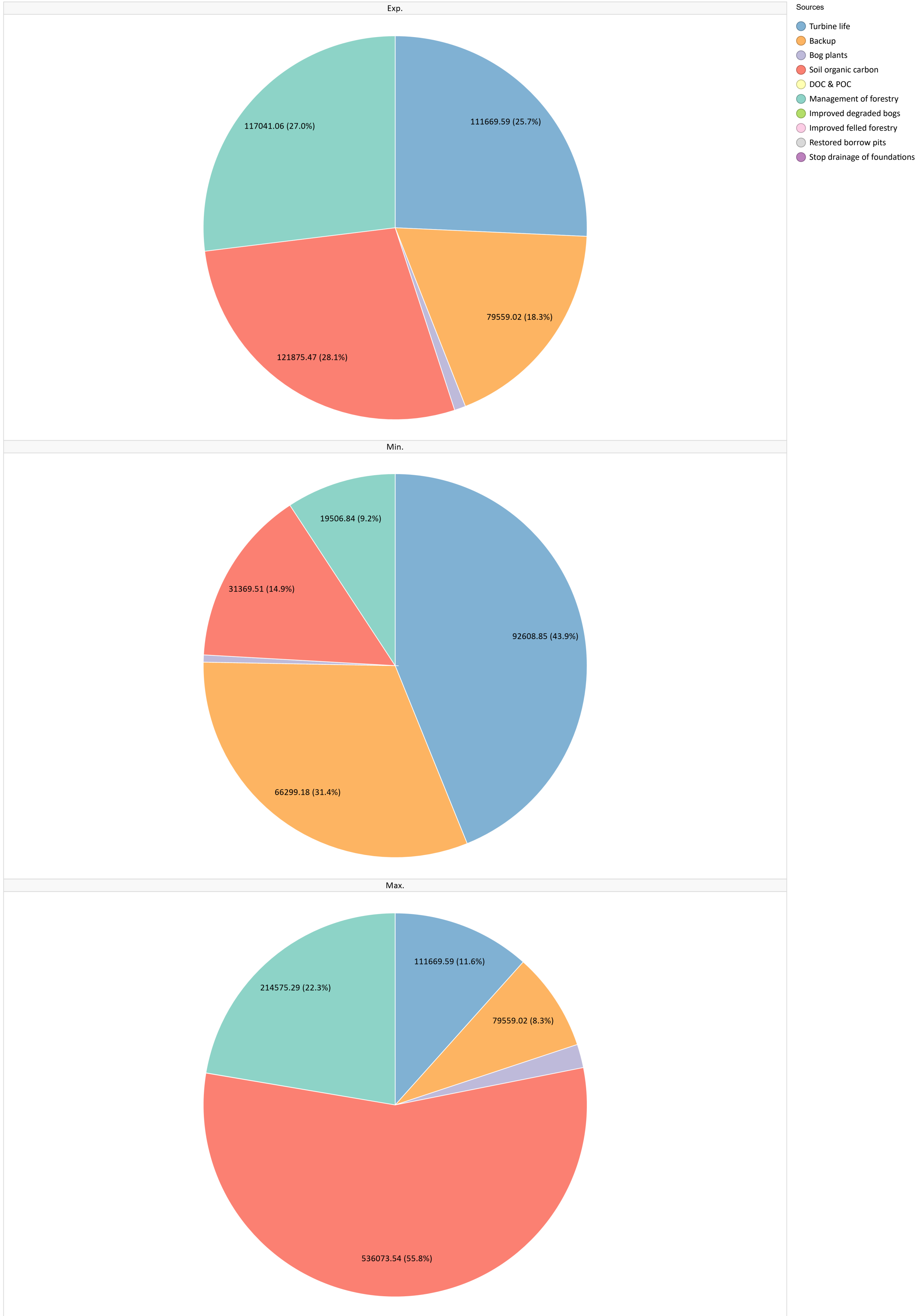
Carbon payback time (months) using fossil-fuel mix as conterfactual



Greenhouse gas emissions (t CO2 eq.)



