# Technical Appendix 3.3: Carbon Balance Assessment

# Technical Appendix 3.3: Carbon Balance Assessment

## 3.3.1 Introduction

3.3.1.1 This appendix presents full details of the methodology and results of the Carbon Balance Assessment undertaken for Novar 1 Wind Farm Repowering (the Proposed Development). The Proposed Development involves repowering the Novar 1 Wind Farm by removing the existing 34 turbines and infrastructure and replacing them with up to nine larger turbines, associated foundations, Internal Tracks, cabling, substation and construction compounds, alongside ancillary construction works and biodiversity enhancement measures.

3.3.1.2 Most of the Site is located within an area identified in high-level mapping (Carbon and Peatland Map 2016) as potentially nationally important peatland (Class 1 Peat) with areas of upland heath, acid grassland and blanket bog.

3.3.1.3 Policy 5 of National Planning Framework 4 (NPF4)[1] supports development on peatland, carbon-rich soils and priority peatland habitats only in limited circumstances, including where development contributes to greenhouse gas (GHG) emissions reduction targets through renewable energy generation and where adverse effects on peatland are avoided, minimised or offset. Where development on peatland is proposed, NPF4 requires a detailed, site-specific assessment to identify baseline peat depth and condition, the potential effects of disturbance, and the likely net effect on carbon emissions and carbon loss. All applications that are over 50 megawatt (MW) are dealt with through the Scottish Government's Energy Consents Unit (ECU) in accordance with Section 36 of the Electricity Act 1989[2] and require a carbon balance assessment using the latest version available of the Scottish Government's Carbon Calculator Tool.

3.3.1.4 Ramboll UK Ltd (Ramboll) has been commissioned by the Applicant to undertake a Carbon Balance Assessment for the Proposed Development. This assessment estimates that carbon payback period for the Proposed Development and considers the following carbon saving, loss and site-improvement parameters:

- Carbon savings associated with displacement of fossil-fuel electricity generation;
- Loss of carbon arising from the manufacture, transportation, installation, and operation of the wind farm, with emissions associated with the dismantling and disposal of the turbines included in the boundary of the turbine Life Cycle Assessment (LCA) rather than being treated as a separate carbon-loss parameter;
- Loss of carbon from backup power generation;
- Loss of carbon-fixing potential of peatland;
- Loss and/or saving of carbon stored in peatland (by peat removal or changes in drainage); and
- Carbon gains due to improvement of habitat.

## 3.3.2 Consultation

3.3.2.1 An EIA Scoping Report (presented in **Technical Appendix 1.3 Scoping Report (EIAR Volume 4)**) was submitted to the ECU on 23rd January 2025 with a formal request for a Scoping Opinion on the proposed scope of the EIA and assessment methodologies. The ECU subsequently issued their Scoping Opinion on the proposed scope and methodology of the topics for assessment within the EIA on 23rd May 2025. A copy of ECU's Scoping Opinion is provided in **Technical Appendix 1.4 Scoping Opinion (EIAR Volume 4)**.

3.3.2.2 A summary of the key points raised in ECU's Scoping Opinion, relevant to Carbon Balance Assessment, are presented in Table 3.3.1.

**Table 3.3.1: Summary of ECU Scoping Opinion Comments**

| Organisation | Scoping opinion |
|---|---|
| The Highland Council (THC) | Carbon balance calculations should be undertaken and included within the EIAR with a summary of the results provided focussing on the carbon payback period for the wind farm. |
| Scottish Environment Protection Agency (SEPA) | Where proposals are on peatland or carbon rich soils (CRS), a carbon balance assessment should be submitted to address SEPA's requirements in relation to NPF4 Policy 5 to protect CRS and the ecosystem services they provide (including water and carbon storage). Peatland in near natural condition generally experiences low greenhouse gas emissions, is accumulating and may be sequestering carbon. |

3.3.2.3 This Technical Appendix addresses the requirements of THC by providing carbon balance calculations, including the wind farm carbon payback period, and meets SEPA's expectations under NPF4 Policy 5 by assessing impacts on peatland.

## 3.3.3 Assessment Methodology

3.3.3.1 GHG emissions have been measured in tonnes of carbon dioxide equivalent ($tCO_2e$) which is a quantity that describes, for a given mixture and amount of GHG, the amount of carbon dioxide ($CO_2$) that would have the same global warming potential (GWP), when measured over a 100-year timescale. These units therefore enable comparison of different GHGs emitted, or saved, at different project stages. For the purposes of this assessment GHG emissions are hereafter referred to as carbon for consistency with the Scottish Government Windfarm Carbon Assessment Tool.

### Assessment Approach

3.3.3.2 The Carbon Balance Assessment has been undertaken using the Scottish Government Windfarm Carbon Assessment Tool (v2.15.6) for wind farms on Scottish peatlands[3] (hereafter referred to as the "Carbon Calculator"). The tool is based on the Scottish Government methodology "*Calculating carbon savings from wind farms on Scottish peat lands: a new approach*[4], which was designed in

[1] Scottish Government (2023), National Planning Framework 4. Available at: National Planning Framework 4 - gov.scot [accessed September 2026].

[2] Scottish Government (2022), Electricity Act 1989 - sections 36 and 37: applications guidance. Available at: Electricity Act 1989 - sections 36 and 37: applications guidance - gov.scot [accessed September 2026].

[3] Scottish Government (2022), Carbon calculator for wind farms on Scottish peatlands: factsheet. Available at: Carbon calculator for wind farms on Scottish peatlands: factsheet - gov.scot [accessed September 2026].

[4] Scottish Government (2008), Calculating carbon savings from wind farms on Scottish peat lands: a new approach. Available at: Appendix 2: Calculating Potential Carbon Losses & Savings from Wind Farms on Scottish Peat lands: a total life cycle perspective - Calculating carbon savings from wind farms on Scottish peat lands: a new approach - gov.scot [accessed September 2026].

response to concerns on reliability of methods used to calculate reductions in carbon emissions arising from large scale wind farm developments on peat land.

3.3.3.3 The Carbon Calculator assesses the benefit of displacing conventionally generated electricity in the grid compared to the predicted direct and indirect carbon emissions from the construction, operation, and decommissioning of a wind farm. It provides an estimate of the carbon payback period for the Proposed Development based on predicted emissions from construction materials and grid backup, as well as losses and gains of stored carbon on site.

3.3.3.4 The Carbon Calculator is provided as an Excel-based tool with integrated high-level automated checking, detailed user guidance and cells for identification of data sources and relevant data calculations. This Technical Appendix has used the Excel version of the tool (v2.15.6), obtained from Scottish Government's Energy Consents Unit. The Carbon Calculator has been submitted separately to the Energy Consent Unit (ECU). This includes input data and the results of the Carbon Balance Assessment.

3.3.3.5 Any assumptions and limitations inherent within the tool therefore apply to these carbon calculations. Project specific aspects of the methodology, input parameters used in the Carbon Calculator, and assumptions and limitations will be discussed further within this Technical Appendix.

