
**THREE OAKS RENEWABLE
ENERGY PARK
EXTENSION**

**Environmental
Statement Appendix 10.4:
Carbon Balance Assessment**

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GONDOLIN
Land & Water
Civil Engineering & Environmental Solutions

Three Oaks Renewable Energy Park Extension

ES Report Appendix 10.4: Carbon Balance Assessment

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1. Introduction

1.1 Remit

Three Oaks REP Extension Ltd (the Applicant) is applying to East Riding of Yorkshire Council (the Council) to construct, operate, maintain and decommission a wind farm development (along with associated development), to be known as the Three Oaks Renewable Energy Park Extension (hereafter referred to as the 'Proposed Development'). It would have an export capacity of 25.2 megawatts (MW) with a proposed operating lifetime of 40 years.

Gondolin Land and Water Ltd (Gondolin) has been appointed by Ridge Clean Energy Ltd (the Applicant) to prepare a Carbon Balance Assessment in support of the planning application for the Proposed Development and to accompany the Environmental Statement (ES). This Carbon Balance Assessment has been undertaken to calculate the carbon pay-back period for the Proposed Development using the Scottish Government Carbon Calculator Tool¹ which has been specifically developed for carbon balance calculations for Windfarm Developments.

1.2 Description of the Proposed Development

The component parts of the Proposed Development are as follows:

- Wind turbines;
- Wind turbine foundations;
- Crane hardstandings;
- Met mast;
- Site access and maintenance tracks;
- Transformers;
- Cabling;
- Temporary construction compound;
- Mitigation and Enhancement; and
- The substation and access tracks from the adjacent consented (yet to be built) Three Oaks Renewable Energy Park.

The Proposed Development is located approximately 1.6 km to the northeast of Burton Agnes at approximate National Grid Reference (NGR) TA 11487 65171. The Site is located on a network of regular sized, mixed arable farmland comprising large and medium sized fields across an undulating and sloped terrain, defined by linear hedgerows with occasional trees.

Supporting figures include a Site Location Plan (Figure 2.1 – Volume 3), an Indicative Site Layout Plan (Figure 2.2 - Volume 3), and a Contextual Site Layout Plan showing the Proposed Development in context with the consented Three Oaks Renewable Energy Park (Figure 2.3 – Volume 3).

Full details of the project and site description are provided in Chapter 2 of the ES.

1.3 Scope of Report

The scope of this report is to determine the carbon costs of the Proposed Development against the carbon savings made by the Proposed Development's generation of renewable energy and gives the estimated length of time it will take the Proposed Development to become a net-avoider of emissions (the pay-back period). Technical information including design, ground conditions and onshore wind technology data has been gathered and inputted into the calculator.

¹Scottish Government (2022) *Carbon calculator for wind farms on Scottish peatlands: factsheet*, February 2022, Available at <https://www.gov.scot/publications/carbon-calculator-for-wind-farms-on-scottish-peatlands-factsheet/> (Accessed 6th February 2026).

This report contains background information and methodology for the carbon calculation, data assumptions made and summarises the results of the carbon calculations.

2. Context

The UK Government are committed to doubling onshore wind energy by 2030². The UK's energy mix is required to diversify, and onshore wind has an important role to play as one of the most cost-effective and proven renewable energy technologies. Electricity generated from wind power has one of the lowest carbon footprints compared with other forms of electricity generation and can make a significant contribution to carbon reduction targets. Onshore wind power has a relatively very small carbon footprint range of between 8 and 20 g CO₂e/kWh, taking into account not only emissions from generation of electricity but those incurred during the manufacture, construction and decommissioning phases. By comparison, the average emissions from fossil-fuelled power generation in the UK was around 500 g CO₂/kWh³.

The UK Government Clean Power by 2030 Action Plan⁴ states that the '2030 power system will see clean sources produce as much power as Great Britain consumes in total over the whole year, and at least 95% of Great Britain's generation; reducing the carbon intensity of our generation from 171 g CO₂e/kWh in 2023¹ to well below 50 g CO₂e/kWh in 2030.' This is equivalent to 0.05 t CO₂e/MWh.