Proportions of greenhouse gas emissions from different sources



View Input Data • VYXV-DX5B-23SY v4

Print this page

Carbon Calculator v1.8.1

Cummeennabuddoge Wind Farm Location: 51.99492 -9.167813

Cummeennabuddoge Wind (DAC)

Core input data

Input data	Expected value	Minimum value	Maximum value	Source of data
Windfarm characteristics				
Dimensions				
No. of turbines	17	17	17	Chapter 4: Description of Development
Duration of consent (years)	35	35	35	Chapter 4: Description of Development
Performance				
Power rating of 1 turbine (MW)	7.2	6	7.2	Chapter 4: Description of Development
Capacity factor	35	34.999999	35.000001	Chapter 4: Description of Development which sourced its figure from: Baringa (2018). A 70% Renewable Electricity Vision for Ireland in 2030. [Online] Available at https://windenergyireland.com/images/files/70by30-report-final.pdf Accessed 18 July 2022
Backup				
Fraction of output to backup (%)	5	5	5	The extra electricity generation capacity required to maintain electricity supply during times of low wind generation. It 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).
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	Chapter 10 - Soils, Geology and Hydrogeology
Average annual air temperature at site (°C)	10.44	10.439999	10.440001	Chapter 12 - Air and Climate
Average depth of peat at site (m)	1.3	1.299999	1.300001	Appendix 10-3 PMP
C Content of dry peat (% by weight)	55.5	49	62	Default value: An estimate of the range of %C in peat of between 49% and 62% is provided by Birnie et al. (1991). Estimated value is the median of the range.
Average extent of drainage around drainage features at site (m)	10	5	50	Carbon Calculator Estimated Value
Average water table depth at site (m)	0	0	1	Technical Appendix 10-1 Geotechnical Interpretive Report
Dry soil bulk density (g cm^{-3})	0.132	0.072	0.293	Carbon Calculator Estimated Value
Characteristics of bog plants				
Time required for regeneration of bog plants after restoration (years)	10	5	15	Carbon Calculator Value: "The physical and hydrological restoration of the site post construction, even if no wider site improvements and restoration are undertaken, should allow the vegetation to recover more rapidly than within 15 years."
Carbon accumulation due to C fixation by bog plants in undrained peats (tC ha^{-1} yr^{-1})	0.25	0.12	0.31	Carbon Calculator default value: Apparent C accumulation rate in peatland is 0.12 to 0.31 tC ha-1 yr-1 (Turunen et al., 2001; Botch et al., 1995). The SNH guidance uses a value of 0.25 tC ha-1 yr-1 .
Forestry Plantation Characteristics				
Area of forestry plantation to be felled (ha)	152	151.999999	152.000001	Technical Appendix 4-2 Forestry Management Plan and Chapter 4: Project Description
Average rate of carbon sequestration in timber (tC ha^{-1} yr^{-1})	6	1	11	Values of 13.2 , 11.8, 14.5 for expected, minimum and maximum respectively taken from "Calculating potential carbon losses and savings from wind farms on Scottish peatlands Technical Note – Version 2.10.0" However the carbon calculator allowed values between 0 and 11 only. Full range given with the expected value as the median 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	4	4	4	Chapter 4: Description of Development
Average length of pits (m)	342.5175	342.5175	342.5175	Each borrow pit is irregular, the average area of all four borrow pits is 34,251.75 m2 based on Chapter 4: Description of Development Table 4-1. As such the value has been entered which provides the total area when length x width is performed.
Average width of pits (m)	100	100	100	Each borrow pit is irregular, the average area of all four borrow pits is 34,251.75 m2 based on Chapter 4: Description of Development Table 4-1. As such the value has been entered which provides the total area when length x width is performed.
Average depth of peat removed from pit (m)	1.25	1.25	1.25	Appendix 10-3 PMP. Value is the average of the averages of all Borrow Pits
Foundations and hard-standing area associated with each turbine				
Average length of turbine foundations (m)	38	38	38	The foundations are irregular in shape, as such a value has been entered which provides the total area of one turbine foundation when width x length is performed. Total area of all 17 foundations can be found in Chapter 4: Description of Development
