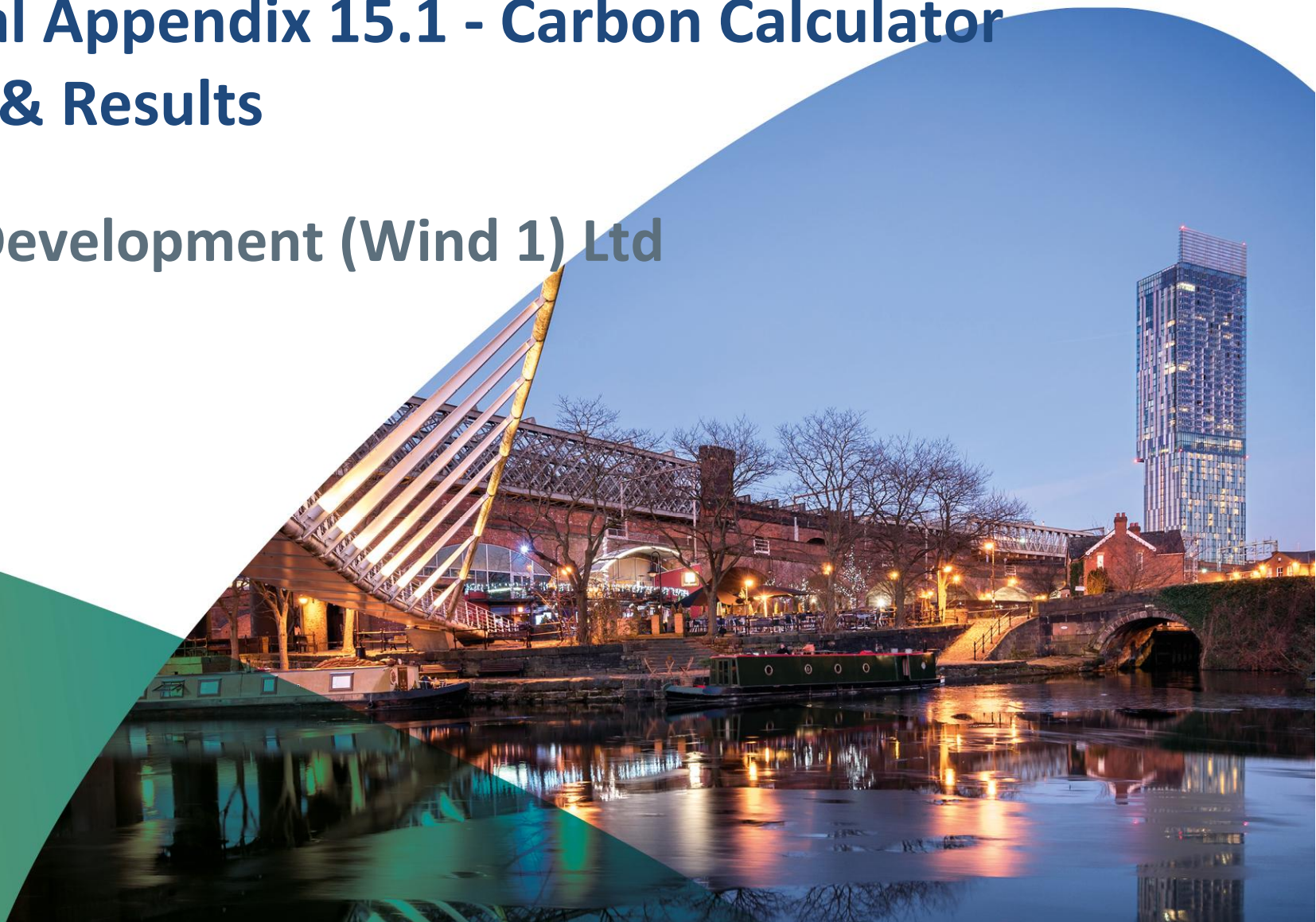


Scout Moor II FEI

ES Technical Appendix 15.1 - Carbon Calculator Input Data & Results

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1. Introduction

1.1 Introduction

This ES Technical Appendix 15.1 reports the input data and associated results of the Scottish Government's Carbon Calculator for wind farms on Scottish Peatland¹, as applied to the Scout Moor II FEI proposals. It should be read in conjunction with ES Chapter 15 Climate Change for which it provides the primary assessment of lifecycle greenhouse gas (GHG) emissions and savings from the construction, operation and decommissioning stages of the Proposed Scheme, including habitat restoration. The forecast 'carbon payback period' is also reported, being the period of time at which GHG emissions during construction are forecast to be balanced out by GHG savings from the operational development.

As explained in ES Chapter 15 Climate Change, the online version of the tool (<https://informatics.sepa.org.uk/CarbonCalculator/>) is not available for use at the time of writing. Scottish Government's Directorate for Energy and Climate Change who administer the tool on behalf of the Scottish Environment Protection Agency (SEPA) provided the Microsoft Excel version of the tool (v 2.14.1) which has been used in the current absence of the online version.

The Directorate notes that the Excel version provided does not exactly replicate the online version due to differences regarding the precision of constants, nevertheless the Excel tool version provided is considered the best and most

reasonable approach available to estimating GHG emissions and savings from the Proposed Scheme, and it is acknowledged that an update of the Carbon Balance Assessment may be necessary once the online version becomes available.