The Scottish Government's Carbon Calculator Tool is the only standard approach for assessing carbon balance and carbon payback in wind farms in the UK and has been used outside of Scotland to assess wind farm carbon balance in recent years. It is noted that the Applicant did not undertake Scoping and has instead volunteered to undertake an ES to support the application. A formal pre-application request was submitted by the applicant with a response received from the council (ref: 25/10744/STPREP) which made no reference to a need for a carbon balance assessment to support the application. The Applicant has volunteered to undertake this assessment to assess the carbon balance for the Proposed Development and estimate the carbon payback time due to turbine life. The carbon payback time is calculated within the tool by comparing the emissions due to turbine life with carbon-savings achieved by displacing electricity generated from sources supplying the GB grid as a whole.

To calculate the pay-back period, the Scottish Government's Carbon Calculator Tool considers the following carbon saving and carbon loss parameters:

- Carbon emissions savings, based on emissions from different power sources.
- Loss of carbon due to production, transportation, erection, operation and decommissioning of the wind farm.
- Loss of carbon from backup power generation.
- Loss of carbon-fixing potential of peatland, not applicable to the Proposed Development.
- Loss and/or saving of carbon stored in peatland (by peat removal or changes in drainage), not applicable to the Proposed Development.
- Carbon saving due to improvement of habitat.
- Loss and/or saving of carbon-fixing potential as a result of forestry clearance, not applicable to the Proposed Development.

3. Assessment Methodology

The Scottish Government's Carbon Calculator Tool for Windfarms on Scottish Peatland, has been applied to the Proposed Development. Despite peat not being present onsite, the Carbon Calculator Tool has been used as it is considered to be the most reliable tool for estimating the carbon payback

²UK Government (2024) *Policy statement on onshore wind*, Available at <https://www.gov.uk/government/publications/policy-statement-on-onshore-wind/policy-statement-on-onshore-wind> (Accessed 12th February 2026).

³UK Government (2013) *Onshore wind: part of the UK's energy mix*, Available at [Onshore wind: part of the UK's energy mix - GOV.UK](https://www.gov.uk/government/publications/onshore-wind-part-of-the-uk-s-energy-mix/onshore-wind-part-of-the-uk-s-energy-mix) (Accessed 12th February 2026).

⁴ UK Government (2024) *Clean Power 2030 Action Plan: A new era of clean electricity*, Available at <https://www.gov.uk/government/publications/clean-power-2030-action-plan> (Accessed 12th February 2026).

time associated with the Proposed Development, in the absence of an alternative onshore windfarm specific tool. This approach has been used to support planning applications for other proposed wind farms in England and Wales also.

The online version of the tool was not available for use at the time of writing. Scottish Government's Directorate for Energy and Climate Change who administer the tool provide the Microsoft Excel version of the tool (V2.15.0) which has been used in the current absence of the online version. The excel version mirrors the web-version.

The excel tool includes manual data entry for various elements relating to the development proposals and site-specific details which feed into automatic calculations within the excel tool.

Generally, the Carbon Calculator Tool requires an expected, minimum and maximum value for each parameter. For data relating to the infrastructure component values and dimensions, the expected, minimum and maximum have all been set as those stated in Chapter 2: Project and Site Description as these are not anticipated to vary. Chapter 2 provides details relating to infrastructure foundation sizing, access track width and length (including newly constructed track and existing track to be upgraded), materials and operational period.

A 10% buffer has been applied to estimate minimum and maximum values where variation from the expected value may arise due to site conditions, where applicable.

The Carbon Calculator Tool also provides direct input options and default values for some input data which has been adopted where suitable and appropriate. This includes;

- Counterfactual emission factors which are automatically included in the tool.
- Extra capacity required for backup (%) which is included in the tool's user notes, recommending a set value.
- Additional emissions due to reduced thermal efficiency of the reserve generation (%) which is included in the tool's user notes, recommending a set value.
- Carbon Dioxide emissions from turbine life (e.g. manufacture, construction, decommissioning) have been calculated with respect to the installed capacity.

Input parameters, their data source and any assumptions made are detailed in Table 1. These input parameter values are those used in the online Carbon Calculator Tool (V1.15.0).

