16 CLIMATE CHANGE MITIGATION

16.1 Introduction

16.1.1 In addition to the value wind farms provide in terms of the electricity they produce; wind turbines and other renewable technologies further provide an important mechanism for the reduction of carbon dioxide (CO_2), and other greenhouse gas (GHG) emissions, into the atmosphere. This offers a sustainable alternative to emissions-intensive electricity generated from fossil fuels.

16.1.2 Operational wind farms achieve emissions savings by reducing the consumption of fossil fuel generated mains electricity. However, during their manufacture, construction and decommissioning, wind farms can themselves result in the emissions of CO_2 gas, particularly in such instances as where natural carbon stores such as peat are present and potentially impacted by the development.

16.1.3 For this reason, this chapter provides an approximation of the CO_2 emissions associated with the manufacture, construction and decommission of the Proposed Development. It further provides an estimate of the contribution which the Proposed Development would make towards the reduction of emissions which would otherwise be produced by fossil fuel power generation. This provides an indication of the whole life carbon balance of the Proposed Development, together with an understanding of the emissions 'pay-back' period. Once emissions resulting from the manufacture, construction and decommission of the Proposed Development have been paid back (offset) by the wind farm, then each subsequent unit of wind generated electricity would displace a unit of conventionally generated electricity, thereby contributing to the overall reduction in emissions into the atmosphere.

16.2 Carbon and Peatland

16.2.1 Wind farm developments in upland areas are often sited on areas of peatland which hold stocks of poorly protected carbon. If disturbed, these stocks have the potential to release carbon into the atmosphere in the form of CO_2. For this reason, this carbon balance assessment must consider the implications of all parts of the Proposed Development which could lead to the release of CO_2 due to the disturbance of peat.

16.2.2 The disturbance of peat has been considered during the design process which has avoided areas of deep peat. The Site design process is described in **Chapter 2: Proposed Development** whilst specific details relating to peat depth are included in **Chapter 10: Geology, Hydrogeology, Hydrology and Peat**.

16.3 Characteristics of Peatland

16.3.1 The loss of carbon from the carbon fixing potential of vegetation on peatland is small but is calculated for the area from which peat is removed and the area affected by drainage. The carbon stored in the peat itself represents a much larger potential source of carbon loss.

16.3.2 When flooded, peat soils emit less CO_2 than when they are drained, as the water-logged conditions slow plant decomposition and the subsequent release of organic-bound carbon back into the atmosphere. In flooded soils, any CO_2 emissions are usually exceeded by plant fixation, so the net exchange of carbon within the atmosphere is negative and soil stocks increase. When soils are aerated, CO_2 emissions usually exceed plant fixation, so the net exchange of carbon within the atmosphere is positive. Methane (CH_4) emissions increase from flooded peat soils, however due to their small contribution (3-5% of peat-related GHG emissions) and shorter atmospheric lifetime, the climatic effects of increased methane flux to the atmosphere do not outweigh the climatic benefits of increased carbon sequestration from flooded soils (Günther et al., 2020)[181].

16.3.3 To calculate the CO_2 emissions attributable to the removal or drainage of the peat, emissions occurring if the soil had remained in situ and undrained are subtracted from the emissions occurring after removal or drainage. The indirect loss of CO_2 uptake (fixation) by plants originally on the surface of the site but eliminated by construction activity including the destruction of active bog plants and felling, is calculated using site-specific data collected as part of the EIA process and based upon blanket bog.

16.3.4 Emissions due to the indirect, long-term liberation of CO_2 from carbon stored in peat due to drying and oxidation processes caused by on-site construction can also be calculated from site-specific data for the Proposed Development. The resultant figure is a reasonable worst-case scenario, as peat would be reused onsite to minimise carbon losses for restoration of the renewables project, and for habitat restoration including ditch blocking.

16.4 Turbine Manufacture

16.4.1 Emissions arising from the fabrication of the turbines and associated components of the Proposed Development are based on the full life-cycle analysis of a typical turbine and include CO_2 emissions resulting from transportation, erection, operation, dismantling and removal of turbines and foundations and transmission grid connection equipment from the existing electricity grid system.