¹ <https://www.gov.scot/publications/carbon-calculator-for-wind-farms-on-scottish-peatlands-factsheet/>

2. Input Data

2.1 Input Data

Table 1 below presents all input data for the Carbon Calculator with associated data sources and assumptions etc.

Table 1. Carbon Calculator Input Data

Section	Details	Data			Notes
		Expected	Minimum	Maximum	
1. Windfarm characteristics					
Dimensions	Number of turbines	12	12	12	12 turbines are proposed.
	Duration of consent (years)	40	40	40	A 40-year duration of planning consent is sought.
Performance	Power rating of turbines (turbine capacity) (MW)	5.7 MW	5.7 MW	5.7 MW	The assessment is based on a 5.7 MW candidate turbine, however turbines with a higher rating e.g. 6 or 7MW may potentially be used in which case 5.7 MW is a reasonable worse case assumption.
	Estimated capacity factor (percentage efficiency)	38.1%	38.1%	38.1%	The assessment is based on a 38.1% capacity factor (percentage efficiency) however a higher figure is likely in which case this is a reasonable worse-case assumption.
Back up	Extra capacity required for backup (%)	5%	5%	5%	The extra capacity needed for backup power generation is estimated to be 5% of the rated capacity of the wind plant where wind power contributes more than 20% to the national grid (Dale et al., 2004). Wind power accounted for 30% of UK electricity generation in 2025 (https://assets.publishing.service.gov.uk/media/69cd1451b5210036050bc625/Energy_Trends_March_2026.pdf)
	Additional emissions due to reduced thermal efficiency of reserve generation	10%	10%	10%	Extra emissions due to reduced thermal efficiency of the reserve power generation ≈10% (Dale et al 2004).