It is noted that several of the sections within the tool require data input relating to peatland and bog plant characteristics, peatland restoration and forestry felling which are not considered to be applicable to this site. This is discussed in further detail in Table 1.



Table 1 Carbon Calculator Input Parameter

Parameters	Expected	Minimum	Maximum	Data Source	Assumptions
Wind Farm Characteristics					
Dimension					
No. of turbines	6	6	6	Chapter 2.	-
Duration of consent (years)	40	40	40	Chapter 2.	-
Performance					
Power rating of 1 turbine (MW)	4.2	4.2	4.2	Chapter 2.	-
Capacity factor	25.7	23.1	28.3	Direct input option. The load factor for English onshore wind technology in 2024 has been applied as the expected value, which is 25.7% ⁵ . This value aligns with the average capacity factor between 2020 and 2024 for onshore wind within the UK which is also 25.7% ⁶ . Although the Applicant has modelled a capacity factor of over 30% for the site, this carbon calculator assessment applies the value above to provide a conservative, worst-case scenario.	A 10% buffer has been applied to calculate minimum and maximum
Backup					
Fraction of output to backup (%)	5	5	5	The extra capacity needed for backup power generation; backup is currently estimated to be 5% of the rated capacity of the wind plant if wind power contributes more	-

⁵ Department for Energy Security & Net Zero (DESNZ) (2025) *Energy Trends UK, April to June 2025*, September 2025, Available at <https://www.gov.uk/government/statistics/energy-trends-september-2025> (Accessed 13th February 2026).

⁶ Department for Energy Security & Net Zero (DESNZ) (2025) *Digest of UK Energy Statistics (DUKES): Renewable sources of energy, Chapter 6: Statistics on energy from renewable sources. Load factors for renewable electricity generation (DUKES 6.3)*, July 2025, Available at [Digest of UK Energy Statistics \(DUKES\): renewable sources of energy - GOV.UK](#) (Accessed on 4th February 2026).



Parameters	Expected	Minimum	Maximum	Data Source	Assumptions
				than 20% to the national grid (Technical Note Version 2.10.0 ⁷) and is referenced within the calculator.	
Additional emissions due to reduced thermal efficiency of the reserve generation (%)	10	10	10	Default value within tool.	-
CO ₂ emissions from turbine life (tCO ₂ /MW)	Calculated with respect to installed capacity	Calculated with respect to installed capacity	Calculated with respect to installed capacity	Emissions have been calculated according to turbine capacity, using the calculator's embedded method.	-
Characteristics of peatland before windfarm development					
Type of peatland	N/A	N/A	N/A	The Carbon Calculator Tool requires the selection of either Acid Bog or Fen for peatland type, with subsequent characteristics relating to peatland to be entered. Neither option is representative of the site, and the tool does not provide an alternative category. When entering site values in 'Characteristics of peatland before windfarm development' with the Acid Bog or Fen option selected, the calculator generates a negative value for 'Losses from soil organic matter' within the results section of the calculator. This occurs because the tool automatically applies a default carbon emission factor for Acid Bog or Fen soils (t CO ₂ /ha/yr) across the development footprint, to account for their 'removal' and reflecting the assumption that these peatland types naturally emit CO ₂ . This happens even when peat depth is	-
Average annual air temperature at site (°C)	N/A	N/A	N/A		-
Average depth of peat at site (m)	N/A	N/A	N/A		-
C Content of dry peat (% by weight)	N/A	N/A	N/A		-
Average extent of drainage around drainage features at site (m)	N/A	N/A	N/A		-

⁷ Scottish Government) (2018) *Calculating potential carbon losses and savings from wind farms on Scottish peatlands Technical Note – Version 2.10.0*, December 2018, Available at <https://www.gov.scot/publications/carbon-calculator-technical-guidance/> (Accessed on 4th February 2026).