3.3.3.6 The Carbon Balance Assessment has been undertaken in the context of NPF4 Policy 5, which requires that where development on peatland or carbon-rich soils is proposed, a carbon balance assessment must demonstrate that the development would result in a net reduction in GHG emissions over its lifetime. The Scottish Government's Section 36 guidance further stipulates that carbon balance calculations should be provided for all wind farm developments on peatland to demonstrate that the proposal is consistent with climate change mitigation objectives.

### Assessment Scope

3.3.3.7 Table 3.3.2 outlines potential carbon emission sources, and savings, of carbon emissions from the project stages that are covered by the Carbon Balance Assessment and additionally identifies emission sources that fall outside of the scope of the Carbon Calculator.

3.3.3.8 Carbon emissions associated with removal and decommissioning of the existing 34 wind turbines and reinstatement of redundant areas have not been assessed within the Carbon Calculator, as the tool covers only the lifecycle emissions and savings associated with the new Proposed Development and does not allow to input information on the pre-construction activities.

**Table 3.3.2: Carbon Emissions and Savings Included in the Assessment**

| Project phase | Included/excluded from assessment | Carbon emissions/savings source |
|---|---|---|
| Construction | Included | Carbon emissions resulting from the extraction, production, manufacture of turbine components. The turbine Lifecycle Carbon Assessment (LCA) values are available from the manufacturer of the candidate wind turbine. |
| | Included | Carbon emissions resulting from the manufacture of concrete required for foundations. |
| | Included | Carbon emissions resulting from the direct excavation of peat on-Site for building tracks, hardstanding, turbine foundations and other infrastructure. |
| | Excluded | Carbon emissions resulting from manufacture and transport of other materials required for foundations and Internal Tracks e.g., steel, sand, rock and geotextile. These materials are not explicitly included in the Scottish Government Carbon Calculator for wind farms on peat. |
| | Excluded | Carbon emissions resulting from the transport of labour to the construction site. This element is not included in the Scottish Government Carbon Calculator for wind farms on peat. |
| | Excluded | Carbon emissions resulting from the use of plant and equipment during construction, including for forestry felling. This element is only included in the Scottish Government Carbon Calculator if the detailed forestry felling calculations are required for large scale felling activities. A simplified approach has been used for the Site due to the small area of felling. |
| Operation | Included | Carbon emissions from the indirect impact of drainage on peat surrounding the Proposed Development infrastructure. |
| | | Carbon savings resulting from the generation of electricity by wind turbines and displacement of grid electricity generated by fossil fuels. |
| | Included | Carbon emissions during the lifetime of the Proposed Development resulting from the loss of active carbon-absorbing habitat, including forestry and bog habitat. |
| | | Carbon uptake resulting from the restoration of carbon-absorbing habitat. |
| | Excluded | Carbon emissions resulting from transport of labour required throughout the lifetime of the Proposed Development are not explicitly included in the Scottish Government Carbon Calculator for wind farms on peat. |
| | Excluded | Emissions from use of diesel in generators used to restart turbines following |

| Table 3.3.2: Carbon Emissions and Savings Included in the Assessment | | |
|---|---|---|
| **Project phase** | **Included/excluded from assessment** | **Carbon emissions/savings source** |
| | | shutdown, based on assessment assumption that generators may be required. This is likely to be a very small emission source. |
| | Excluded | Carbon removals resulting from the creation or restoration of active carbon-absorbing habitat. The Scottish Government Carbon Calculator for wind farms on peat does not estimate future sequestration from restored vegetation, only the change to the existing carbon balance of soils in restored areas. |
| Decommissioning | Included | Carbon emissions from dismantling and disposal of turbines are included within the boundary of the LCA, however these are not separated from the overall embodied emissions of the turbines in the Scottish Government Carbon Calculator for wind farms on peat. |
| | Excluded | No detailed assessment of decommissioning emissions of other elements of the Proposed Development has been carried out as these are not included within the Scottish Government Carbon Calculator for wind farms on peat. |

### Temporal Scope

3.3.3.9 The temporal scope for the Carbon Balance Assessment has been set in line with the lifespan of the consent for the operation of the Proposed Development, i.e., 35 years. Following the operational phase of the project, the Proposed Development would either be decommissioned or repowered. Where decommissioning is required, it has been assumed that disturbed areas would be reinstated, with hydrological and habitat conditions restored as far as practicable in accordance with best practice and any agreed restoration plans. On this basis, carbon losses associated with peat disturbance are assumed to be limited to the operational period and are not extended beyond the consent lifespan.

### Study Area

3.3.3.10 For the purposes of the carbon payback assessment, carbon emissions and savings have been considered within a global context, recognising that they contribute to a shared atmospheric carbon pool. Therefore, this assessment is not limited solely to emissions or savings occurring within the Site boundary. Land-based emissions associated with peat disturbance and habitat loss have been quantified based on the physical footprint of the Proposed Development. Emissions arising from other activities, such as the extraction, manufacture and processing of materials, have been attributed to the Proposed Development, even though these are likely to occur in other parts of the world.

### Data Sources and Assumptions

3.3.3.11 The Carbon Calculator has been prepared on the basis of the following information sources:

- Novar 1 Wind Farm EIAR Chapter 3: Site Description and Proposed Development (EIAR Volume 2);
- Novar 1 Wind Farm EIAR Chapter 4: Design Evolution and Alternatives (EIAR Volume 2);
- Novar 1 Wind Farm EIAR Chapter 7: Ecology (EIAR Volume 2);
- Novar 1 Wind Farm EIAR Technical Appendix 3.2: Arboricultural Assessment (EIAR Volume 4);
- Novar 1 Wind Farm EIAR Technical Appendix 7.3: Deer Management Plan (EIAR Volume 4);
- Novar 1 Wind Farm EIAR Technical Appendix 7.4: Outline Biodiversity Enhancement Management Plan (EIAR Volume 4);
- Novar 1 Wind Farm EIAR Chapter 9: Hydrology, Hydrogeology and Soils (EIAR Volume 2);
- Novar 1 Wind Farm EIAR Technical Appendix 9.5: Peat Depth Survey Results (EIAR Volume 4);
- Novar 1 Wind Farm EIAR Technical Appendix 9.6: Outline Peat Management Plan (EIAR Volume 4);
- Novar 1 Wind Farm EIAR Technical Appendix 9.7: Peat Landslide and Hazard Risk Assessment (EIAR Volume 4); and
- Novar 1 Wind Farm EIAR Technical Appendix 9.8: Borrow Pit Assessment (EIAR Volume 4).

3.3.3.12 This Carbon Calculator has been populated based on information available at the time of writing. Subsequent changes to the design specifications of the project may change the results produced by this Carbon Calculator.

3.3.3.13 The Carbon Calculator requires a range of data to be inputted to utilise expected, minimum and maximum values, where relevant and applicable. The approach for this assessment has been to include maximum values as those values which would result in the longest (maximum) payback period; and minimum values as those values which would result in the shortest (minimum) payback period. The expected value is based on the most realistic option for the Proposed Development. In some cases, assumptions have been made to estimate values required for the input data.

