# 6. Carbon Balance and Peat Management

## 6.1 Introduction

6.1.1 The Electricity Works (Environmental Impact Assessment) (Scotland) Regulations 2017 require consideration of the impact of the Proposed Development on climate (for example the nature and magnitude of greenhouse gas ('GHG') emissions) and the vulnerability of the Proposed Development to climate change (climate change resilience ('CCR')).

6.1.2 This appendix reports on the carbon balance calculation that has been completed for the Proposed Development. The assessment determines the benefit of the Proposed Development in terms of reduced carbon emissions compared to a reference energy mix. This is considered in the context of carbon budgets and targets for Scotland and the UK, aligned to a trajectory compatible with limiting the increase in global average temperature below 1.5°C. This includes consideration of GHG emissions in the production, transportation, erection, operation and decommissioning phases of the Proposed Development.

6.1.3 Given the inherent carbon benefit of wind farms, a standalone GHG EIA Report chapter is not required. The Scottish Government Carbon Calculator Tool (2020) has been used for the carbon balance calculation. The Carbon Calculator Tool is designed for applications for the construction and operation of onshore windfarms in Scotland located where peat is present. The wind farm layout, design and construction methodology has been refined to minimise peat excavation from tracks and turbine infrastructure, but it has not been possible to avoid it entirely. An Outline Peat Management Plan ('PMP') has been prepared (**Appendix 6A**) which demonstrates how excavated peat can be reinstated within the Development Site following construction.

## 6.2 Renewable Energy Policy Context

6.2.1 **Chapter 5 – Planning Policy Context** provides an overview of the applicable renewable energy policy and strategies that the proposals should have regard to. This includes the relevant UK wide and Welsh legislative and policy framework for the development of renewable energy schemes. Current legislation, national policies, and local policy and guidance recognise climate change as a pressing concern. GHG emissions are expected and required to reduce in the future.

6.2.2 The approach taken by the UK and Scotland to addressing climate change has been shaped and informed by a range of international agreements and climate change obligations including the Kyoto Protocol (1997), the Paris Agreement (2015) and the 2021 Glasgow Climate Compact (2021) reflecting the UK's role as a signatory to the United Nations Framework Convention on Climate Change ('UNFCCC').

6.2.3 The UK Government has set a net zero target which requires the UK to reduce GHG emissions by 100% below 1990 levels by 2050[17], this being the UK position in terms of meeting international obligations to reduce carbon emissions. The UK carbon budgets

[17] *The Climate Change Act 2008 (2050 Target Amendment) Order 2019*

require the UK to continually reduce emissions in line with the net zero target (UK Government, 2009). Scotland is also committed to a net zero target for 2045, and has interim targets for 2030 and 2040, and a series of 5-year carbon budgets (Scottish Government, 2019).

## 6.3 Scope and Receptors

6.3.1 The scope of the assessment of GHG emissions associated with the Proposed Development includes GHG emissions from all activities within the Development Site, arising from the construction, operation, maintenance and decommissioning phases, as well as the GHG emissions associated with material processing and transportation of materials and labour outside of the Site.

6.3.2 GHG emissions have a global effect rather than directly affecting any specific local receptor to which a level of sensitivity can be assigned. The global climate is the only receptor for the climate change assessment.

6.3.3 Given the global impacts of climate change and the globally recognised requirement to limit GHG emissions to maintain global average temperature increase below 1.5°C to 2°C, as laid out in the Paris Agreement[18], the receptor is considered highly sensitive to GHG emissions.

## 6.4 Potential Contribution of the Proposed Development to Government Objectives

### Energy Yield

6.4.1 The installed capacity is a measure of the maximum rated output, which in the context of the Proposed Development is an estimated 10MW (assuming two x 5MW wind turbine machines – noting the battery storage goes not generate electricity and instead stores the energy generated by the two MW turbines). Calculations of the likely electricity generation of the turbines are dependent on the 'capacity factor', which involves an assessment of the actual output of the development against its installed capacity[19].