Parameters	Expected	Minimum	Maximum	Data Source	Assumptions
Average water table depth at site (m)	N/A	N/A	N/A	set to 0 m, resulting in an artificial carbon gain being calculated.	-
Dry soil bulk density (g cm-3)	N/A	N/A	N/A	To avoid including this non-representative and inappropriate automatic assumption for a site that is neither Acid Bog nor Fen, the 'Losses from soil organic matter' value has therefore been manually set to zero. This ensures the carbon balance reflects site conditions more accurately. The values in this section are not applicable because peat is absent and have therefore been marked as N/A.	-
Characteristics of bog plants					
Time required for regeneration of bog plants after restoration (years)	0	0	0	N/A	-
Carbon accumulation due to C fixation by bog plants in undrained peats (tC/ha/y)	0	0	0	N/A	-
Forestry Plantation Characteristics					
Area of forestry plantation to be felled (ha)	0	0	0	N/A - no felling will occur as a result of the Proposed Development.	-
Average rate of carbon sequestration in timber (t C/ha/yr)	0	0	0	N/A - no felling will occur as a result of the Proposed Development.	-



Parameters	Expected	Minimum	Maximum	Data Source	Assumptions
Counterfactual emission factors					
Coal-fired plant emission factor († CO ₂ /MWh)	1.046	1.046	1.046	Default fixed value within tool. It is acknowledged that whilst there is no longer coal generation in the UK at the time of writing, the coal-fired electricity generation is still presented as a defined counterfactual within the tool's methodology and a defined displacement scenario. In order to maintain consistency with the tool's methodology, the default emission factors have been retained.	-
Grid-mix emission factor († CO ₂ /MWh)	0.20705	0.20705	0.20705	Default fixed value within tool. It is acknowledged that recent grid-mix emission factors have been lower than the default value provided in the tool, reflecting higher renewable output. However, this assessment retains the prescribed default value within the latest version of the tool to ensure methodological consistency.	-
Fossil fuel-mix emission factor († CO ₂ /MWh)	0.437	0.437	0.437	Default fixed value within tool.	-
Borrow pits (if any)					
Number of borrow pits	0	0	0	N/A	-
Average length of pits (m)	0	0	0	N/A	-
Average width of pits (m)	0	0	0	N/A	-
Average depth of peat removed from pit (m)	0	0	0	N/A	-



Parameters	Expected	Minimum	Maximum	Data Source	Assumptions
Construction Input Data					
Number of turbines	6	6	6	Chapter 2.	-
Turbine foundations					
Average peat depth excavated when constructing foundations (m)	0	0	0	N/A	-
Approximate geometric shape of hole dug when constructing foundations	Rectangular	Rectangular	Rectangular	Whilst the turbine foundations are anticipated to be circular, the option to input 'Circular' geometric shape is not possible in V2.15.0 of the excel template. 'Rectangular' is the only option.	-
Length at surface (m)	22.2	22.2	22.2	Chapter 2 notes that the foundation diameter would be 25 m, equating to an area of 491 m ² . Given the only selection possible in the excel tool for the geometric shape is 'Rectangular' the square root of the total area value has been calculated to give the width and length, to represent the appropriate area.	-
Width at surface (m)	22.2	22.2	22.2	As above.	-
Length at bottom (m)	22.2	22.2	22.2	As above.	-
Width at bottom (m)	22.2	22.2	22.2	As above.	-
Hardstanding					
Average peat depth when constructing	0	0	0	N/A	-



Parameters	Expected	Minimum	Maximum	Data Source	Assumptions
hardstandings (m)					
Approximate geometric shape of hole dog when constructing hardstanding	Rectangular	Rectangular	Rectangular	'Rectangular' is the only option to select within the excel tool.	-
Length at surface	46.6	46.6	46.6	Total area of 2,171 m ² per turbine (Chapter 2). Given that the hardstanding is not a straightforward rectangle shape, the square root of the total area value has been calculated to give the width and length.	-
width at surface	46.6	46.6	46.6	As above.	-
length at bottom	46.6	46.6	46.6	As above.	-
width at bottom	46.6	46.6	46.6	As above.	-
Piling					
Is piling used?	Yes	Yes	Yes	Chapter 2 notes that 'Each turbine would have a steel reinforced concrete foundation of piled, slab or hybrid design'.	-
Volume of concrete					
Volume of concrete used (m ³) in the entire area	4320	4320	4320	Chapter 2 states there will be concrete material requirements of 720 m ³ for each turbine foundation.	-
Access Tracks					
Total length of access track	4980	4980	4980	Chapter 2 states that 2.0 km of existing track between the junction with the A614 and 'off shoot' tracks into adjacent fields, and 2.98 km of new track are proposed to be constructed to facilitate access to wind turbines.	-
Existing track (m)	2000	2000	2000	Chapter 2, see above.	-