16.4.2 With respect to the turbines, emissions from material production are the dominant source of CO_2. Emissions arising from the construction (including transportation of components, quarrying, building foundations, access tracks and hard standing) and commissioning are also included in the calculations. This assessment has used Nayak et al. (2008, 2010)[182] default values for 'turbine life' emissions, calculated with respect to installed capacity.

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181 Günther, A., Barthelmes, A., Huth, V., Joosten, H., Jurasinki, G., Koebsch, F. and Couwenberg, J. (2020) Prompt rewetting of drained peatlands reduces climate warming despite methane emissions. Nat Commun 11, 1644. https://doi.org/10.1038/s41467-020-15499-z

182 Nayak, D.R., Miller, D., Nolan, A., Smith, P., and Smith, J. (2008, revised 2010) Calculating carbon savings from wind farms on Scottish peat lands: a new approach. Available at: https://www.gov.scot/publications/calculating-carbon-savings-wind-farms-scottish-peat-lands-new-approach/, accessed Sep 2021.

16.4.3 A number of technical papers (detailed in Nayak et al., 2008, 2010) have reported a wide range of wind farm emissions values; these being between 6 and 34 tCO_2 GWh^{-1}.

16.4.4 These emissions are considerable, and so it is essential that they are considered in relation to calculating the CO_2 payback period of the Proposed Development. However, it should be noted that this may still compare very favourably with the life cycle analysis of other means of non-fossil fuel-based power generation, such as nuclear, particularly when the full energy costs of construction, operation, maintenance and decommissioning, uranium mining and transportation as well as long-term waste management are taken into account.

16.5 Scope and Methodology

16.5.1 The assessment of the carbon balance of the Proposed Development is based upon a detailed baseline description of the Proposed Development and its location. All calculations are premised upon site-specific data, where available. Where site-specific data are not available, national/regional information has been used.

16.5.2 The methodology used to calculate CO_2 emissions which would result from the Proposed Development is based upon the work of Nayak et al. (2008, 2010) and Smith et al. (2011)[183], which are the basis for the latest version (V1.6.1) of the Scottish Government's Carbon Calculator Tool. This tool enables carbon losses and carbon savings to be quantified across the project lifecycle stages (construction, operation and decommissioning/site restoration), and these losses and savings are combined to establish the overall (net) carbon effect of the Proposed Development, as well as its 'carbon payback period'.

16.5.3 The Proposed Development is anticipated to have an operational life of 35 years, after which it would be decommissioned, and the turbines dismantled and removed in accordance with SEPA Guidance (2016)[184] regarding 'Life Extension and Decommissioning of Onshore Windfarms'. Specifically, that is to:

- Remove infrastructure unless the potential environmental risks posed by removal (e.g., carbon loss, impacts on the water environment) would outweigh the benefits.
- Maximise recovery of materials from removed infrastructure and treat as high up on the waste hierarchy as possible.
- Optimise habitat restoration of area affected by infrastructure removal.

Nayak D.R., Miller D., Nolan A., Smith P., and Smith J. (2010) Calculating carbon budgets of wind farms on Scottish peatlands; Mires and Peat (Article 09), 4, 1-23. Available at: http://mires-and-peat.net/pages/volumes/map04/map0409.php, accessed Sep 2021

183 Smith, J.U., Graves, P., Nayak, D.R., Smith, P., Perks, M., Gardiner, B., Miller, D., Nolan, A., Morrice, J., Xenakis, G., Waldron, S., and Drew, S. (2011) Carbon implications of windfarms located on peatlands – Update of the Scottish Government Carbon Calculator tool. Final Report, RERAD Report CR/2010/05.

184 SEPA Guidance regarding Life Extension and Decommissioning of Onshore Windfarms; 2016. Available at: https://www.sepa.org.uk/media/219689/sepa-guidance-regarding-life-extension-and-decommissioning-of-onshore-windfarms.pdf>

- Implement a long-term aftercare programme established to monitor/manage any potential long-term environmental risks.

16.5.4 Turbine foundations would be set down to the depth of suitable bearing strata with an approximate diameter of 25m (octagonal). Should geotechnical investigations demonstrate that the required bearing capacities are not achievable; a piled foundation design would be adopted using the same overall design footprint. As this requirement is not yet known, it has been assumed, for the purpose of deriving a meaningful result from the application of the calculator, that piling is used.