3.3.3.14 Table 3.3.3 outlines the input data used in the Carbon Calculator along with data sources and assumptions applied in the absence of the site-specific information.

| Table 3.3.3: Carbon Calculator Input Parameters, Data Sources and Assumptions | | | | | |
|---|---|---|---|---|---|
| **Parameter** | **Expected** | **Minimum** | **Maximum** | **Data Source** | **Key Assumption** |
| **Wind Farm Characteristics** | | | | | |
| **Dimensions** | | | | | |
| No. of turbines | 9 | 9 | 9 | **Chapter 3: Site Description and Proposed Development (EIAR Volume 2**): up to 9 turbines planned. | None |
| Lifetime of wind farm (years) | 35 | 35 | 35 | **Chapter 3: Site Description and Proposed Development (EIAR Volume 2):** Proposed Development has been designed with an operational life of up to 35 years. | None |
| **Performance** | | | | | |
| Turbine capacity (MW) | 6.2 | 6.2 | 6.2 | **Chapter 3: Site Description and Proposed Development (EIAR Volume 2):** 6.2 MW turbine has been identified as a candidate turbine for the EIA purposes. | None |
| Capacity factor – using direct input of capacity factor (percentage efficiency) | 29.80 | 28.31 | 31.29 | Calculated as a rolling average of the past five years using data from the Digest of UK Energy Statistics[5]. Using stats 2021-2025 data. | A range of +/- 5% has been used to calculate the likely minimum and maximum. |
| **Backup** | | | | | |
| Extra capacity required for backup (%) | 5 | 5 | 5 | The Carbon Calculator indicates that if over 20% of national electricity is generated by wind energy, the extra capacity required for backup is 5% of the rated capacity of the wind plant. In 2024, Scotland generated 59.02% via onshore wind (DESNZ, 2024). No full dataset available for 2025. | Assumed there is no significant improvement in demand side management or energy storage for intermittent generation over the lifetime of the project. |
| Additional emissions due to reduced thermal efficiency of the reserve generation (%) | 10 | 10 | 10 | Fixed value within the Carbon Calculator for scenario where extra capacity for backup is required. | None |
| Carbon dioxide emissions from turbine life - (e.g. manufacture, construction, decommissioning) | Direct input of total emissions | | | Based on manufacturer provided Life Cycle Assessment data of electricity production from an Onshore 6.2 MW wind plant. | None |
| Total $CO_2$ emissions from turbine life ($tCO_2/MW$) | 430 | 387 | 473 | Performance metric for total tonnes of $CO_2e$ per MW for a wind plant and wind turbine-only, based on a 6.2 MW turbine. | A range of +/- 10% has been used to calculate the likely minimum and maximum. |
| **Characteristics of peat land before wind farm development** | | | | | |
| Type of peat land | Acid Bog | Acid Bog | Acid Bog | Carbon Calculator options include acid bog and fen. Based on **Chapter 7: Ecology (EIAR Volume 2)**, the dominant habitats (excluding the coniferous woodland plantation) are peatlands in the form of blanket bog (much of it in a degraded state). | None |

[5] DESNZ (2025), Digest of UK Energy Statistics (DUKES): renewable sources of energy. Load factors for renewable electricity generation (DUKES 6.3) [accessed February 2026].

| Table 3.3.3: Carbon Calculator Input Parameters, Data Sources and Assumptions | | | | | |
|---|---|---|---|---|---|
| **Parameter** | **Expected** | **Minimum** | **Maximum** | **Data Source** | **Key Assumption** |
| Average air temperature at site (°C) | 8.48 | 4.76 | 12.25 | Annual average data for local weather station at Tain Range (approx. 22 km from the site) for period 1991 to 2020. | Impacts of global climate change not accounted for as overall payback is not sensitive to temperature. |
| Average depth of peat at the site (m) | 0.5 | 0 | 3.55 | **Technical Appendix 9.5: Peat Depth Survey Results (EIAR Volume 4):** approximately 52% of peat depth probes recorded peat depths less than or equal to 0.5 m[6] depth; 34% of locations recorded peat depths greater than 1 m, with the maximum depth being 3.55 m. | None |
| Carbon (C) Content of dry peat (% by weight) | 56 | 49 | 62 | Default values for carbon content of peat 49% and 62% are provided in the Carbon Calculator. The estimated midpoint value aligns with Carbon and Peatland 2016 map available from Scottish Soils Knowledge and Information Base (SSKIB)[7]. | Upper and lower range provided as default. Midpoint used as expected value. |
| Average extent of drainage around drainage features at site (m) | 10.0 | 5.0 | 50.0 | In the absence of detailed drainage modelling, the value recommended in the Carbon Calculator guidance has been adopted. | None |
| Average water table depth at site (m) | 0.25 | 0.23 | 0.28 | **Technical Appendix 9.5: Peat Depth Survey Results (EIAR Volume 4)** states that acrotelm and catotelm are present in two distinct layers within undisturbed peat that control the hydrological regime. The depth of the acrotelm has been assumed as 0.5 m based on a precautionary approach. | Assumed the water table would sit on average around the middle of the acrotelm, which is 0.25 m. A range of +/- 10% used. |
| Dry soil bulk density (g/cm³) | 0.132 | 0.072 | 0.293 | The default values for dry soil bulk density of peat provided in the Carbon Calculator have been used. | |
| **Characteristics of bog plants** | | | | | |
| Time required for regeneration of bog plants after restoration (years) | 6 | 2 | 10 | Based on technical estimation and similar projects in Scotland. These values are not expected to deviate from standard regeneration timescales. | Based on precautionary approach. |
| Carbon accumulation due to C fixation by bog plants in undrained peats (tC/ha/yr) | 0.25 | 0.12 | 0.31 | Carbon Calculator user guidance notes. | Values are based on Scottish generic values. |
| **Forestry Plantation Characteristics** | | | | | |
| Area of forestry plantation to be felled (ha) | 0.7 | 0.7 | 0.7 | **EIAR Chapter 7: Ecology (EIAR Volume 2).** | Subject to further detailed survey. This value was selected as worst case. |

[6] The expected peat depth of 0.5 m entered into the Carbon Calculator was adopted with reference to the peat depth survey results, which recorded no peat or shallow peat (≤0.5 m) at approximately 52% of probes. This differs from the overall mean peat depth of 0.73 m reported in **Technical Appendix 9.5.**

[7] Scottish Soil (2023), Carbon and peatland 2016 map. Available at: Carbon and peatland 2016 map | Scotland's soils [accessed September 2026].