Parameters	Expected	Minimum	Maximum	Data Source	Assumptions
Floating Road (m)					
Length of access track	0	0	0	N/A, no floating road proposed.	-
Floating road width	N/A	N/A	N/A	N/A, no floating road proposed.	-
Floating road depth	N/A	N/A	N/A	N/A, no floating road proposed.	-
Length of floating road that is drained	N/A	N/A	N/A	N/A, no floating road proposed.	-
Average depth of drains associated with floating road	N/A	N/A	N/A	N/A, no floating road proposed.	-
Excavated Road					
Length of access track	2980	2980	2980	Chapter 2 states there will be 2.98 km of new track to be constructed to facilitate access to wind turbines. Whilst there may be upgrading of 2.0 km of existing farm track, given that the existing farm tracks are already built and generally ~4.5 m or greater, excavation of these has been excluded.	Excludes upgrade of existing farm track, given that the existing farm tracks are already built and generally ~5.5 m or greater, and as such excavation is anticipated to be minimal.
Excavated road width	5.5	5.5	5.5	Chapter 2.	-
Average depth of peat excavated for road	0	0	0	N/A	-
Rock Filled Road	N/A				
Cable Trenches					



Parameters	Expected	Minimum	Maximum	Data Source	Assumptions
Length of any cable trench on peat that does not follow access tracks and is lined with a permeable medium (e.g. sand) (m)	343	343	343	Chapter 2 states that there will be 343 m of dedicated cable trench 1 m wide and 1 m deep between T3 and the consented substation at the Three Oaks Renewable Energy Park. All remaining cables will be laid in trenches alongside the access track.	-
Average depth of peat cut for cable trenches (m)	0	0	0	N/A	-
Additional peat excavated (not already accounted above)					
Volume of additional peat excavated (m³)	0	0	0	N/A	-
Area of additional peat excavated (m²)	0	0	0	N/A	-
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	-
Water table depth in degraded bog before improvement (m)	N/A	N/A	N/A	N/A	-



Parameters	Expected	Minimum	Maximum	Data Source	Assumptions
Water table depth in degraded bog after improvement (m)	N/A	N/A	N/A	N/A	-
Time required for hydrology and habitat of bog to return to its previous state on improvement (years)	N/A	N/A	N/A	N/A	-
Period of time when effectiveness of the improvement in degraded bog can be guaranteed (years)	N/A	N/A	N/A	N/A	-
Improvement of felled plantation land	N/A	N/A	N/A	N/A	-
Restoration of peat removed from borrow pits					
Area of borrow pits to be restored (ha)	N/A	N/A	N/A	N/A	
Depth of water table in borrow pit before restoration with respect to the	N/A	N/A	N/A	N/A	



Parameters	Expected	Minimum	Maximum	Data Source	Assumptions
restored surface (m)					
Depth of water table in borrow pit after restoration with respect to the restored surface (m)	N/A	N/A	N/A	N/A	
Time required for hydrology and habitat of borrow pit to return to its previous state on restoration (years)	N/A	N/A	N/A	N/A	
Period of time when effectiveness of the restoration of peat removed from borrow pits can be guaranteed (years)	N/A	N/A	N/A	N/A	
Early removal of drainage from foundations and hardstanding	N/A	N/A	N/A	It is assumed that in drainage measures will remain in place during the operational development.	
Restoration of site after decommissioning					
Will the hydrology of the site be restored on decommissioning					



Parameters	Expected	Minimum	Maximum	Data Source	Assumptions
Will you attempt to block any gullies that have formed due to the windfarm?	N/A	N/A	N/A	Refers to drained peatland and this is not applicable for this site.	-
Will you attempt to block all artificial ditches and facilitate rewetting?	N/A	N/A	N/A	Refers to drained peatland and this is not applicable for this site.	-
Will the habitat of the site be restored on decommissioning?					
Will you control grazing on degraded areas?	N/A	N/A	N/A	Refers to peatland habitat and this is not applicable for this site.	-
Will you manage areas to favour reintroduction of species?	N/A	N/A	N/A	Refers to peatland habitat and this is not applicable for this site.	-

4. Results

4.1 Carbon Balance Assessment – Emissions

The calculated carbon emissions as provided in the Carbon Calculator Tool are provided in Table 2 below. Additionally, each loss has been calculated as a percentage of overall emissions.