6.4.2 On this basis, and with an estimated installed capacity of 10MW (for turbines only), the amount of electricity produced by the Proposed Development has been estimated to be 37.7 GWh per year, using site specific capacity factor of 43[20]% (in this case, relating only to the turbines).

6.4.3 This 43% capacity factor has been used to calculate potential annual energy yield for the Proposed Development, shown in **Table 6.1**.

### Carbon Dioxide Savings and Electricity Generation

6.4.4 It is widely accepted that electricity produced from wind energy has a positive benefit with regard to reducing carbon dioxide ($CO_2$) emissions. However, there has been much

[18] UNFCC (2015). *Paris Agreement* [online]. Available at: https://unfccc.int/sites/default/files/english_paris_agreement.pdf [Accessed 29 June 2023].

[19] The net capacity factor of a wind farm is the ratio of its actual energy output (after energy losses within the wind farm have been accounted for) over a defined period of time (typically a year) to its energy output, had it operated at maximum power output continuously, over the same period of time.

[20] Site specific capacity factor provided by RWE Renewables UK Onshore Wind Limited.

debate about the actual level of emissions savings that might arise from a wind farm development.

6.4.5 In estimating the actual saving it is important to consider the mix of alternative sources of electricity generation, for example, coal, oil and gas powered. Digest of UK Energy Statistics (DUKES) (July 2022) sets the static figure of emission related with electricity generated by ‘all non-renewable fuels’ at 432 tonnes of $CO_2$ for every GWh generated (Renewable UK, 2022). A figure of 432 tonnes of $CO_2$ for every GWh has therefore been assumed for the purposes of this assessment, with savings of $CO_2$ estimated on the basis of the Scottish average capacity factor.

6.4.6 The Department of Business, Energy and Industrial Strategy (‘BEIS’) produces a range of statistics detailing electricity consumption across the UK. In 2020 the average domestic household consumption in area of the Proposed Development (East Ayrshire) was 3,433 kWh per household (BEIS, 2022). However, the electricity generated by the Proposed Development would enter the National Grid, and therefore cannot be tracked to the individual consumer. Therefore, it is relevant to consider electricity demand in the context of UK as a whole, rather than within the area surrounding the Proposed Development. In 2020 the average domestic household consumption in the UK, was 3,880 kWh per household[Error! Bookmark not defined.].

6.4.7 The potential electricity generation and ‘Homes Equivalent’ electricity generation associated to Proposed Development are provided in **Table 6.1**, which also identifies the potential $CO_2$ saving.

### Table 6.1 Potential electricity generation and CO2 savings (Proposed Development)

| Capacity Factor (%) | Electricity Generation (MWh per year)[21] | Homes Equivalent (based on average consumption)[22] | Carbon dioxide savings (Tonnes of $CO_2$ per year) based on Renewable UK savings figure |
|---|---|---|---|
| **A43%** | 37,668 | 9,708 | 16,237 |

## 6.5 Peat Management

6.5.1 An Outline PMP has been produced (**Appendix 6A**) using the results of comprehensive peat probing surveys that have been carried out in accordance with SEPA’s peat depth probing survey guidance.

6.5.2 The predicted volume of excavated peat is 16,289m$^3$ (**Table 2.1** of **Appendix 6A**), all of which can be re-used for reinstatement operations within the Development Site (**Table 2.2** of **Appendix 6A**).

[21] Figures are derived as follows: 10MW (2 × 5MW turbine) × 8,760 hours/year × 0.43 (capacity factor) = 37,668MWh.

[22] This is calculated using the most recent statistics from the DECC showing that annual local (Enoch Hill, East Ayrshire) average domestic household consumption is 3,433 kWh : https://www.gov.uk/government/statistical-data-sets/regional-and-local-authority-electricity-consumption-statistics

## 6.6 Carbon Balance of the Proposed Development

### Overview

6.6.1 The following sections outline the specific values for the carbon losses and carbon gains associated with the Proposed Development. For each input parameter (as outlined in **Appendix 6B** to this document), an expected, minimum and maximum value is required to provide an expected, minimum and maximum scenario for the carbon payback.