16.5.5 Results from the above assessment are reported below in accordance with the Institute of Environmental Management and Assessment's Environmental Impact Assessment guide to: Assessing Greenhous Gas Emissions and Evaluating their Significance (2017)[185].

16.6 Consultation undertaken

16.6.1 A number of responses were received in relation to the detailed scoping exercise which commenced on 13 March 2020. Those which concerned climate change mitigation are as follows:

The Highland Council

16.6.2 With regards to sustainability, the Highland Council (THC) states that:

16.6.3 "a Sustainable Design Statement is required. Wind farms produce a sustainable form of energy, however, the Council will need to be satisfied in reaching a conclusion on any consultation or application that the development in its entirety is in fact sustainable development. In order for us to do so we recommend that matters related to the three pillars of sustainable development are fully assessed in the information which supports the application. The wind farm needs to be considering the provision of energy systems within the holistic demand cycle of the network. The developer needs to consider the impact of the installation and the prospective long-term use of the energy to accommodate the requirements of a decarbonised energy provision for Scotland and the Highlands. The application should include a statement on how the development is likely to contribute to the Scottish Government Energy Efficient Scotland roadmap and provide the Highlands with secure and clean electricity supplies[186]."

16.6.4 In addition, THC notes that

16.6.5 "energy storage technology is of interest to the Council as an emerging new aspect of renewable energy developments with considerable potential benefits for energy generation, efficiency and supply." "The developer should also consider the potential for generation of alternative fuels as part of the development. Consideration to be given to an element of local use of the energy and particular use of hydrogen generation if there

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185 IEMA (2017) Environmental Impact Assessment Guide to: Assessing Greenhouse Gas Emissions and Evaluating their Significance. Available at: https://www.iema.net/preview-document/assessing-greenhouse-gas-emissions-and-evaluating-their-significance, accessed Sep 2021

186 Section 3.9 – The Highland Council Scoping response to energy consents unit. 27th April 2020. Reference 20/01270/SCOP.

is an opportunity in the development for redundancy supply profiles. The Council also encourage the inclusion of electric car charging facilities within all new developments. A strategy for the provision of charging points within the development should be submitted with the application.[187]"

Scottish Environment Protection Agency (SEPA)

16.6.6 SEPA referenced the Scottish Planning Policy that states (Paragraph 205) that "where peat and other carbon rich soils are present, applicants must assess the likely effects of development on carbon dioxide (CO_2) emissions. Where peatland is drained or otherwise disturbed, there is liable to be a release of CO_2 to the atmosphere. Developments must aim to minimise this release."

16.6.7 SEPA further stated that planning submission must "a) demonstrate how the layout has been designed to minimise disturbance of peat and consequential release of CO_2 and b) outline the preventative/mitigation measures to avoid significant drying or oxidation of peat through, for example, the construction of access tracks, drainage channels, cable trenches, or the storage and re-use of excavated peat."

16.6.8 With regards to life extension, repowering and decommissioning, they state that proposals must "demonstrate accordance with SEPA Guidance on the life extension and decommissioning of onshore wind farms. Table 1 of the guidance provides a hierarchical framework of environmental impact based upon the principles of sustainable resource use, effective mitigation of environmental risk (including climate change) and optimisation of long-term ecological restoration. The submission must demonstrate how the hierarchy of environmental impact has been applied, within the context of latest knowledge and best practice, including justification for not selecting lower impact options when life extension is not proposed."

Royal Society for the Protection of Birds (RSPB)

16.6.9 The RSPB notes that "impacts on carbon rich soils should be assessed using the carbon calculator to determine the 'carbon payback period' over the operational life of the development. We recommend that the carbon calculator is used as early as possible in the planning process, to inform siting and micro-siting of both turbines and tracks and other infrastructure."