| Table 3.3.3: Carbon Calculator Input Parameters, Data Sources and Assumptions | | | | | |
|---|---|---|---|---|---|
| **Parameter** | **Expected** | **Minimum** | **Maximum** | **Data Source** | **Key Assumption** |
| Average rate of carbon sequestration in timber (tC/ha/yr) | 1.51 | 1.36 | 1.64 | **EIAR Technical Appendix 3.2: Arboricultural Assessment (Volume 4)** details number of trees and species of mixed woodland that would be impacted**.** The Woodland Carbon Code Carbon Calculator (August 2025)[8] estimates average annual sequestration rate per ha. | It was estimated that the area to be felled is composed of broadleaf (34%) and conifers (66%); it was assumed that the woodland is mature and on average 30 years old (2m spacing, no thin management).<br>A range of +/-10% used to calculate the likely minimum and maximum values. |
| **Counterfactual emission factors** | | | | | |
| Coal-fired plant emission factor ($tCO_2$/MWh) | 0.919 | 0.919 | 0.919 | Fixed counterfactual emission factors are provided in the Carbon Calculator and cannot be altered. Values for both coal-fired and fossil fuel-mix emission factors are updated from DUKES[9] data for the UK which is published annually (2024 values used). The source for the grid-mix emission factor is the list of emission factors used to report on GHG emissions by UK organisations published by DESNZ[10]. | None |
| Grid-mix emission factor ($tCO_2$/MWh) | 0.177 | 0.177 | 0.177 | | None |
| Fossil fuel-mix emission factor ($tCO_2$/MWh) | 0.448 | 0.448 | 0.448 | | None |
| **Borrow Pit** | | | | | |
| Number of borrow pits | 1 | 1 | 1 | **EIAR Technical Appendix 9.8: Borrow Pit Assessment (Volume 4)**. | Assumed that there would be only 1 borrow pit required. |
| Average length of pits (m) | 180 | 180 | 180 | **EIAR Technical Appendix 9.8: Borrow Pit Assessment (Volume 4).** | None |
| Average width of pits (m) | 115 | 115 | 115 | **EIAR Technical Appendix 9.8: Borrow Pit Assessment (Volume 4).** | None |
| Average depth of peat removed from pit (m) | 0.08 | 0 | 0.3 | **EIAR Technical Appendix 9.5: Peat Depth Survey Results (Volume 4)**, Table 1 states the mean pit depth for borrow pit.<br>**EIAR Technical Appendix 9.8.: Borrow Pit Assessment (Volume 4)** states maximum peat depth of 0.3 m observed at the proposed pit location. | None |
| **Foundations and hard-standing area associated with each turbine** | | | | | |
| Method used to calculate $CO_2$ loss from foundations and hard-standing | Regular, with vertical sides | | | The simple method of calculation for turbine foundations was used for this application. | The foundation is assumed to be a reinforced concrete gravity type with sloping sides. Values are |

[8] Woodland Carbon Code (2025), Template Documents and Tools. Carbon Calculator. Available at: Template documents and tools | Woodland Carbon Code [accessed September 2026].

[9] Department for Energy Security and Net Zero (2025), Digest of UK Energy Statistics (DUKES): electricity. Available at: Digest of UK Energy Statistics (DUKES): electricity - GOV.UK [accessed September 2026].

[10] Department for Energy Security and Net Zero (2025), Greenhouse gas reporting: conversion factors 2025. Available at: Greenhouse gas reporting: conversion factors 2025 - GOV.UK [accessed September2026].

| Table 3.3.3: Carbon Calculator Input Parameters, Data Sources and Assumptions | | | | | |
|---|---|---|---|---|---|
| **Parameter** | **Expected** | **Minimum** | **Maximum** | **Data Source** | **Key Assumption** |
| Average length of turbine foundations (m) | 22 | 22 | 22 | The Applicant. **Figure 3.3 Typical Turbine Foundation (EIAR Volume 3a)**. | based on the central excavation diameter of 25 m, approximated by a rectangular footprint of 22 m × 22 m. |
| Average width of turbine foundations (m) | 22 | 22 | 22 | The Applicant**. Figure 3.3 Typical Turbine Foundation (EIAR Volume 3a)**. | |
| Average depth of peat removed from turbine foundations (m) | 0.7 | 0.6 | 0.8 | **Technical Appendix 9.6: Outline Peat Management Plan (EIAR Volume 4)** provides estimated peat volume to be excavated. Peat depth has been derived by dividing estimated peat volume to be excavated for foundation, crane pad and hardstanding by the area of these elements, which was provided by the Applicant. | As peat depths is variable at the site, expected value is based on the average peat depth recorded.<br>A range of +/-10% used to calculate the likely minimum and maximum values. |
| Average length of hardstanding (m) | 49.0 | 49.0 | 49.0 | The Applicant. **Figure 3.4 Typical Turbine Hardstanding (EIAR Volume 3)**. | Values are approximate as hardstanding is not rectangular. |
| Average width of hardstanding (m) | 30.0 | 30.0 | 30.0 | Site designer. **Figure 3.4 Typical Turbine Hardstanding (EIAR Volume 3)**. | Values are approximate as hardstanding is not rectangular. |
| Average depth of peat removed from hardstanding (m) | 0.7 | 0.6 | 0.8 | Estimated using similar approach as for turbine foundations. | Same assumptions used as for turbine foundations. |
| **Internal Tracks** | | | | | |
| Total length of Internal Track (m) | 22,455 | 22,455 | 22,455 | Calculated by Ramboll based on information provided by the Applicant. This includes upgraded and new Internal Tracks. | None |
| Existing Internal Track length (m) | 19,498 | 19,498 | 19,498 | Based on the information provided by the Applicant. This includes upgraded Internal Tracks. | None |
| Length of Internal Track that is floating road (m) | 0 | 0 | 0 | The Applicant. No floating track currently proposed. | None |
| Length of Internal Track that is excavated road (m) | 2,957 | 2,957 | 2,957 | The Applicant. Proposed new Internal Track approximate length is 2,957m. | None |
| Excavated road width (m) | 6.0 | 6.0 | 6.0 | Based on the information provided by the Site designer. | None |
| Average depth of peat excavated for road (m) | 0.47 | 0 | 0.5 | As detailed information on excavation depth is not available, calculated by dividing volume of peat excavated for road by area of the road, based **Technical Appendix 9.6: Outline Peat Management Plan (EIAR Volume 4).** | Based on the **Technical Appendix 9.5: Peat Depth Survey Results (EIAR Volume 4)** assumed 0 m as minimum value and 0.5 m as the worst-case. |
| **Cable Trenches** | | | | | |