6.6.2 For this application, version 1.7.0 of the online Scottish Government Carbon Calculator Tool was used on 29 June 2023, the reference number is not supplied in this document, but has been communicated separately to relevant consultees.

6.6.3 A table containing the values for each scenario and the justification for the values used for the carbon balance calculations can be found in **Appendix 6B** to this document**.**

### Carbon Losses

6.6.4 The manufacturing, construction and installation (including concrete) of the wind turbines at the Proposed Development has an associated carbon cost. Using figures from the online calculator, the expected case carbon emission losses associated with the manufacture, construction and decommissioning of the 21MW installed capacity, is 8,949 t $CO_2$ equivalent (t $CO_2$e), which equates to approximately 38.3% of total $CO_2$e losses.

6.6.5 The carbon payback model attributes carbon losses due to the requirement for extra capacity to back up wind power generation at times of peak demand. This is quantified as a percentage of total capacity, which was input as 5% for this case (the recommended figure within the model) and equates to 6,623t $CO_2$e (i.e., approximately 26.5% of total $CO_2$e losses).

6.6.6 Peatlands are a high conservation priority because of their function in storing carbon in addition to their biodiversity value. The Proposed Development has therefore been designed to avoid areas of deeper peat as far as possible, allowing for all other environmental and engineering constraints. Nevertheless, the construction will involve disturbance of a volume of peat. This is quantified within the Outline PMP (**Appendix 6A**), which sets out a series of control measures for in-situ peat protection, peat stripping and excavation, temporary peat stockpiling and reinstatement to ensure that impacts upon excavated peat will be minimised. The Outline PMP also demonstrates how excavated peat can be beneficially re-used within the Development Site following construction.

6.6.7 Carbon losses associated with $CO_2$ release from soil organic matter for the expected case amount to 3,327 t $CO_2$e, which equates to approximately 13.3% of total $CO_2$e losses. These losses result from peat removal and drainage effects following excavation for items of infrastructure, notably turbine foundations, hard standings and access tracks. It is worth noting that this figure assumes 100% loss of $CO_2$ from removed/disturbed peat, as this is the default value within the carbon model and cannot be amended. In reality, losses are likely to be considerably less than this, as it is expected that the full amount of the disturbed peat would be used in reinstating the Development Site (see **Appendix 6A**)

6.6.8 Small carbon losses are generated by the reduction of carbon fixing potential which occurs due to the loss of bog plants as a result of wind farm construction. For the expected case, this is 205t $CO_2$e, which equates to 0.8% of total $CO_2$e losses.

6.6.9 The layout of the Proposed Development would require the felling of plantation woodland habitat around all turbines (see **Appendix 3A - Forestry Assessment**). Re-planting may be undertaken within the felled area, but a buffer oof 500m would be maintained between the any infrastructure and the re-planted plantation woodland (and existing woodland to be retained). The net loss of forestry as a result of the windfarm development proposals would be 12.68 ha, losses due to forestry felling in the expected case equate to 5,858t CO2e, which equates to approximately 23.5% of total losses.

6.6.10 Total $CO_2$e losses due to the Proposed Development are 24,843 t $CO_2$e.

### Table 6.2 Summary of total carbon losses

| CO2 Losses | Losses due to turbine life (manufacture, construction, decommissioning) | Losses due to backup | Losses due to reduced carbon fixing potential | Losses from soil organic matter | Losses due to felling forestry |
|---|---|---|---|---|---|
| **T CO2 eq.** | 8,949 | 6,623 | 205 | 3,327 | 5,858 |

## Carbon Gains

6.6.11 There are small carbon gains anticipated (see **Appendix 6B)** due to the peat and forestry restoration plans in **Appendix 3A - Forestry Assessment** and **Appendix 6A.**

# 6.7 Carbon Payback of the Proposed Development

6.7.1 To calculate the carbon payback period, the online calculator uses three different fossil fuel displacement scenarios, which are updated automatically using data from DUKES:

- Grid mix - the mix of electricity sources supplying the UK as a whole;
- Coal fired - for coal fired electricity generation; and
- Fossil fuel mix - for fossil fuel sourced electricity generation alone.