16.7 Statutory and Planning Context

International Context

The Paris Agreement[188]

The Paris Agreement is a legally binding international treaty which commits Parties to the United Nations Framework Convention on Climate Change to the reduction of GHG emissions, with the view to limiting global average temperature rise to well below 2°C

187 Section 3.10 – The Highland Council Scoping response to energy consents unit. 27th April 2020. Reference 20/01270/SCOP

188 United Nations Framework Convention on Climate Change (2015) Adoption of the Paris Agreement, 21st Conference of the Parties, Paris: United Nations. Available at: https://unfccc.int/process-and-meetings/the-paris-agreement/the-paris-agreement

above pre-industrial levels, whilst "pursuing efforts to limit the temperature increase to 1.5˚C". With this objective in mind, the Agreement is revisited on a five-yearly basis to allow Parties to the Convention to evaluate and enhance the level of ambition of their climate action plans, known as nationally determined contributions (NDCs). In the lead up to COP26, which took place in Glasgow in November 2021, Parties to the Convention submitted updated NDCs which aim to deliver enhanced ambition in comparison to those submitted previously.

National Context

The Climate Change (Emissions Reduction Targets) (Scotland) Act 2019[189]

16.7.1 The Climate Change (Scotland) Act 2009 set a target of reducing GHG emissions by at least 80% by 2050, relative to the baseline year of 1990, with an interim target of reducing emissions by at least 42% by 2020.

16.7.2 In October 2019, this was amended by the Climate Change (Emissions Reductions Targets) (Scotland) Act 2019 which sets a target of net-zero emissions by 2045 (in line with the recommendations of the Committee on Climate Change). The interim targets of the Act are:

- 56% reduction in emissions by 2020;
- 75% reduction in emissions by 2030; and
- 90% reduction in emissions by 2040.

Scottish Climate Change Plan 2018

16.7.3 The Scottish Climate Change Plan (SCCP, 2018)[190] includes a target of 50% of Scotland's energy needs to be met by renewable energy by 2030. The SCCP also included a goal for 100% of Scotland's electricity to be generated by renewables by 2020.

16.7.4 In December 2021, the Plan was updated in light of the Coronavirus pandemic. Specifically, it provides an approach towards the delivery of an economic recovery that is in keeping with the ambitious targets set out in the Climate Change (Emissions Reduction Targets) (Scotland) Act 2019. To achieve this, the Update sets out a number of policies and proposals for each sector, which build upon those contained in the original Plan. With respect to electricity generation, these include to, but are not limited to:

- Support the development of a wide range of renewable technologies by addressing current and future challenges, including market and policy barriers.
- Support improvements to electricity generation and network asset management, including network charging and access arrangements that encourage the deployment and viability of renewables projects in Scotland.
- Publish a revised and updated Energy Strategy, reflecting [the Scottish government's] commitment to net zero and key decisions on the pathways to take us there.

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189 The Climate Change (Emissions Reduction Targets) (Scotland) Act 2019. Available at: https://www.legislation.gov.uk/asp/2019/15/contents

190Scottish Climate Change Plan (SCCP: 2018) Climate Change Plan: third report on proposals and policies 2018-2032 (RPP3). Available at: https://www.gov.scot/publications/scottish-governments-climate-change-plan-third-report-proposals-policies-2018/pages/3/

- A new renewable, all energy consumption target of 50% by 2030, covering electricity, heat and transport.

Scottish Planning Policy (2014)[191]

16.7.5 The Scottish Planning Policy (SPP, 2014) sets out how the Climate Change (Scotland) Act 2009 (as amended) should be delivered on the ground. The SPP states that, "*by seizing opportunities to encourage mitigation and adaptation measures, planning can support the transformational change required to meet emission reduction targets and influence climate change*" (para 19, SPP, 2014).

16.7.6 The SPP states (para 205) that, "where peat and other carbon rich soils are present, applicants should assess the likely effects of development on carbon dioxide (CO_2) emissions. Where peatland is drained or otherwise disturbed, there is liable to be a release of CO_2 into the atmosphere. Developments should aim to minimise this release".

Good Practice During Wind Farm Construction, NatureScot et al. (2019)[192]

16.7.7 The SNH, now NatureScot, 'Good Practice During Wind Farm Construction' guidance recognises that one of the key aims of wind farm development is to reduce carbon emissions, but that wind farm developments, through the materials used, during the construction processes employed and the potential emissions from disturbed soils and habitats, do result in carbon emissions.