Section	Details	Data			Notes
		Expected	Minimum	Maximum	
Carbon dioxide emissions from turbine life	Total CO ₂ emission from turbine life (tCO ₂ /MW)	Calculate with respect to installed capacity	Calculate with respect to installed capacity	Calculate with respect to installed capacity	
2. Characteristics of peatland before windfarm development					
	Type of peatland	Acid bog	Acid bog	Acid bog	
	Average annual air temperature at site (°C)	7.15	7.15	7.15	Mean annual temperature in southern England is close to 10°C at sea level. The mean annual temperature in Scotland and Northern Ireland is close to 9°C at sea level. These temperatures fall by 0.5°C for each 100 m of altitude above sea level (https://www.icax.co.uk/Mean_Annual_Air_Temperature.html). SMWFII is at an elevation of c. 473m (https://en.wikipedia.org/wiki/Scout_Moor_Wind_Farm). Assuming mean annual air temperature at sea level in the southern Pennines of halfway between the above values for Scotland and southern England (9.5°C) and adjusting for altitude (i.e. subtracting 0.5°C x 4.7) gives 7.15°C.
	Average depth of peat at site (m)	0.54	0.45	0.65	From peat probing
	C Content of dry peat (% by weight)	55	49	62	The default values for carbon content of peat 49% and 62% is provided in the Carbon Calculator. Upper and lower range provided as default, midpoint calculated as mean.
	Average extent of drainage around drainage features at site (m)	19	17	28	Likely worse-case (10m, 5m and 20m values are typical).
	Average water table depth at site (m)	0.10	0.05	0.20	Based on acrotelm depth.
	Dry soil bulk density (g/cm ³)	0.22	0.18	0.22	Estimated from the Von Post scores of peat cores
3. Characteristics of bog plants					
	Time required for regeneration of bog plants after restoration (years)	8	2	25	
	Carbon accumulation due to C fixation by bog plants in undrained peats (tC/ha/yr)	0.25	0.10	0.40	

Section	Details	Data			Notes
		Expected	Minimum	Maximum	
4. Forestry Plantation Characteristics					
	Area of forestry plantation to be felled (ha)	0	0	0	No forestry plantation is to be felled.
	Average rate of carbon sequestration in timber (tC/ha/yr)	N/a	N/a	N/a	Not applicable.
5. Counterfactual emission factors					
	Coal fired (tCO ₂ /MWh)	0.91929	0.91929	0.91929	Digest of UK Energy Statistics (DUKES): Electricity 5.14 – estimated carbon dioxide intensity of electricity supplied, 2024 (https://assets.publishing.service.gov.uk/media/688a2923a11f85999440927c/DUKES_5.14.xlsx)
	Grid mix (tCO ₂ /MWh)	0.15438	0.15438	0.15438	
	Fossil fuel mix (tCO ₂ /MWh)	0.44823	0.44823	0.44823	
6. Borrow pits					
	Number of borrow pits	0	0	0	No borrow pits are proposed.
	Average length of pits (m)	N/a	N/a	N/a	Not applicable.
	Average width of pits (m)	N/a	N/a	N/a	Not applicable.
	Average depth of peat removed from pit (m)	N/a	N/a	N/a	Not applicable.
7. Foundations and hard-standing area associated with each turbine					
	Average length of turbine foundations (m)	25	25	25	Turbine foundations will be circular (not rectangular) with a diameter of 25m hence this is an over-estimate.
	Average width of turbine foundations (m)	25	25	25	
	Average depth of peat removed from turbine foundations (m)	0.38	0.25	0.50	Assumes all turbine bases, crane hardstandings and clearance areas including associated earthworks.
	Average length of hard-standing (m)	54.55	54.55	54.55	Each turbine has a load-bearing hardstanding area of 2,975 sqm comprising 787 sqm of permanent hard-standing and 2,188 sqm of temporary hard-standing.
	Average width of hard-standing (m)	54.55	54.55	54.55	
	Average depth of peat removed from hard-standing (m)	0.38	0.25	0.50	Assumes compound and substation including associated earthworks.
8. Access tracks					
	Total length of access track (m)	15,112	15,112	15,112	