6.7.2 The carbon calculator recommends using the fossil fuel sourced mix scenario as the most appropriate for calculating the carbon payback time (the counterfactual)[23]. Based on this scenario, the payback for the Proposed Development is predicted to be 1.5 years for the expected outcome. However, the payback period could be as low as 0.7 years for the minimum scenario but increases to 2.5 years for the maximum scenario for fossil fuel mix.

6.7.3 The carbon payback time for each scenario is shown in **Table 6.3**

### Table 6.3 Payback in years for each Scenario used in the Carbon Calculator

| Fuel Source | Carbon Payback Time (years) Expected Value | Carbon Payback Time (Years) Minimum value | Carbon Payback Time (Years) Maximum Value |
|---|---|---|---|
| **Coal Fired** | 0.7 | 0.3 | 1.1 |
| **Grid Mix** | 3.4 | 1.5 | 5.5 |

[23] Note on limitations: wind power will not replace all forms of conventional generation equally, so the true carbon emissions displacement will be dependent on a combination of factors e.g. the types of power generation being replaced, any decrease in efficiency of conventional plant operating at part load, and the impact of any increase in frequency of start-up and shut-down of conventional plant.

| | | | |
|---|---|---|---|
| **Fossil Fuel Mix** | 1.5 | 0.7 | 2.5 |

## 6.8 Climate Change Resilience

6.8.1 A standalone assessment of CCR has not been completed as part of the EIA. The projected impacts of climate change on the Proposed Development are considered in relevant sections of the following EIA Report chapters:

- **Chapter 3 – Description of the Proposed Development**;
- **Chapter 11 – Ecology**;
- **Chapter 12 – Ornithology**; and
- **Chapter 13 – Geology, Hydrology (including flood risk) and Hydrogeology**.

6.8.2 The design of the Proposed Development will consider climate projections for a variety of environmental parameters (e.g., rainfall, temperature, etc.) to ensure that appropriate mitigation measures are embedded within the design. The worst-case climatic conditions at the end of the design life of the Proposed Development will be considered. Climate change impacts will be considered within the detailed design of the Proposed Development where appropriate.

6.8.3 The vulnerability to climate change measures are summarised in **Table 6.4**.

### Table 6.4 Embedded measures improving climate change resilience

| Chapter | Environmental Measure | Relevance for Climate Change Resilience |
|---|---|---|
| **Chapter 3 - Description of the Proposed Development** | Modern wind turbines are designed to withstand high wind speeds and are normally certified against structural failure for wind in excess of 120 mph. At high wind speeds, the wind farms will shut themselves down to avoid excessive wear. | These measures increase the resilience of the wind turbines to increasing wind speeds that may be experienced as part of storm events associated with climate change. |
| | The wind turbines will be fitted with a lightning protection system as part of the design. | These measures increase the resilience of the wind turbines to increasing lightning strikes that may be experienced associated with climate change. |
| | Occasionally very heavy snow and ice may affect the anemometer or aerodynamics of the turbine blades resulting in temporary automatic shutdown. The wind turbine would restart automatically after accumulations have naturally thawed. | Although climate change trends show increasing mean annual temperatures, cold weather events could still occur. These measures increase the resilience of the wind turbines to cold weather events. |
| | Turbines and High Voltage equipment (substation) would be inspected and maintained by a | This allows for adaptative capacity to be built into the operation of the wind turbines. The routine |