| Table 3.3.3: Carbon Calculator Input Parameters, Data Sources and Assumptions | | | | | |
|---|---|---|---|---|---|
| **Parameter** | **Expected** | **Minimum** | **Maximum** | **Data Source** | **Key Assumption** |
| Length of any cable trench on peat that does not follow Internal Tracks and is lined with a permeable medium (e.g. sand) (m) | 0 | 0 | 0 | The Applicant stated that all trenches associated with the Proposed Development are laid alongside Internal Tracks. | Assumed that all cable trenches associated with the Proposed Development follow access Internal Track routes. |
| **Additional peat excavated (not accounted for above)** | | | | | |
| Volume of additional peat excavated ($m^3$) | 4,446 | 4,446 | 4,446 | **Technical Appendix 9.5: Peat Depth Survey Results (EIAR Volume 4).**<br>Includes:<br>Substation compound (upgrade to existing) – 612$m^3$<br>Construction compound 1 (temporary) – 925$m^3$<br>Construction compound 2 (temporary) – 2909$m^3$<br>Construction compound 3 (temporary) – 0$m^3$ | None |
| Area of additional peat excavated ($m^2$) | 9,800 | 9,800 | 9,800 | Technical Appendix 9.5: Peat Depth Survey Results (EIAR Volume 4).<br>Includes:<br>Substation compound (upgrade to existing) – 1800$m^2$<br>Construction compound 1 (temporary) – 5000$m^2$<br>Construction compound 2 (temporary) – 3000$m^2$<br>Construction compound 3 (temporary) – 0$m^2$ | None |
| **Improvement of Carbon sequestration at site by blocking drains, restoration of habitat etc.** | | | | | |
| **Improvement of degraded bog** | | | | | |
| Area of degraded bog to be improved (ha) | 135.7 | 135.7 | 135.7 | Technical Appendix 7.4: Outline Biodiversity Enhancement Management Plan (EIAR Volume 4) states that no less than 135.7 ha would be restored. | The extent of restoration is subject to refinement. |
| Water table depth in degraded bog before improvement (m) | 0.25 | 0.23 | 0.28 | Same assumptions used as per previously used average water table depth values. | |
| Water table depth in degraded bog after improvement (m) | 0.10 | 0.09 | 0.11 | Based on the similar projects in Scotland. Target optimum water table depth for restoring peat is around 0.1 m. | A range of +/- 10% used to calculate the likely minimum and maximum values. |
| Time required for hydrology and habitat of bog to return to its previous state on improvement (years) | 15 | 10 | 25 | Assumption based on professional experience and previous similar projects. | None |
| Period of time when effectiveness of the improvement in degraded bog can be guaranteed (years) | 35 | 35 | 35 | The Carbon Calculator states that if the time required for hydrology and habitat to return to its previous state is 10 years and the restoration can be guaranteed over the lifetime of the Proposed Development (35 years), the period of time when the improvement can be guaranteed should be entered as 35 years. | None |
| **Improvement of felled planation land** | | | | | |
| Area of felled plantation to be improved (ha) | 0 | 0 | 0 | **Technical Appendix 7.4: Outline Biodiversity Enhancement Management Plan (EIAR Volume 4)** states that no replanting of the areas felled would take place within the Site. Areas along the Access Route | As the worst case assumed that no areas of felled plantation would be improved. Off-Site restoration would be no less than 0.7 ha. This |

| Table 3.3.3: Carbon Calculator Input Parameters, Data Sources and Assumptions | | | | | |
|---|---|---|---|---|---|
| **Parameter** | **Expected** | **Minimum** | **Maximum** | **Data Source** | **Key Assumption** |
| | | | | where woodland would be felled may be considered for restoration, although this is subject to refinement. | could not be accounted within the tool. |
| **Restoration of peat removed from borrow pits** | | | | | |
| Area of borrow pits to be restored (ha) | 1.67 | 1.67 | 1.67 | **EIAR Technical Appendix 9.6: Outline Peat Management Plan (Volume 4).** | None |
| Depth of water table in borrow pit before restoration with respect to the restored surface (m) | 0.25 | 0.23 | 0.28 | Same assumptions used as per previously used average water table depth values. | None |
| Depth of water table in borrow pit after restoration with respect to the restored surface (m) | 0.10 | 0.09 | 0.11 | Same assumptions used as per previously used average water table depth values after restoration. | None |
| Time required for hydrology and habitat of borrow pit to return to its previous state on restoration (years) | 15 | 10 | 25 | Assumption based on professional experience and previous similar projects. | None |
| Period of time when effectiveness of the restoration of peat removed from borrow pits can be guaranteed (years) | 35 | 35 | 35 | Same assumption as above covering the lifetime of Proposed Development. | None |
| **Early removal of drainage from foundations and hardstanding** | | | | | |
| Water table depth around foundations and hardstanding before restoration (m) | 0 | 0 | 0 | Unknown at present. | None |
| Time to completion of backfilling, removal of any surface drains, and full restoration of the hydrology (years) | 0 | 0 | 0 | Not applicable. | None |
| Time to completion of backfilling, removal of any surface drains, and full restoration of the hydrology (years) | 0 | 0 | 0 | Not applicable. | None |
| **Restoration of site after decommissioning** | | | | | |
| Will the hydrology of the site be restored on decommissioning? | Yes | Yes | Yes | The proposals for the decommissioning or repowering are not known at this stage.<br>**Chapter 9: Hydrology, Hydrogeology and Soils (EIAR Volume 2)** states that should full decommissioning of the Site be carried out the Site would be returned to 'the same' or 'a better' condition. | Natural drainage conditions would be replicated, as far as practicably possible based on the intended land use. |

| Table 3.3.3: Carbon Calculator Input Parameters, Data Sources and Assumptions | | | | | |
|---|---|---|---|---|---|
| **Parameter** | **Expected** | **Minimum** | **Maximum** | **Data Source** | **Key Assumption** |
| Will you attempt to block any gullies that have formed due to the windfarm? | Yes | Yes | Yes | **EIAR Technical Appendix 9.6: Outline Peat Management Plan (Volume 4).** | |
| **Will the habitat of the site be restored on decommissioning?** | | | | | |
| Will you control grazing on degraded areas? | Not applicable | Not applicable | Not applicable | **Technical Appendix 7.3: Deer Management Plan (EIAR Volume 4)** notes low density of deer population at present and that no intensive efforts to reduce the numbers are currently required. | Assumed no grazing control required. |
| Will you manage areas to favour reintroduction of species? | Yes | Yes | Yes | The proposals for the decommissioning or repowering are not known at this stage.<br>**Chapter 9: Hydrology, Hydrogeology and Soils (EIAR Volume 2)** states that should full decommissioning of the Site be carried out the Site would be returned to 'the same' or 'a better' condition. | Assumed that areas would be manged to favour regeneration and vegetation reinstatement. |
| Choice of methodology for calculating emission factors | Site specific (required for planning applications). | | | | |

### Assessment Limitations

3.3.3.15 The assessment of the carbon payback time for the Proposed Development is subject to limitations associated with the scope and functionality of the Carbon Calculator. The tool does not account for carbon emissions or savings related to pre-construction decommissioning activities. The project proposes to treat the 34 decommissioned turbines and associated infrastructure where possible, as material resources rather than waste, forming a key element of its circular economy approach. Carbon savings associated with the high-value recycling of materials such as steel, copper and aluminium, as well as the on-Site processing and reuse of excavated concrete foundations as certified aggregate for tracks and hardstanding, could not be captured by the tool. As a result, the calculated carbon balance is likely to be conservative.

3.3.3.16 The **Technical Appendix 9.6: Outline Peat Management Plan (EIAR Volume 4)** provides detailed measures for the handling, storage and reinstatement of excavated peat. These measures are designed to minimise carbon losses from peat disturbance during construction and ensure that excavated peat is reused on-Site where practicable, in accordance with SEPA's regulatory position statement on developments on peat.