Table 2 Total CO₂ losses due to wind farm (t CO₂e)

Description of Loss	Expected (t CO ₂ e)	Minimum (t CO ₂ e)	Maximum (t CO ₂ e)	% of overall emissions (expected scenario)
Losses due to turbine life (e.g. manufacture, construction, decommissioning)	22,105	22,105	22,105	53.4
Losses due to backup	19,294	19,294	19,294	46.6
Losses due to reduced carbon fixing potential	0	0	0	0
Losses from soil organic matter	0	0	0	0
Losses due to DOC & POC leaching	0	0	0	0
Losses due to felling forestry	0	0	0	0
Total losses of carbon dioxide	41,399	41,399	41,399	

Table 3 shows that 53% of the emissions are a result of losses due to the turbine life including manufacturing, construction and decommissioning.

Losses due to the requirement for back-up power in the grid is the second largest contributor to carbon losses at 47% of the total carbon emissions. The tool assumes that back-up would come from fossil fuels however it is noted that renewables may also be used for backup. This conservative, worst-case assumption embedded within the default values of the latest version of the tool may make the value for backup generation too high should other sources be used.

Given the losses due to reduced carbon fixing potential relates purely to emissions due to loss of bog plants which is not applicable to this site, no losses are calculated.

As discussed in Table 1, losses from soil organic matter have been manually set to 0. This is calculated from the CO₂ loss from removed peat (not applicable to this site) and the CO₂ loss from drained peat (again, not applicable to this site). To avoid including this non-representative and inappropriate automatic assumption for a site that is neither Acid Bog nor Fen (refer to Table 1), the 'Losses from soil organic matter' value has therefore been manually set to 0. This ensures the carbon balance reflects site conditions more accurately.

Losses due to Dissolved Organic Content and Particulate Organic Content leaching are 0. Losses due to felling forestry is 0 as no felling is required for the Proposed Development.

4.2 Carbon Balance Assessment – Gains

The carbon calculator accounts for gains such as improvements of degraded bogs, improvement of felled forestry, peatland restoration in borrow pits and removal of drains within peatland post construction. None of these gains are applicable to this site.

4.3 Carbon Balance Assessment – Net emissions of Carbon Dioxide

The net emission of CO₂ (t CO₂e) is calculated by combining the total losses of carbon dioxide with the total change in emission due to improvement. This is set out below in Table 3.

Table 3 Net emissions of carbon dioxide due to wind farm (t CO₂e)

Description	Expected (t CO ₂ e)	Minimum (t CO ₂ e)	Maximum (t CO ₂ e)
Total losses of carbon dioxide	41,399	41,399	41,399
Total change in emissions due to improvements	0	0	0
Net emissions of carbon dioxide	41,399	41,399	41,399

4.4 Carbon Balance Assessment – Savings

The carbon payback time of the Proposed Development is calculated by comparing the net loss of carbon from the site due to wind farm development with the carbon savings achieved by the wind farm while displacing electricity generated from coal fired capacity, grid mix or fossil fuel mix. The grid mix is the annual average mix of fuels used to produce electricity for the GB electricity grid (including nuclear and renewables). The fossil fuel mix is the annual average mix of fuels used to produce electricity for GB electricity grid excluding nuclear and renewables.

Table 4 below provides the annual and lifetime savings of carbon dioxide emissions for each of the electricity generation displacement from the Proposed Development.