Average width of turbine foundations (m)	10	10	10	The foundations are irregular in shape, as such a value has been entered which provides the total area of one turbine foundation when width x length is performed. Total area of all 17 foundations can be found in Chapter 4: Description of Development
Average depth of peat removed from turbine foundations(m)	1.3	1.3	1.3	Appendix 10-3 PMP
Average length of hard-standing (m)	109.319	109.319	109.319	This is used to find area of the turbine hardstanding. The hardstandings are irregular in shape, as such a value has been entered which provides the average area of one hardstanding when width x length is performed. Total area of all 17 hardstandings can be found in Chapter 4: Description of Development.
Average width of hard-standing (m)	100	100	100	This is used to find area of the turbine hardstanding. The hardstandings are irregular in shape, as such a value has been entered which provides the average area of one hardstanding when width x length is performed. Total area of all 17 hardstandings can be found in Chapter 4: Description of Development.
Average depth of peat removed from hard-standing (m)	1.3	1.3	1.3	Appendix 10-3 PMP
Volume of concrete used in construction of the ENTIRE windfarm				
Volume of concrete (m^3)	16625	16625	16625	Chapter 4: Description of Development
Access tracks				
Total length of access track (m)	26039	26038.999999	26039.000001	Chapter 4: Description of Development.
Existing track length (m)	6999	6999	6999	Chapter 4: Description of Development
Length of access track that is floating road (m)	0	0	0	
Floating road width (m)	0	0	0	
Floating road depth (m)	0	0	0	
Length of floating road that is drained (m)	0	0	0	
Average depth of drains associated with floating roads (m)	0	0	0	
Length of access track that is excavated road (m)	0	0	0	
Excavated road width (m)	0	0	0	
Average depth of peat excavated for road (m)	0	0	0	
Length of access track that is rock filled road (m)	19040	19039.999999	19040.000001	Chapter 4: Description of Development. All access track is rock filled road.
Rock filled road width (m)	5	5	5	Chapter 4: Description of Development
Rock filled road depth (m)	1.3	1.299999	1.300001	Planning Application Drawings
Length of rock filled road that is drained (m)	19040	19039.999999	19040.000001	Chapter 11: Hydrology, Water Quality and Flood Risk. All rock filled road will be drained
Average depth of drains associated with rock filled roads (m)	0.5	0.5	1.5	Chapter 11: Hydrology
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)	1270	1270	1270	Chapter 4: Description of Development
Average depth of peat cut for cable trenches (m)	1.3	1.3	1.3	Chapter 4: Description of Development
Additional peat excavated (not already accounted for above)				
Volume of additional peat excavated (m^3)	33049.3	33049.3	33049.3	Appendix 10-3 PMP. Includes: Substation, Met Mast Hardstand, Contractor Compound.
Area of additional peat excavated (m^2)	28914	28914	28914	Chapter 4: Description of Development. Includes: Substation, Met Mast Hardstand, Contractor Compound.
Peat Landslide Hazard				
Peat Landslide Hazard and Risk Assessments: Best Practice Guide for Proposed Electricity Generation Developments	negligible	negligible	negligible	Fixed
Improvement of C sequestration at site by blocking drains, restoration of habitat etc				
Improvement of degraded bog				
Area of degraded bog to be improved (ha)	0	0	0	n/a as no degraded bog will be improved
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				
Area of felled plantation to be improved (ha)	40.03	40.03	40.03	GIS generated, See Figure 4-7a. The areas to be improved are the green felling area circles around the turbines, minus the hardstands and access tracks.
Water table depth in felled area before improvement (m)	0	0	2.5	No borehole data available at this preliminary stage. Trial pits show 0-2.5m water depth (Appendix 10-1).
Water table depth in felled area after improvement (m)	0	0	1	No borehole data available at this preliminary stage. Trial pits show 0-2.5m water depth (Appendix 10-1). A maximum value of 1 was selected due to input constaints on the carbon calculator
Time required for hydrology and habitat of felled plantation to return to its previous state on				The habitats we are restoring are wet heath and to a lesser extent, blanket bog. Time to target condition for wet heath to reach good condition is 30 years. This is based on information in Table TS3-1 which assumes 'Heathland and shrub - Upland Heathland' as a correlate for wet heath as there is not a wet heath category https://www.n-