Section	Details	Data			Notes
		Expected	Minimum	Maximum	
	Existing track length (m)	4,884	4,884	4,884	
Floating road	Length of access track (m)	752	752	752	
	Floating road width (m)	6	4.5	6	All tracks are expected to be 6m wide although localised narrowings to a minimum 4.5m may be introduced at detailed design stage.
	Floating road depth (m)	0.8	0.8	0.8	Floated track construction is expected to be 0.8m deep. Localised infills may be required to create a consistent, flat track on top of dips in the undulating peaty terrain.
	Length of floating road that is drained (m)	752	752	752	The only instance a floating road would have no associated drainage would be where it runs exactly perpendicular to the slope or along a ridge crest, hence all floating road is assumed to be drained.
	Average depth of drains associated with floating roads (m)	0.5	0.5	0.5	
Excavated road	Length of access track (m)	9,476	9,476	9,476	
	Excavated road width (m)	6	4.5	6	All tracks are expected to be 6m wide although localised narrowings to a minimum 4.5m may be introduced at detailed design stage.
	Average depth of peat excavated for road (m)	0.54	0.40	0.65	
Rock filled road	Length of access track (m)	0	0	0	No rock filled road is proposed.
	Rock filled road width (m)	N/a	N/a	N/a	Not applicable.
	Rock filled road depth (m)	N/a	N/a	N/a	Not applicable.
	Length of rock filled road that is drained (m)	N/a	N/a	N/a	Not applicable.
	Average depth of drains associated with rock filled roads (m)	N/a	N/a	N/a	Not applicable.
9. Cable trenches					
	Length of any cable trench on peat that does not follow access tracks and is lined with a permeable medium (e.g. sand) (m)	0	0	0	All cable trenches will follow track alignments.
	Average depth of peat cut for cable trenches (m)	N/a	N/a	N/a	Not applicable.

Section	Details	Data			Notes
		Expected	Minimum	Maximum	
10. Additional peat excavated (not already accounted for above)					
	Volume of additional peat excavated (m³)	0	0	0	The total volume of peat to be extracted (96,674 m³) minus the volume of peat to be extracted for turbine foundations (2,693 m³), turbine hardstanding including clearance areas and associated earthworks (41,296 m³), excavated roads including associated earthworks (45,945 m³), including associated earthworks all based on expected peat depths, gives 0 m³ volume of additional peat to be excavated not already accounted for above.
	Area of additional peat excavated (m²)	0	0	0	No additional peat will be excavated.
11. 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)	116.7	116.7	116.7	116.7 ha of peatland restoration is proposed.
	Water table depth in degraded bog before improvement (m)	0.30	0.23	0.38	
	Water table depth in degraded bog after improvement (m)	0.10	0.09	0.11	
	Time required for hydrology and habitat of bog to return to its previous state on improvement (years)	8	2	25	
	Period of time when effectiveness of the improvement in degraded bog can be guaranteed (years)	8	2	25	
Improvement of felled plantation land	Area of felled plantation to be improved (ha)	0	0	0	No forestry plantation is to be felled.
	Water table depth in felled area before improvement (m)	N/a	N/a	N/a	Not applicable.
	Water table depth in felled area after improvement (m)	N/a	N/a	N/a	Not applicable.

Section	Details	Data			Notes
		Expected	Minimum	Maximum	
	Time required for hydrology and habitat of felled plantation to return to its previous state on improvement (years)	N/a	N/a	N/a	Not applicable.
	Period of time when effectiveness of the improvement in felled plantation can be guaranteed (years)	N/a	N/a	N/a	Not applicable.
Restoration of peat removed from borrow pits	Area of borrow pits to be restored (ha)	0	0	0	No borrow pits are proposed.
	Depth of water table in borrow pit before restoration with respect to the restored surface (m)	N/a	N/a	N/a	Not applicable.
	Depth of water table in borrow pit after restoration with respect to the restored surface (m)	N/a	N/a	N/a	Not applicable.
	Time required for hydrology and habitat of borrow pit to return to its previous state on restoration (years)	N/a	N/a	N/a	Not applicable.
	Period of time when effectiveness of the restoration of peat removed from borrow pits can be guaranteed (years)	N/a	N/a	N/a	Not applicable.
Early removal of drainage from foundations and hardstanding	Water table depth around foundations and hardstanding before restoration (m)	1.5	0.3	3.0	
	Water table depth around foundations and hardstanding after restoration (m)	0.5	0.3	1.0	
	Time to completion of backfilling, removal of any surface drains, and	1.0	0.1	5.0	