16.7.8 The guidance recognises that, in some circumstances, the carbon payback of wind farm developments could be significantly affected by the construction methods used and the degree of restoration of the site. The guidance therefore seeks to ensure that good practice is adopted to reduce the carbon emissions associated with wind farm development.

16.7.9 The good practice approach to development on peat and carbon savings recommended by this guidance can be summarised as follows:

- Conduct a detailed peat survey.
- Where possible, position the site infrastructure in areas of shallower peat or design an appropriate engineering solution to avoid and/or minimise excavation of peat (for example floating roads and piling solutions).
- Minimise the detriment to peat if excavation cannot be fully avoided.
- Avoid or reduce peat displacement from the development of borrow pits.
- Excavations should be prevented from drying out or desiccating as far as possible. Consideration should also be given to spraying with water.
- If stockpiling peat, assess the potential loading effects for peat slide risk.
- The peat should be restored as soon as possible after disturbance.
- Consider cable trenching operations and timings.

191 Scottish Planning Policy (SPP: 20214) Scottish Planning Policy. Available at: https://www.gov.scot/publications/scottish-planning-policy/pages/3/

192 NatureScot et al. (2019) Good Practice during Wind Farm Construction, Fourth Edition; A joint publication by Scottish Renewables, Scottish Natural Heritage, Scottish Environment Protection Agency, Forestry Commission Scotland, and Historic Environment Scotland. Available at: https://www.nature.scot/doc/guidance-good-practice-during-wind-farm-construction

- Floating roads should be used in areas of deeper peat.
- Minimise plant movements and haul distances in relation to any earthworks activities including peat management.
- Developers should take ancillary opportunities to improve habitats.

Local Context

The Highland Council

16.7.10 The Highland Council recognises that climate change is a significant global challenge and are "*committed to a carbon neutral Inverness and a low carbon Highlands by 2025*". In line with the Climate Change (Scotland) Act 2009 the Highland Council is working to:

- Reduce greenhouse gas emissions across the region
- Implement measures to adapt to a changing climate
- Work in a sustainable way

16.8 Existing Environment

16.8.1 Baseline environmental conditions in relation to potential climate change impacts from the Proposed Development include existing carbon stored in the site (such as peat and forestry) that could be impacted by the Proposed Development resulting in CO_2 and other GHG emissions.

16.8.2 The site currently comprises upland grazing and shooting land located on the Dalnessie Estate, 13 km northeast of Lairg in the Scottish Highlands. The Proposed Development will comprise 16 turbines, with a maximum height to blade tip of 200 m. Associated infrastructure will also be developed including access tracks, a meteorological mast, LiDAR compounds, borrow pits, transformers, underground cables, onsite sub-station/control building, a prospective energy storage facility, and temporary construction compounds. The individual turbine generating capacity is anticipated to be approximately 6 MW, with the total generating capacity for the development expected to be greater than 50 MW.

16.8.3 The site comprises peaty gleys with dystrophic blanket peat with peaty gleyed podzols. The Scottish Government Carbon and Peatland Map 2016 has been consulted to understand the carbon-rich soils, deep peat and priority peatland habitat within the site. This exercise found that the site was comprised predominantly of Class 1 and 2 mineral soils; correlating with the mineral soils identified in the Soils Survey of Scotland. Class 1 indicates areas likely to be of high conservation value; Class 2 indicates areas of potentially high conservation value and restoration potential. Class 1 peat is located primarily in the western half of the site, indicating that the peat in the western half of the site is in better condition than the peat in the eastern half of the site.

16.8.4 Peat depth and peat condition surveys were undertaken in June 2020 across site and in October 2020 and May 2021 for areas of proposed infrastructure. The peat depth surveys and reconnaissance survey confirm that peat across the site is in a near-natural condition consisting of a patchwork of peaty soils, shallow peat and deeper peat reflecting the underlying topography.

16.8.5 Very deep peat (>2.5 m) is primarily located in the south-western half of the site, and in some isolated areas in the eastern part of the site. Peaty soils and shallow peat cover the steeper slopes in the north-eastern part of the site.

16.8.6 No areas of forestry are to be felled as part of the Proposed Development.

16.9 Predicted Impacts

16.9.1 The results of the carbon balance assessment carried out for the Proposed Development are presented below for each project stage.