5. Loss of soil CO2 (a, b)

5. Loss of soil CO_2 (a, b) • VYXV-DX5B-23SY v4

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.)	123754....	31369.51	341289....
CO2 loss from drained peat (t CO2 equiv.)	-1878.68	0	194784....
RESULTS			
Total CO2 loss from peat (removed + drained) (t CO2 equiv.)	121875....	31369.51	536073....
Additional CO2 payback time of windfarm due to loss of soil C...			
...coal-fired electricity generation (months)	4.12	1.27	18.14
...grid-mix of electricity generation (months)	18.83	5.81	82.81
...fossil fuel - mix of electricity generation (months)	9.19	2.84	40.43

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)	155280....	74778.64	385042....
CO2 loss from undrained peat left in situ (t CO2)	31526.02	43409.13	43753.17
RESULTS			
CO2 loss atributable to peat removal only (t CO2)	123754....	31369.51	341289....

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)	137007	137007	137007
Volume of peat removed from borrow pits (m3)	171258.75	171258.75	171258.75
Peat removed from turbine foundations			
Area of land lost in foundation (m2)	6460	6460	6460
Volume of peat removed from foundation area (m3)	8398	8398	8398
Peat removed from hard-standing			
Area of land lost in hard-standing (m2)	185842.3	185842.3	185842.3
Volume of peat removed from hard-standing area (m3)	241594.99	241594.99	241594.99
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)	0	0	0
Volume of peat removed from excavated roads (m3)	0	0	0
Area of land lost in rock-filled roads (m2)	95200	95200	95200
Volume of peat removed from rock-filled roads (m3)	123760	123759.9	123760.1
Total area of land lost in access tracks (m2)	95200	95200	95200
Total volume of peat removed due to access tracks (m3)	123760	123759.9	123760.1
RESULTS			
Total area of land lost due to windfarm construction (m2)	453423.3	453423.3	453423.3
Total volume of peat removed due to windfarm construction (m3)	578061.04	578060.94	578061.14

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

5. Loss of soil CO_2 (c, d, e) • VYXV-DX5B-23SY v4

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)	37001.4	18100.7	217007
Total volume affected by drainage around borrow pits (m3)	23125.88	11312.94	135629.38
Peat affected by drainage around turbine foundation and hardstanding			
Total area affected by drainage of foundation and hardstanding area (m2)	94288.46	45444.23	607442.3
Total volume affected by drainage of foundation and hardstanding area (m3)	61287.5	29538.75	394837.5
Peat affected by drainage of access tracks			
Total area affected by drainage of access track(m2)	380800	190400	1904000
Total volume affected by drainage of access track(m3)	95200	47600	1428000
Peat affected by drainage of cable trenches			
Total area affected by drainage of cable trenches(m2)	25400	12700	127000
Total volume affected by drainage of cable trneches(m3)	16510	8255	82550
Drainage around additional peat excavated			
Total area affected by drainage (m2)	6341.96	3092.44	37992.99
Total volume affected by drainage (m3)	7248.99	3534.72	43426.78
RESULTS			
Total area affected by drainage due to windfarm (m2)	543831.82	269737.37	2893442.29
Total volume affected by drainage due to windfarm (m3)	203372.37	100241.41	2084443.65

5d. CO2 loss from drained peat

	Exp.	Min.	Max.
Calculations of C Loss from Drained Land if Site is NOT Restored after Decomissioning			
Total GHG emissions from Drained Land (t CO2 equiv.)	54630.38	12967.35	1388432....
Total GHG emissions from Undrained Land (t CO2 equiv.)	56509.06	12967.35	1193648....
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.)	384.65	5.79	107.21
CO2 emissions from drained land (t CO2)	36170.28	25817.91	324657.58
Total GHG emissions from Drained Land (t CO2 equiv.)	54630.38	12967.35	1388432....
Losses if Land is Undrained			
CH4 emissions from undrained land (t CO2 equiv.)	18502.98	5.79	108272.82
CO2 emissions from undrained land (t CO2)	19309.04	25817.91	170930.45
Total GHG emissions from Undrained Land (t CO2 equiv.)	56509.06	12967.35	1193648....
RESULTS			
Total GHG emissions due to drainage (t CO2 equiv.)	-1878.68	0	194784.39