Section	Details	Data			Notes
		Expected	Minimum	Maximum	
	full restoration of the hydrology (years)				
12. Restoration of site after decommissioning					
	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 you control grazing on degraded areas?	Yes	Yes	Yes	Fencing will be in place in peat restoration areas to exclude stock until the peatland has been restored.
	Will you manage areas to favour reintroduction of species?	Yes	Yes	Yes	Sphagnum plug planting and seeding included in peatland restoration areas.

3. Results

3.1 Introduction

Table 2 presents the Carbon Calculator results. In summary, a maximum (i.e. worse case) carbon payback period of less than 2 years is forecast against the fossil fuel grid mix, with minimum net GHG savings of 115,020 tCO₂e predicted. It is acknowledged that the GHG benefit achieved by renewable electricity generation such as the Proposed Scheme through the avoidance of fossil fuel power generation will reduce as the national grid decarbonises, however the Proposed Scheme is forecast to supply some 11,347,704 megawatt hours (MWh) of clean electricity over its lifetime.

Table 2. Carbon Calculator Results

Results	Expected	Minimum	Maximum
Windfarm CO₂ emission saving over...			
Coal-fired electricity generation (tCO ₂ /year)	209,864	209,864	209,864
Grid-mix of electricity generation (tCO ₂ /year)	35,243	35,243	35,243
Fossil fuel - mix of electricity generation (tCO ₂ /year)	102,326	102,326	102,326
Energy output from windfarm over lifetime (MWh)	9,131,564	9,131,564	9,131,564
Total CO₂ losses due to wind farm (tCO₂e)			
Losses due to turbine life (manufacture, construction & decommissioning)	58,299	58,299	58,299
Losses due to backup	53,714	53,714	5,3714
Losses due to reduced carbon fixing potential	2,586	800	7,879
Losses from soil organic matter	21,776	7,198	24,382
Losses due to DOC & POC leaching	2,521	0	12,099
Losses due to felling forestry	0	0	0
Total losses of CO₂	138,896	120,011	156,373
Total CO₂ gains due to improvement of site (tCO₂e)			
Change in emissions due to improvement of degraded bogs	0	0	-29,267

Results	Expected	Minimum	Maximum
Change in emissions due to improvement of felled forestry	0	0	0
Change in emissions due to restoration of peat from borrow pits	0	0	0
Change in emissions due to removal of drainage from foundations & hardstanding	-3,446	0	-8,766
Total change in emissions due to improvements	-3,446	0	-38,033
Results			
Net emissions of carbon dioxide (tCO₂e)	135,450	81,978	156,373
Carbon Payback Time			
Coal-fired electricity generation (years)	0.6	0.4	0.7
Grid-mix of electricity generation (years)	3.8	2.3	4.4
Fossil fuel - mix of electricity generation (years)	1.3	0.8	1.5
Ratio of soil carbon loss to gain by restoration (TARGET ratio (Natural Resources Wales) < 1.0)	No gains	No gains	No gains
Ratio of CO₂e emissions to power generation (g / kWh) (TARGET ratio by 2030 (electricity generation) < 50 g /kWh)	15	9	17

Figure 1. GHG Emissions Sources (tCO₂e)