3.3.3.17 The Carbon Calculator also only accounts for carbon savings associated with improvement of felled plantation land. **Technical Appendix 3.2: Arboricultural Assessment (EIAR Volume 4)** states that replanting of felled areas is not currently proposed, although some areas along Access Route may be considered for restoration subject to design refinement. In addition, the Applicant has committed to providing 0.7 ha of compensatory planting, in an area outside the Application Site boundary on the Novar Estate. These woodland creation and restoration measures were not confirmed at the time of the assessment and are not reflected in the calculation outputs. An in-principle agreement has since been reached with the landowner, in relation to the relevant land and its potential inclusion in the proposed woodland creation and restoration measures. Consequently, the potential carbon sequestration benefits associated with these measures are not currently included in the Carbon Calculator, and the overall project carbon savings may be underestimated.

3.3.3.18 Inputs to the Scottish Government Carbon Assessment Tool were provided by relevant technical specialists. Any uncertainties in the data used, together with discipline-specific assumptions and limitations related to data collection, are described within the respective **technical chapters of the EIAR (Volume 2)**.

3.3.3.19 A capacity factor of 29.2 % has been applied in the Carbon Calculator based on a rolling average of UK onshore wind performance for 2021–2025 derived from Digest of UK Energy Statistics data[5], with a sensitivity range of +/-5% to reflect inter-annual variability. Site-specific generation data were not available at the time of assessment; therefore, a national average value has been used as a reasonable proxy. Should project-specific performance data become available at a later stage, the assessment could be refined accordingly.

## 3.3.4 Results of Carbon Balance Assessment

### Carbon Savings

3.3.4.1 Every unit of electricity produced by a wind farm development displaces a unit of electricity which would otherwise have been produced by a conventional power station and therefore presents carbon savings.

3.3.4.2 The electricity produced by a wind farm is assumed to substitute energy production by entirely coal-fired generation, or a mix of fossil fuels, or the national grid mix of energy generation. As it is not appropriate to define the electricity source for which this renewable electricity project would substitute, due to uncertainty in future grid mix, carbon emission savings have been calculated for each scenario included in the Carbon Calculator. It should be noted that renewable energy developments achieve the greatest potential carbon savings when assumed to displace coal-fired electricity generation. However, as the UK phased out coal-fired power generation in 2024 following the closure of the last operational plant, the coal-fired scenario is therefore presented for comparison purposes only as a theoretical counterfactual.

3.3.4.3 The potential carbon savings for the Proposed Development have been calculated based on the latest DUKES Statistics[9] and an average capacity factor of 29.8% (calculated as a rolling average of the past five years using data from the Digest of UK Energy Statistics[5], using data for the period 2021-2025). It is expected the Proposed Development would result in the production of approximately 145,665 megawatt hours (MWh) annually, equating to approximately 5,098, 267 MWh over the operational life of Proposed Development (35 years). The annual energy-generation figure is calculated from the proposed installed capacity of 55.8 MW and the 29.8% capacity factor, with the resulting annual generation used to derive the 35-year lifetime generation. This equates to avoiding approximately 2,284,023 tonnes of fossil fuel-mix generation equivalent $CO_2$ emissions, over the operational life. This figure is calculated by applying the fossil fuel-mix emission factor used in the Scottish Government Carbon Calculator to the estimated lifetime electricity generation.

3.3.4.4 Table 3.3.4 provides the estimates of $CO_2$ emission savings for the Proposed Development when compared against coal-fired, grid-mix and fossil fuel electricity generation. The potential energy output from the Proposed Development over the 35-year lifetime is also shown.

**Table 3.3.4: Estimate of $CO_2$ savings**

| **Windfarm $CO_2$ emission saving over…** | **Expected** | **Minimum** | **Maximum** |
|---|---|---|---|
| Coal-fired electricity generation ($tCO_2$/yr) | 133,866 | 127,128 | 140,559 |
| Grid-mix of electricity generation ($tCO_2$/yr) | 25,783 | 24,485 | 27,072 |
| Fossil fuel-mix of electricity generation ($tCO_2$/yr) | 65,258 | 61,973 | 68,521 |
| Energy output from windfarm over lifetime (MWh) | 5,098,267 | 4,841,643 | 5,353,181 |

### Carbon Losses and Gains

3.3.4.5 As detailed within the Scottish Government's Technical Note Version 2.10.0 on Calculating potential carbon losses and savings from wind farms on Scottish peatlands[11], the manufacturing, construction and installation of the wind turbines on Site has an associated carbon cost, and carbon losses are also generated by the requirement for extra capacity to back up wind power generation. Carbon losses associated with reduced carbon fixing potential and loss of soil organic matter occurs through drainage effects and excavation of peat for construction. Carbon losses at the Site may also be associated with felling of existing forestry.

[11] Calculating potential carbon losses and savings from wind farms on Scottish peatlands. Available at: Revised Guidance [accessed September 2026].

3.3.4.6 Organic soils (peatlands) in Scotland act as carbon sinks, whereby they absorb $CO_2$ during their formation. As detailed in **Technical Appendix 9.5: Peat Depth Survey Results (EIAR Volume 4) a**round half of locations (52%) had no peat or shallow peat (≤0.5 m), including areas with existing Internal Tracks, while 34 % had peat deeper than 1 m, with a maximum depth of 3.55 m and a mean depth of 0.73 m. The Proposed Development design prioritised siting infrastructure on organo-mineral soils or areas with no peat to minimise impacts on deep peat. However, due to the Site's peat distribution and other design constraints, it was not possible to entirely avoid areas of deep peat.

3.3.4.7 Table 3.3.5 provides the estimated losses and gains from the various aspects of the wind farm construction and operation.

**Table 3.3.5: Total $CO_2$ losses and gains due to wind farm ($tCO_2e$)**

| **Total $CO_2$ losses due to wind farm (tCO2e)** | **Expected** | **Minimum** | **Maximum** |
|---|---|---|---|
| Losses due to turbine life (e.g. manufacture, construction, decommissioning) | 23,994 | 21,595 | 26,393 |
| Losses due to backup | 38,323 | 38,323 | 38,323 |
| Losses due to reduced carbon fixing potential | 605 | 183 | 3,208 |
| Losses from soil organic matter | 4,632 | -291 | 22,562 |
| Losses due to DOC (Dissolved Organic Carbon) & POC (Particulate Organic Carbon) leaching | 210 | 161 | 2,533 |
| Losses due to felling forestry | 136 | 122 | 147 |
| **Total losses of carbon dioxide** | 67,899 | 60,092 | 93,167 |
| **Total $CO_2$ gains due to improvement of site ($tCO_2e$)** | **Expected** | **Minimum** | **Maximum** |
| Change in emissions due to improvement of degraded bogs | -15,009 | 10,315 | -24,037 |
| Change in emissions due to improvement of felled forestry | 0 | 0 | 0 |
| Change in emissions due to restoration of peat from borrow pit | 59 | 127 | -296 |
| Change in emissions due to removal of drainage from foundations & hardstanding | 0 | 0 | 0 |
| Total change in emissions due to improvements | -14,950 | 10,442 | -24,333 |

### Payback Time

3.3.4.8 The Carbon Calculator tool provides an estimated payback time, which is the net emissions of carbon (total of carbon losses and gains) divided by the annual estimated carbon savings. The shorter the estimated payback time the greater benefit the Proposed Development will have in displacing emissions associated with electricity generated by burning fossil fuels.