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)	54.38	26.97	289.34
Average water table depth of drained land (m)	0.37	1	0.72
Selected emission characteristics following site specific methodology			
Rate of carbon dioxide emission in drained soil (t CO2/ha year)	14.78	23.93	22.44
Rate of carbon dioxide emission in undrained soil (t CO2/ha year)	0.65	23.93	0.65
Rate of methane emission in drained soil (t CH4-C/ha year)	0.01	0	0
Rate of methane emission in undrained soil (t CH4-C/ha year)	0.5	0	0.5
RESULTS			
Selected rate of carbon dioxide emission in drained soil (t CO2/ha year)	14.78	23.93	22.44
Selected rate of carbon dioxide emission in undrained soil (t CO2/ha year)	0.65	23.93	0.65
Selected rate of methane emission in drained soil (t CH4-C/ha year)	0.01	0	0

7. Forestry CO2 loss

7. Forestry CO_2 loss • VYXV-DX5B-23SY v4

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)	152	152	152
Carbon sequestered (t C ha-1 yr-1)	6	1	11
Lifetime of windfarm (years)	35	35	35
Carbon sequestered over the lifetime of the windfarm (t C ha-1)	210	35	385
RESULTS			
Total carbon loss due to felling of forestry (t CO2)	117041.06	19506.84	214575.29
Additional CO2 payback time of windfarm due to management of forestry			
...coal-fired electricity generation (months)	3.96	0.79	7.26
...grid-mix of electricity generation (months)	18.08	3.62	33.15
...fossil fuel - mix of electricity generation (months)	8.83	1.77	16.18

8. CO_2 gain - site improvement

8. CO_2 gain - site improvement • VYXV-DX5B-23SY v4

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	0.5	0.5
CH4 emissions from improved land (t CO2 equiv.)	0	0	0
Selected annual rate of carbone dioxide emissions (t CO2 ha-1 yr-1)	0.652	0.652	0.652
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	0.5	0.5
CH4 emissions from improved land (t CO2 equiv.)	0	0	0
Selected annual rate of carbone dioxide emissions (t CO2 ha-1 yr-1)	0.652	0.652	0.652
CO2 emissions from unimproved land (t CO2 equiv.)	0	0	0
Total GHG emissions from unimproved land (t CO2 eqiv.)	0	0	0
RESULTS			
4. Reduction in GHG emissions due to improvement of site			
Reduction in GHG emissions due to improvement (t CO2 equiv.)	0	0	0

Felled Forestry

	Exp.	Min.	Max.
1. Description of site			
Area to be improved (ha)	0	0	40.03
Depth of peat above water table before improvement (m)	0	0	1.3
Depth of peat above water table after improvement (m)	0	1	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	0.5
CH4 emissions from improved land (t CO2 equiv.)	0	0	0
Selected annual rate of carbone dioxide emissions (t CO2 ha-1 yr-1)	0.652	23.929	0.652
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	0.5	0
CH4 emissions from improved land (t CO2 equiv.)	0	0	0
Selected annual rate of carbone dioxide emissions (t CO2 ha-1 yr-1)	0.652	0.652	24.307
CO2 emissions from unimproved land (t CO2 equiv.)	0	0	0
Total GHG emissions from unimproved land (t CO2 eqiv.)	0	0	0
RESULTS			
4. Reduction in GHG emissions due to improvement of site			
Reduction in GHG emissions due to improvement (t CO2 equiv.)	0	0	0

Borrow Pits

	Exp.	Min.	Max.
1. Description of site			
Area to be improved (ha)	0	0	13.701
Depth of peat above water table before improvement (m)	0	0	1.25
Depth of peat above water table after improvement (m)	0	1	0
2. Losses with improvement			
Improved period (years)	33	33	33
Selected annual rate of methane emissions (t CH4-C ha-1 yr-1)	0.5	0	0.5
CH4 emissions from improved land (t CO2 equiv.)	0	0	3381.979
Selected annual rate of carbone dioxide emissions (t CO2 ha-1 yr-1)	0.652	23.929	0.652
CO2 emissions from improved land (t CO2 equiv.)	0	0	150.994
Total GHG emissions from improved land (t CO2 eqiv.)	0	0	3532.973
3. Losses without improvement			
Improved period (years)	33	33	33
Selected annual rate of methane emissions (t CH4-C ha-1 yr-1)	0.5	0.5	0
CH4 emissions from improved land (t CO2 equiv.)	0	0	0
Selected annual rate of carbone dioxide emissions (t CO2 ha-1 yr-1)	0.652	0.652	24.277
CO2 emissions from unimproved land (t CO2 equiv.)	0	0	10975.975
Total GHG emissions from unimproved land (t CO2 eqiv.)	0	0	10975.975
RESULTS			
4. Reduction in GHG emissions due to improvement of site			
Reduction in GHG emissions due to improvement (t CO2 equiv.)	0	0	7443.002