| Chapter | Environmental Measure | Relevance for Climate Change Resilience |
| --- | --- | --- |
| | local team of technicians. Turbines would be typically maintained at six monthly internals. | maintenance would identify any impacts to the wind turbines from extreme weather associated with climate change, allowing for replacement or upgrades, if required. |
| | The onsite battery storage will allow for continued power output during conditions unsuitable for generation or periods of high demand. | The additional power provided by the battery storage will reduce the need to rely on power from non-renewable sources, thus lowering carbon emissions and providing resilience against climate change. |
| **Chapter 11 - Ecology** | Habitat and proposals relevant to **Chapter 11** and **Chapter 12** will include consideration of future climate change. Areas of peat land temporarily lost will be revegetated and reinstated post construction. | Peat bog habitat is known to capture $CO_2$ from the atmosphere through photosynthesis thus acting as a large carbon sink providing valuable resilience against global warming and climate change. |
| **Chapter 12 - Ornithology** | Replanting of any forested area removed as a result of the development. | Climate change may lead to wetter and windier weather during the breeding season period, and this may affect productivity of some bird species. With the maturation of the forestry within the Development site and local area the number of certain woodland species may increase due to an increase in potential nest sites. |
| **Chapter 13 - Geology, Hydrology and Hydrogeology** | The temporal scope of the hydrology assessment will consider NPS EN-1 climate change emissions scenarios appropriate for the Proposed Development's lifetime. | Fluvial flood risk is considered to pose a limited risk to the Proposed Development. |
| | The Proposed Development has been designed to avoid the deepest areas of peat. The turbines have been located in areas of either no peat, or peat less than 0.5m deep. | This approach has assisted in the reduction of disturbance to peat and the volume of excavation required, hence in the reduction of the release of carbon associated to the peat disturbance activities. |
| | Sufficient attenuation storage would be incorporated into site drainage systems to ensure that discharge rates to watercourses do not exceed pre-development rates and taking into account | The implementation of attenuation storage will increase the adaptive capacity of the development allowing for up to the 1% Annual Exceedance Probability ('AEP') event. |

| Chapter | Environmental Measure | Relevance for Climate Change Resilience |
|---|---|---|
| | potential increases in peak rainfall intensity due to climate change | |
| | All watercourse crossings would be designed to convey a 1 in 200-year return period flood event with an allowance for climate change | The designs will mitigate against 1 in 200-year precipitation events that could lead to flooding impacts. |
| | The design for the Proposed Development will comply with good practice in structural design including compliance with the Eurocodes and relevant British Standards. The design will account for the expected ground conditions and design loads, accounting for the effects of climate change. | The detailed design of the foundations and supports will take into account changing ground conditions for the soil type with fluctuations in rainfall anticipated with climate change. |

## 6.9 Summary

6.9.1 The predicted volume of excavated peat required for the Proposed Development is 16,289m$^3$, all of which can be re-used for habitat reinstatement within the Development Site.

6.9.2 On the basis of potential annual $CO_2$ savings of 16,273 tonnes/year (based on figure of 432 tonnes of $CO_2$ savings per GWh and a capacity factor of 43%), the Proposed Development could result in a total carbon saving of approximately 0.57 Million (M) tonnes over its 35-year operational life and generate electricity to annually supply the equivalent of 9,708 homes.

6.9.3 It is predicted that the carbon loss in developing the Proposed Development would be paid back in approximately 1.5 years (4% of the 35-year operational life) based upon the expected outcome under the fossil fuel mix scenario. Even considering the maximum scenario against the fossil fuel mix, the Proposed Development would have achieved the carbon balance within approximately 2.5 years (7.1% of the 35-year operational life).

6.9.4 It is concluded that the GHG impact of the Proposed Development would have beneficial effect. The Proposed Development causes an indirect reduction in atmospheric GHG emissions which has a positive impact on achievement of carbon budgets and targets for Scotland and the UK, and a 1.5°C compatible trajectory.

6.9.5 The vulnerability of the Proposed Development to climate change has been addressed throughout the EIA Report in relevant topic chapters. The design of the wind turbines includes measures to improve the resilience of the Proposed Development, which will continue to be developed throughout the detailed design.