3.3.4.9 Table 3.3.6 provides the net estimated carbon emissions for the Proposed Development would be at 52,949 $tCO_2$. An estimated payback time is 2.1 years, if the electricity generated by the Proposed Development is assumed to displace electricity generated by the grid for a range of different displaced fuels. The carbon intensity of units produced would be lower than the current grid-mix (the value of 0.177kg$CO_2$e/kWh is currently published by DESNZ[10]). In comparison to fossil fuel mix and coal-fired electricity generation, the payback period of the Proposed Development reduces to 0.8 years and 0.4 years respectively.

3.3.4.10 It should also be noted that the assessment boundary of the carbon intensity of electricity generated by the Proposed Development is far wider than the direct operational emissions included in the measurement of carbon intensity of the grid mix; if these were included, the impact of the Proposed Development would be shown to be even more beneficial.

**Table 3.3.6: Net Emissions and Payback Time**

| | **Expected** | **Minimum** | **Maximum** |
|---|---|---|---|
| **Net emissions of carbon dioxide (tCO2e)** | 52,949 | 35,759 | 103,609 |
| **Carbon Payback Time** | | | |
| Coal-fired electricity generation (years) | 0.4 | 0.3 | 0.8 |
| Grid-mix of electricity generation (years) | 2.1 | 1.3 | 4.2 |
| Fossil fuel-mix of electricity generation (years) | 0.8 | 0.5 | 1.7 |
| **Ratio of $CO_2$e emissions to power generation (kg/kWh)** | 0.011 | 0.007 | 0.022 |

3.3.4.11 The sensitivity of the carbon payback time has been tested by varying key input parameters across the minimum and maximum ranges presented in Table 3.3.3. The results demonstrate that the payback time is governed principally by the estimated net carbon emissions rather than by the predicted energy yield. Varying the capacity factor alone across its ±5% range (28.3% to 31.29%) changes the grid-mix payback time by less than 0.2 years, from 2.0 to 2.2 years, whereas varying net emissions across their full range while holding the capacity factor at the expected value changes the payback time from 1.3 to 4.2 years. The counterfactual emission factors are fixed within the Carbon Calculator and cannot be varied, although the choice of counterfactual (coal-fired, fossil fuel-mix or grid-mix) has a substantial effect on the reported payback time, as shown in Table 3.3.6.

3.3.4.12 Within the net emissions total, the single largest source of uncertainty is the estimated loss of soil organic matter, which ranges from −291 $tCO_2$e to 22,562 $tCO_2$e and accounts for approximately 69% of the total variation in carbon losses. This reflects the variability in peat depth across the Site and the consequent uncertainty in the volume of peat disturbed. The change in emissions due to improvement of degraded bogs forms the second largest source of variation, ranging from 10,315 $tCO_2$e to −24,037 $tCO_2$e across the minimum to maximum scenarios. By comparison, the embodied emissions of the turbines vary by only around 4,800 $tCO_2$e across the ±10% range applied to the manufacturer's LCAvalue, and emissions associated with grid backup are invariant, as they are a function of installed capacity rather than of generation.

3.3.4.13 Even under the most conservative combination of assumptions (the maximum payback scenario), the grid-mix carbon payback period remains below five years, which is well within the 35-year operational lifetime of the Proposed Development. The range of payback times of 1.3 to 4.2 years against grid-mix generation confirms that the Proposed Development would deliver substantial net carbon savings under all realistic scenarios.

### Cumulative Carbon Assessment

3.3.4.14 The cumulative carbon balance considers the Proposed Development in the context of other committed developments in the area. The Scottish Government Carbon Calculator assesses

individual wind farm projects and does not include a cumulative assessment function. However, it is noted that committed developments in the surrounding area would each be subject to their own carbon balance assessments as part of their respective consenting processes.

3.3.4.15 The Proposed Development, with an estimated payback period of 2.1 years against the grid-mix, would contribute positively to Scotland's net zero emissions targets. Over the 35-year operational lifetime, the Proposed Development is expected to displace approximately 849,446 $tCO_2e$ of grid-mix emissions, representing a substantial net carbon benefit. This figure is derived from the expected annual grid-mix carbon saving of 25,783 $tCO_2e$/year over the 35-year operational lifetime, less the net project emissions of 52,949 $tCO_2e$.

## 3.3.5 Conclusions

3.3.5.1 Based on the Carbon Calculator it has been estimated that the wind farm component of the Proposed Development could save nearly 25,783 $tCO_2e$ per year by displacing grid electricity, based on the current average grid mix and 65,258 $tCO_2e$ per year, if considering fossil-fuel mix of electricity generation. The actual displacement of existing generation depends on the time of day and how the grid is balanced.

3.3.5.2 The assessment of carbon losses and gains during construction and operation estimates an overall loss of just over 67,899 $tCO_2e$, mainly due to off-Site emissions, including embodied emissions from turbine manufacture and the provision of backup power to the grid. The requirement for back-up power in the grid, which is assumed to come from a fossil fuel source, is the largest source of losses but this is an estimate based on very broad assumptions, including limited energy storage within the grid and no change in demand management.

3.3.5.3 Ecological carbon losses account for a proportion 8.2 % of total emissions mostly due to losses from soil organic matter within the Site expected to be lost. There would be small gain of (-) 15,009 $tCO_2eq$ achieved from restoration of degraded bog areas on-Site, through drain blocking and peat re-wetting. However, as limited information available on improvements of felled forestry, this assessment does not account for replanting of new woodland areas both on and off Site. In addition, 0.7 hectares of compensatory woodland planting is proposed on the Novar Estate. Although this area lies outside the red-line boundary of the Proposed Development, it is located in close proximity to the Site. Accounting for the carbon gains associated primarily with restoration of degraded bog and borrow pit areas, the resulting net carbon loss is approximately 52,949 $tCO_2e$.

3.3.5.4 It should be noted that the carbon gains from habitat restoration are dependent on the successful implementation of the measures described in **Technical Appendix 7.4: Outline Biodiversity Enhancement Management Plan (EIAR Volume 4)**. The effectiveness of drain blocking and peat re-wetting would be monitored as part of the proposed Habitat Management Plan to ensure the projected carbon sequestration benefits are realised.

3.3.5.5 The estimated payback time of the Proposed Development, based on the Carbon Calculator, is around 2.1 years, with a minimum/maximum range of 1.3 and 4.2 years, when compared to grid-mix electricity generation.