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	34	34
Selected annual rate of methane emissions (t CH4-C ha-1 yr-1)	0.5	0.5	0.5
CH4 emissions from improved land (t CO2 equiv.)	0	0	0
Selected annual rate of carbone dioxide emissions (t CO2 ha-1 yr-1)	0.652	0.652	0.652
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	34	34
Selected annual rate of methane emissions (t CH4-C ha-1 yr-1)	0.5	0.5	0.5
CH4 emissions from improved land (t CO2 equiv.)	0	0	0
Selected annual rate of carbone dioxide emissions (t CO2 ha-1 yr-1)	0.652	0.652	0.652
CO2 emissions from unimproved land (t CO2 equiv.)	0	0	0
Total GHG emissions from unimproved land (t CO2 eqiv.)	0	0	0
RESULTS			
4. Reduction in GHG emissions due to improvement of site			
Reduction in GHG emissions due to improvement (t CO2 equiv.)	0	0	0

3. CO2 loss backup

3. CO_2 loss due to backup • VYXV-DX5B-23SY v4

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)	53,611	44,676	53,611
Annual emissions due to backup from fossil fuel-mix of electricity generation (tCO2/yr)	2,273	1,894	2,273
RESULTS			
Total emissions due to backup from fossil fuel-mix of electricity generation (tCO2)	79,559	66,299	79,559

1. CO2 emission saving

1. Windfarm CO_2 emission saving • VYXV-DX5B-23SY v4

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 (%)	35.0	35.0	35.0

	Exp.	Min.	Max.
Annual energy output from windfarm (MW/yr)			
RESULTS			
Emissions saving over coal-fired electricity generatio...	354,638	295,532	354,638
Emissions saving over grid-mix of electricity generati...	77,683	64,736	77,683
Emissions saving over fossil fuel - mix of electricity g...	159,118	132,598	159,118

2. CO_2 loss due to turbine life • VYXV-DX5B-23SY v4

Emissions due to turbine life

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

Calculation of emissions with relation to installed capacity

	Exp.	Min.	Max.
Emissions due to turbine frome energy output (t CO2)	6260	5139	6260
Emissions due to cement used in construction (t CO2)	5254	5254	5254

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)	111670	92609	111670
Additional CO2 payback time of windfarm due to turbine life			
...coal-fired electricity generation (months)	4	4	4
...grid-mix of electricity generation (months)	17	17	17
...fossil fuel - mix of electricity generation (months)	8	8	8

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

4. Loss of CO_2 fixing potential • VYXV-DX5B-23SY v4

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)	99.73	72.32	334.69
Total loss of carbon accumulation up to time of restoration (tCO2 eq./ha)	41	18	57
RESULTS			
Total loss of carbon fixation by plants at the site (t CO2)	4114	1273	19022
Additional CO2 payback time of windfarm due to loss of CO2 fixing potential			
...coal-fired electricity generation (months)	0	0	1
...grid-mix of electricity generation (months)	1	0	3
...fossil fuel - mix of electricity generation (months)	0	0	1

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

6. CO_2 loss by DOC & POC loss • VYXV-DX5B-23SY v4

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	3381.98
Total gaseous loss of C (t C)	0.00	0.00	82.71
Total C loss as DOC (t C)	0.00	0.00	33.08
Total C loss as POC (t C)	0.00	0.00	8.27
RESULTS			
Total CO2 loss due to DOC leaching (t CO2)	0.00	0.00	121.31
Total CO2 loss due to POC leaching (t CO2)	0.00	0.00	30.33
Total CO2 loss due to DOC & POC leaching (t CO2)	0.00	0.00	151.64
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