Table 4 Windfarm CO₂ emission savings by displacing other generators of electricity

Counterfactual Emission Factor	Expected	Minimum	Maximum
Annual Savings			
Coal-fired electricity generation (t CO ₂ /yr)	59,343	53,409	65,277
Grid-mix of electricity generation (t CO ₂ /yr)	11,747	10,572	12,921
Fossil fuel-mix of electricity generation (t CO ₂ /yr)	24,792	22,313	27,272
Lifetime Savings (40-year lifetime)			
Coal-fired electricity generation (t CO ₂)	2,373,720	2,136,360	2,611,080
Grid-mix of electricity generation (t CO ₂)	469,880	422,880	516,840
Fossil fuel-mix of electricity generation (t CO ₂)	991,680	892,520	1,090,880

4.5 Energy Output

The energy output (megawatt-hour, MWh) from the Proposed Development over its lifetime (40 years) as provided in the Carbon Calculator Tool is set out below.

- Expected – 2,269,331 MWh
- Minimum – 2,042,398 MWh
- Maximum – 2,496,264 MWh

4.6 Carbon Payback Time

Table 5 shows the estimated payback time, if the electricity generated by the Proposed Development is assumed to displace energy generated for the different displaced fuels, as calculated in the Carbon Calculator Tool.

Table 5 Carbon Payback Time

Description	Expected	Minimum	Maximum
Coal-fired electricity generation (years)	0.7	0.6	0.8
Grid-mix of electricity generation (years)	3.5	3.2	3.9
Fossil fuel-mix of electricity generation (years)	1.7	1.5	1.9

The following information from the Scottish Government Technical Note for the Carbon Calculator is relevant.

"A renewable energy development will have a maximum potential to 'save' carbon emissions if it is substituting coal fired generation. However, in most circumstances it is not possible to define the electricity source for which a renewable electricity project will substitute."

Table 5 shows that the Proposed Development is estimated to have a payback of 3.5 years based on the current grid mix.

It is worth noting that the capacity factors for turbine operation provided in Table 1 are based on data to represent turbines operating 'today'. By the time of operation, it is anticipated the capacity factors will likely have improved, making the turbines more efficient and increasing generation. Furthermore, the capacity factor for English onshore wind technology in 2024 has been applied as the expected value, which is 25.7% (see Table 1). Although the Applicant has modelled a capacity factor of over 30% for the site, this assessment applies the value of 25.7% to provide a conservative, worst-case scenario. Consequently, this also contributes to a likely over estimation in payback time.

4.7 Carbon Intensity

A useful quantification relating to carbon calculation is the carbon intensity of the units of electricity that will be produced. This is calculated by dividing the net emissions by the total units of electricity expected to be produced over the lifetime of the Proposed Development. Taking the expected energy output of 2,269,331 MWh from Section 4.5 and the expected net emissions of carbon dioxide of 41,399 t CO₂e, the carbon intensity is 0.01824 t CO₂e/MWh, which is significantly lower than the current grid mix (0.20705 t CO₂e/MWh, see Table 1). This will contribute positively to the UK Government's target of decarbonising electricity supply and in line with the UK Governments Clean Power by 2030 expectations of reducing carbon intensity of our generations to well below 0.05 t CO₂e/MWh⁴.

5. Summary

The net emissions of carbon dioxide from the Proposed Development have been calculated as 41,399 t CO₂. This is due to losses due to the turbine life including manufacturing, construction and decommissioning and losses due to the requirement for back-up power in the grid.

The results of the Carbon Calculator using the Scottish Governments Tool show that the Proposed Development is estimated to produce annual carbon savings of approximately 11,747 t CO₂ per year (469,880 t CO₂ over its lifetime). This is based on the displacement of grid electricity based on the current average grid mix. It is acknowledged that the proportion of renewable electricity within the grid mix is expected to increase over time, which will reduce the grid mix emission factor. However, to maintain consistency with the tool's methodology, the default emission factor value from the latest version of the tool have been used.

The Proposed Development is estimated to have an expected payback of 3.5 years based on the current grid mix, which is ~9% of the 40 year lifetime of the Proposed Development. After this period, the Proposed Development will generate carbon savings for the remainder of its operational life.

The carbon intensity of the electricity generated by the Proposed Development is estimated to be approximately 0.02 t CO₂e/MWh, which is below the UK Governments 2030 ambition of 0.05 t CO₂e/MWh.



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