Construction and Decommissioning

16.9.2 **Table 16.1** presents the results of the carbon balance assessment for the manufacture, construction, and decommissioning stages of the Proposed Development. Any post-decommissioning site restoration and enhancement work, such as the blocking of drainage ditches to promote re-wetting will be aligned with the Habitat Management Plan (see **Appendix 8.5**). These kinds of activities have the potential for significant carbon savings by promoting the growth of natural carbon stores such as peat. Other management options may become apparent during the more detailed stages of devising a Habitat Management Plan.

Table 16.1: Predicted GHG emission losses from windfarm manufacture, construction and decommissioning

Source of GHG Emissions/Savings	GHG Emissions (tCO_2e)
Losses due to turbine manufacture, construction and decommissioning	85,061
Losses due to back-up power generation	66,226
Losses due to reduced carbon fixing potential	1,035
Losses from of soil organic matter	27,435
Losses due to Dissolved Oxygen Content and Portable Oxygen Content	201
Losses due to forestry felling	0
Total	**179,957**

16.9.3 **Table 16.1** shows total GHG emissions of 179,957 tCO_2e are predicted from the manufacture, construction and decommissioning of the Proposed Development.

16.9.4 The applicant is committed to undertaking post-construction habitat restoration and enhancement work (see **Appendix 8.5 OHMP**). Minimum, maximum and expected areas have been identified and calculated and included in the Carbon Calculator in **Appendix 16:1: Carbon Calculator Data Input**.

16.9.5 **Table 16.2** shows the total CO_2 gains acquired due to the improvement of the site (tCO_2e). These are predicted to equate to gains of approximately 6,124 tCO_2e.

Table 16.2: Total CO_2 Gains Due to Improvement of the Site (tCO_2e)

Improvement	GHG Emissions (tCO_2e)
Change in emissions due to improvement of degraded bogs	- 6,101
Change in emissions due to improvement of felled forestry	0
Change in emissions due to restoration of peat from borrow pits	0
Change in emissions due to removal of drainage from foundations and hardstanding	- 23
Total change in emissions due to improvements	**- 6,124**

Operation

16.9.6 The operational stage of the Proposed Development has the greatest potential for emissions savings, and therefore beneficial climate change impacts. At this stage, GHG emissions from construction activities have ceased and the operation of the turbines would generate zero-carbon electricity for the remainder of their lifespan.

16.9.7 **Table 16.3** presents the annual emissions savings that are predicted for the Proposed Development, as measured against the fossil fuel mix of the grid electricity, having consideration for the capacity factors (load factors) provided by the applicant (35%) (minimum – 25%, maximum 45%)

Table 16.3: Annual emissions savings against fossil fuel electricity generation mix

Source of GHG savings	GHG savings (tCO_2e)		
Capacity Factor	25%	35%	45%
Wind farm operation	94,608	132,451	170,294
Total CO_2 savings per year	**94,608**	**132,451**	**170,294**

Emissions Payback Period

16.9.8 Dividing the net GHG emissions predicted for the manufacture, construction and decommissioning stages (considering CO_2 gains from improvement of site: 173,833 tCO_2e) by the predicted annual carbon savings from wind farm operation (132,451 tCO_2e) gives a predicted emissions payback of 1.3 years, as shown in **Table 16.4**. Therefore, net GHG emissions from the construction and decommissioning are predicted to be offset by emissions savings from the Proposed Development within 1.3 years of it becoming operational.

Table 16.4: Carbon Payback Period of the Proposed Development for a Range of Capacity Factors

Capacity factor	25%	35%	45%
Carbon payback time (years)	1.8	1.3	1.0

Net GHG Effect

16.9.9 The Proposed Development is anticipated to have an operational life of 35 years, after which it would be decommissioned, and the turbines dismantled and removed. With this in mind, total CO_2 emissions savings over the assumed lifetime of the Proposed Development is expected to be 4,461,952 tCO_2e (35% capacity factor).

16.10 Cumulative Effects

16.10.1 Cumulative effects are defined as “the incremental effects of an action when added to the effect of past, present and reasonably foreseeable future action. Cumulative effects result from individually minor but collectively significant actions taking place over a period of time” (European Commission, 2013).