3.3.5.6 For the fossil fuel-grid fuel mix of electricity generation scenario, estimated carbon payback time is 0.8 years, with a minimum/maximum range of 0.5 to 1.7 years. There are no current guidelines about what payback time constitutes a significant impact, but 0.8 years is around 2.3% of the anticipated lifespan of the Proposed Development.

3.3.5.7 Compared to fossil fuel electricity generation projects, which also produce embodied emissions during the construction phase and then significant emissions during operation due to combustion of fossil fuels, the Proposed Development has a low carbon footprint, and after approximately 2.1 years, the cumulative carbon savings are estimated to offset the calculated net carbon emissions associated with its development. The carbon intensity of the electricity produced by the Proposed Development is estimated at 0.011 $kgCO_2e/kWh$. This is below the 0.05 $kgCO_2e/kWh$ outcome indicator required by the Scottish Government in the Climate Change Plan update[12]. Overall, the Proposed Development is therefore evaluated to have a beneficial effect in terms of carbon emissions associated with energy production.

3.3.5.8 It should be also noted that due to the Carbon Calculator limitations, decommissioning of existing wind turbines has not been included in the assessment. Circularity is central to the project strategy and considers treating all components and materials as resources where possible, rather than waste.

3.3.5.9 A Decommissioning and Restoration Plan would be prepared and agreed with the Highland Council and other relevant consultees prior to decommissioning. The plan would include measures to restore the Site to an agreed condition and would address the management of carbon emissions associated with the removal of infrastructure. It is anticipated that advances in recycling technology and circular economy practices over the operational lifetime of the Proposed Development would reduce the carbon cost of decommissioning.

### Carbon Calculator Verification

3.3.5.10 The Scottish Government Windfarm Carbon Assessment Tool (v2.15.6) has been completed using the simple forestry calculation method and the simple rectangular foundation geometry method, as these are appropriate for the level of design detail available at the consent application stage. The detailed forestry input data sheet and the detailed construction input data sheet have not been populated as the simple methods have been selected; accordingly, calculation sheets dependent on these detailed inputs (sheets 7a, 7b, 7c, 7d, and 7ii) display formula errors. These errors are expected behaviour and do not affect the validity of the results, as the Carbon Calculator uses the simple method outputs (sheet 7i) for the final payback calculations.

3.3.5.11 All input parameters in the Carbon Calculator have been cross-checked against the values presented in Table 3.3.3, and the output results have been verified against Tables 3.3.4, 3.3.5, and 3.3.6. The key verified results are as follows: annual grid-mix $CO_2$ savings of 25,783 $tCO_2$/yr (expected), total carbon losses of 67,899 $tCO_2e$ (expected), and a grid-mix carbon payback time of 2.1 years (expected). The energy output over the 35-year lifetime is calculated as 5,098,267 MWh based on 9 turbines at 6.2 MW with a 29.8% capacity factor. Source data references have been recorded for all input parameters within the Carbon Calculator spreadsheet.

### Comparison with Similar Developments

3.3.5.12 The grid-mix carbon payback time of 2.1 years for the Proposed Development is consistent with, and generally favourable compared to, payback times reported for similar onshore wind farm developments on Scottish peatlands. The relatively short payback period for the Proposed

[12] Scottish Government (2020), Securing a green recovery on a path to net zero: climate change plan 2018–2032 – update. Available at: Annex B: Monitoring Framework - Securing a green recovery on a path to net zero: climate change plan 2018–2032 - update - gov.scot [accessed September 2025].

Development reflects the high energy yield of proposed wind turbines, and the beneficial carbon sequestration effects of the proposed approximate 135.7 ha of degraded bog restoration.

3.3.5.13 The carbon intensity of the electricity produced by the Proposed Development is estimated at 0.011 $kgCO_2e/kWh$, which is substantially lower than the current UK grid average of 0.177 $kgCO_2e/kWh$. This represents a 94% reduction in carbon intensity compared to the grid mix, demonstrating the significant contribution the Proposed Development would make to decarbonising the electricity supply. The Proposed Development's carbon intensity is also well below the Scottish Government's Climate Change Plan target of maintaining grid carbon intensity below 0.05 $kgCO_2e/kWh$.

### Residual Effects

3.3.5.14 Taking into account the mitigation measures described in the **Technical Appendix 9.6: Outline Peat Management Plan (EIAR Volume 4)** and **Technical Appendix 7.4: Outline Biodiversity Enhancement Management Plan (EIAR Volume 4),** the residual effect of the Proposed Development on carbon balance is assessed as beneficial over the operational lifetime. The Proposed Development would achieve carbon payback within 2.1 years against grid-mix generation, after which it would deliver net carbon savings for the remaining 32.9 years of operation. Over the full 35-year operational life, the Proposed Development is estimated to deliver net carbon savings of approximately 849,446 $tCO_2e$ against grid-mix generation (calculated as 35 years of annual savings at 25,783 $tCO_2/yr$ minus net emissions of 52,949 $tCO_2e$).

3.3.5.15 The ecological carbon losses from peat disturbance during construction are localised and represent a small proportion of total carbon losses. The majority of carbon losses are attributable to off-Site emissions from backup power generation and turbine manufacturing, which are not under the direct control of the Applicant but are inherent to any wind energy development. The proposed restoration of approximate 135.7 ha of degraded bog and 1.67 ha of borrow pit areas would provide carbon sequestration benefits and partially offset the carbon losses associated with construction, as reflected in the Carbon Calculator.

### NPF4 Policy Compliance

3.3.5.16 NPF4 Policy 5 states that development on peatland, carbon-rich soils and priority peatland habitat will only be supported in limited circumstances where the development would contribute to significant GHG emissions reduction. The Carbon Balance Assessment demonstrates that the Proposed Development would achieve a grid-mix carbon payback of 2.1 years and deliver substantial net $CO_2$ savings over its 35-year operational life, thereby satisfying the emissions reduction criterion of NPF4 Policy 5. The assessment also addresses NPF4 Policy 11, which supports all forms of renewable energy development where proposals maximise net economic impact and are accompanied by a satisfactory scheme of restoration or compensatory measures.

3.3.5.17 The Proposed Development is consistent with Scotland's statutory target of achieving net zero greenhouse gas emissions by 2045, as set out in the Climate Change (Scotland) Act 2009 as amended. The Climate Change (Emissions Reduction Targets) (Scotland) Act 2024 removed the previous system of annual and interim percentage reduction targets, including the 2030 interim target, and replaced it with a framework of five-yearly carbon budgets setting a cap on total emissions across each budget period. The 2045 net zero target is unchanged. By displacing grid electricity generated in part from fossil fuel sources, the Proposed Development would contribute to reducing emissions within the current and subsequent carbon budget periods and to the delivery of the 2045 target. The repowering of the Novar 1 Wind Farm with modern, higher-capacity turbines represents an efficient use of an established wind energy site, maximising renewable energy output whilst utilising existing access infrastructure and grid connection capacity. The carbon balance results confirm that the environmental cost of construction-phase peat disturbance and associated carbon losses is substantially outweighed by the long-term carbon savings from renewable electricity generation.

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