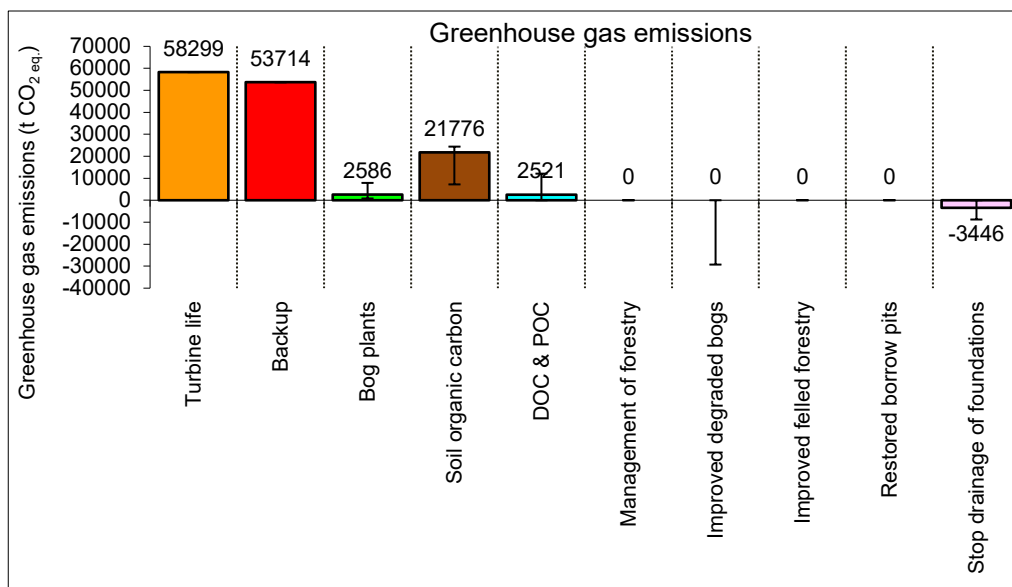
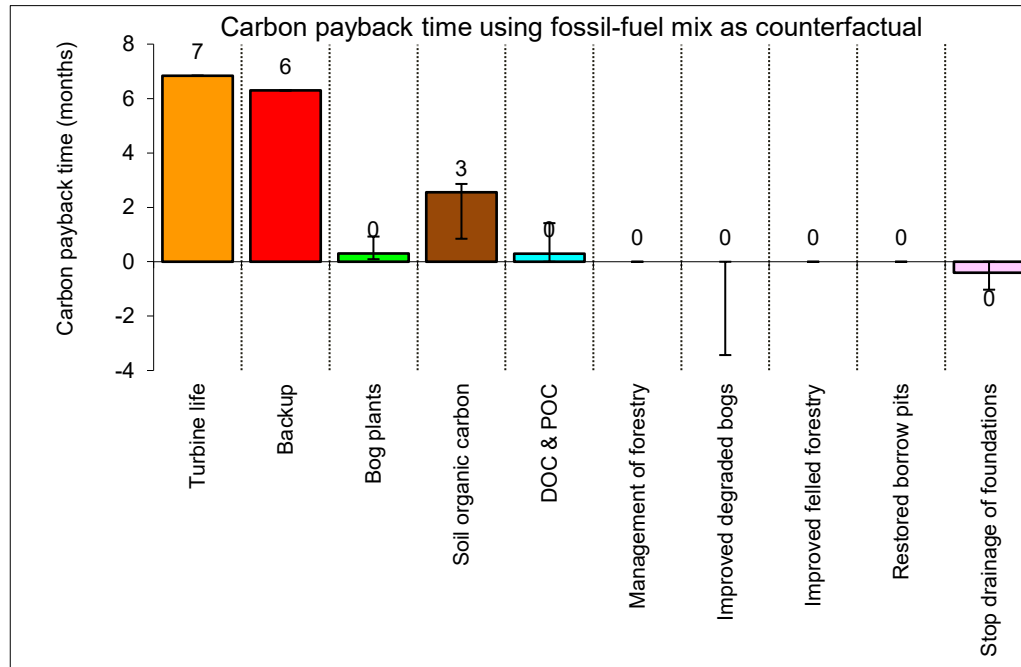


Figure 2. Carbon Payback Time Using Fossil Fuel Mix as Counterfactual (Months)



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