16.10.2 Inter-project effects are the impacts from other planned or potential developments, together with the Proposed Development which individually may be insignificant, but when considered together could be considered to have a significant cumulative effect.

16.10.3 The Proposed Development has multiple operational wind farm developments within a 50 km radius. These include the Strath Tirry Wind Farm (in planning), the Creag Riabhach Wind Farm (under construction) and both the South East and South West wind farm groups (see **Chapter 6: Landscape and visual assessment, Table 6.6** for more details).

16.10.4 The cumulative effects from these existing and potential surrounding wind farm developments would be positive, contributing towards climate change mitigation. Although carbon rich peat would be lost from the area, the nature of the developments sees a total emissions savings from offsetting of fossil fuel mix of grid electricity. Therefore, the GHG savings would outweigh losses from construction, including disturbance and removal of peat and forestry.

16.11 Mitigation

16.11.1 The substantial carbon savings that are predicted from operating the Proposed Development represent, in and of themselves, a method of climate change mitigation. This is one of the key benefits of the Proposed Development.

16.11.2 A key form of embedded mitigation is to avoid construction activities within areas of deep peat (see **Chapter 10: Geology, Hydrogeology, Hydrology and Peat**,*)*. The location of turbines and associated infrastructure take cognisance of this, resulting in appropriate positioning in areas of shallow or no peat.

16.11.3 Access tracks are anticipated to be constructed using established cut-and-fill construction methods and be designed to maintain or impede drainage through habitats, whichever is most appropriate.

16.11.4 Sub-surface drainage pipes would be used to help maintain hydrological connectivity where the track crosses peatland habitats and where wetland habitat is downslope of infrastructure. Drainage would be encouraged through use of porous materials or pipes.

16.11.5 Wetland and peatland vegetation would not be used to filter silty run-off as these are habitats of high conservation value.

16.11.6 Drains and culverts would be designed to preserve natural drainage continuity and not to lead to erosion, scouring and the spread of silt.

16.11.7 Excavation of new drains would be avoided where possible.

16.11.8 Soil stripping would be undertaken with care and would be restricted to as small a working area as practicable. Topsoil would be removed and laid in a storage bund, up to 2 m in height, on unstripped ground adjacent to the working area. It would be attempted to retain the turf layer vegetation-side-up where possible, although ground conditions may make this challenging. Subsoils and superficial geological deposits would be removed subsequently and laid in storage bunds, also up to 2 m in height, clearly separated from the topsoil bund. Care would be taken to maintain separate bunds for separate soil types in order to preserve the soil quality.

16.11.9 All soil and peat storage bunds would be left with rough, unsmoothed surfaces to minimise soil loss from rainfall erosion. Bunds on sloping ground would have sediment control measures installed near the base, on the downslope side, to collect and retain any sediment mobilised by rainfall.

16.11.10 Excavated soil and peat would be used in site restoration and rehabilitation at the end of the construction period, in order to promote fast re-establishment of vegetation cover on worked areas and areas of bare soil that are not required for the operational phase of the development. Soils and peat would be stored for as short a time as practicable, in order to minimise degradation through erosion and desiccation.

16.11.11 Should prolonged periods of dry weather occur, a damping spray would be employed to maintain surface moisture on the soil bunds. This would help to maintain vegetation growth in the turves and to retain the soil structure.

16.11.12 Micrositing would be used to avoid possible problem areas identified during ground investigation or other detailed design works. This would be assisted by additional verification of peat soil depths, to full depth, in any areas where construction work is required. Track drainage would be installed in accordance with published good practice documentation and would be minimised in terms of length and depth in order to minimise concentration of flows.

16.11.13 Construction work would make use of current best practice guidance relating to developments in peat soil areas. A risk management system, such as a geotechnical risk register, would be compiled and maintained at all stages of the project and developed as part of the post-consent detailed design works, and would be updated as new information becomes available.

16.11.14 Construction activities would be restricted during periods of wet weather, particularly for any work occurring within 20 m of a watercourse. Careful track design would ensure that the volume and storage timescale for excavated materials would be minimised as far as practicable during construction works.

16.11.15 Drainage would be designed to separate clean and dirty water and to provide appropriately located and sized silt traps. Upslope cut off ditches would be included in the design to ensure that un-contaminated run-off is diverted away from construction areas.

16.11.16 All works through and adjacent to wetland areas would be supervised by an Environmental Clerk of Works (ECoW).

16.11.17 The following mitigation measures would be implemented to reduce the scale of temporary habitat loss and to increase the success of temporarily disturbed infrastructure edge habitat regeneration (see **Chapter 8: Ecology, section 8.11**):

- Construction of the project will be supervised by the ECoW.
- Measures to protect habitats during construction and measures to restore temporarily disturbed habitats during construction will be included within the Construction Environmental Management Plan.
- Infrastructure construction will have a micro-siting tolerance of 50 m. The ECoW will review infrastructure locations when these are marked out and advise on micro-siting to reduce effects on habitats. Where the client or principal contractor requests micro-siting of infrastructure this will require sign off from the ECoW and where the adjustment results in an impact on high quality patches of bog, heath, flush or marshy grassland which was not anticipated by the original lay-out, it will not be permitted.
- Temporary storage of peat and other excavated materials would only be allowed by the ECoW if effects were minimised by a choosing an appropriate storage area off sensitive habitats.
- The construction footprint would be limited as far as possible and adjacent sensitive habitats requiring avoidance (such as flushes) would be marked.
- Restoration of temporarily disturbed areas would be undertaken as soon as practicably possible. Track edges, cable trenches and the disturbed edges of infrastructure would be excavated in a sequenced manner, removing turves, topsoil and subsoil separately and storing turves vegetation side up. The soil and turves would subsequently be replaced in the appropriate sequence to maximise restoration of vegetation. Where necessary, seeding with a seed mix of native upland species would be used to speed restoration. Turves and topsoil from peatland habitat would be used to restore infrastructure edges within 14 days of excavation to prevent drying affecting the integrity of turves.

16.11.18 The Proposed Development is anticipated to have an operational life of 35 years, after which it would be decommissioned and the turbines dismantled and removed, unless further consent is secured to operate for an additional time period. Decommissioning of the Proposed Development will be undertaken in line with SEPA Guidance (2016) regarding *Life Extension and Decommissioning of Onshore Windfarms*[193]. Specifically, that is to:

- Remove infrastructure unless the potential environmental risks posed by removal (e.g., carbon loss, impacts on the water environment) would outweigh the benefits.

[193] SEPA Guidance regarding Life Extension and Decommissioning of Onshore Windfarms; 2016. <Available at: https://www.sepa.org.uk/media/219689/sepa-guidance-regarding-life-extension-and-decommissioning-of-onshore-windfarms.pdf

- Maximise recovery of materials from removed infrastructure and treat as high up the waste hierarchy as possible.
- Optimise habitat restoration of areas affected by infrastructure removal.
- Long-term aftercare programme established to monitor/manage any potential long-term environmental risks.

16.12 Mitigating Cumulative Effects

16.12.1 The cumulative effects relating to climate change and GHG emissions would be positive over the medium- and long-term, as indicated in Section 16.15. As such, cumulative effects do not require any additional mitigation.

16.13 Summary of Effects

16.13.1 GHG emissions are predicted to arise from the manufacture, construction and decommissioning activities. In particular, the principal sources of emissions include turbine manufacture and the loss of peat from the construction of turbines and associated infrastructure.

16.13.2 However, these GHG emissions are predicted to be offset 1.3 years after the Proposed Development becomes operational (against a fossil fuel mix of electricity). The Proposed Development is predicted to deliver total emissions savings of 4,461,952 tCO_2e (35% capacity factor) over its 35-year operational lifetime.

16.13.3 In addition, GHG emissions savings are predicted from post-construction site restoration, including the habitat restoration and compensatory planting.

16.13.4 The overall emissions impact is considered to represent a significant beneficial and long-term climate change effect. Consequently, the Proposed Development contributes towards Scotland's emissions reduction targets as set out in the Climate Change (Emissions Reductions Targets) (Scotland) Act 2019, together with its renewable energy obligations as set out in the Scottish Climate Change Plan.

16.14 References

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