Balliemeanoch Pumped Storage Hydro

Environmental Impact Assessment Report

Volume 2: Main Report
Chapter 17: Climate

ILI (Borders PSH) Ltd

July 2024

Delivering a better world

Quality information

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Revision History

Revision	Revision date	Details	Authorized	Name	Position
1	July 2024	Submission	DL	David Lee	Technical Director

Distribution List

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17. Climate

17.1 Introduction

This chapter of the EIAR identifies the potential impacts and effects of the Development on the climate, as well as the impacts and effects of climate change on the Development, that are to be considered as part of the EIA. A comprehensive description of the Development is contained in *Chapter 2: Project and Site Description.*

This chapter has been informed by an overview of the environmental baseline conditions, along with the anticipated key issues likely to be associated with the Development.

In order to comply with the requirements of the Electricity Works (Environmental Impact Assessment) (Scotland) Regulations 2017 (Ref. 17-1) and the Institute of Environmental Management and Assessment (IEMA) Guidance for assessing climate mitigation (Ref. 17-2) and adaptation (Ref. 17-3) in EIAs, consideration has been given within this chapter to the following three aspects of climate change assessment:

- Lifecycle Greenhouse Gas (GHG) Impact Assessment – the impact of GHG emissions arising from the Development on the climate over its life-time;
- In-Combination Climate Change Impact (ICCI) Assessment – the combined impact of the Development and future climate change on the receiving environment; and
- Climate Change Resilience (CCR) Assessment – the resilience of the Development to the potential impacts of climate change.

This chapter should be read in conjunction with:

- *Chapter 2: Project and Site Description*;
- *Chapter 4: Approach to EIA***;**
- *Appendix 17.1 Climate Change Risk Register (Volume 5 Appendices);*
- *Appendix 17.2 In-combination Climate Change Impact (ICCI) Assessment (Volume 5 Appendices).*

17.2 Legislation and Policy

The Legislation, Policy and Guidance section of this chapter provides an overview of the relevant legislation, planning policy and technical guidance relevant to the climate assessments.

17.2.1 Legislation

Legislation relevant to the climate change assessments have been summarised in *Table 17-1 Legislation Relevant to Climate Change,* below*.*

Table 17-1: Legislation Relevant to Climate Change

Policy Reference	Policy Context
International	
United Nations Framework Convention on Climate Change Paris Agreement (Ref. 17-4)	The Paris Agreement requires all signatories to strengthen their climate change mitigation efforts to keep global warming to below 2°C this century and to pursue efforts to limit global warming to 1.5°C.
National	
UK Nationally Determined Contribution (Ref. 17-5)	In 2020, the UK communicated its updated Nationally Determined Contribution to the United Nations Framework Convention on Climate Change (UNFCCC). Within this, the UK has committed to reducing GHG emissions by at least 68% by 2030 compared to 1990 levels.
The Climate Change (Scotland) Act 2009 (Ref. 17-6)	The Climate Change (Scotland) Act 2009 originally set a legally binding target for Scotland to reduce its greenhouse gas (GHG) emissions from 1990 levels by at least 80% by 2050 to help ensure the delivery of these targets. This part of the 2009 Act also requires that the Scottish Ministers set annual targets, in secondary legislation, for Scottish GHG emissions from 2010 to 2050.

Climate Change (Emissions Reduction Targets) (Scotland) Act (Ref. 17-7)	In 2019, The Climate Change (Scotland) Act 2009 was amended by the Climate Change (Emissions Reduction Targets) (Scotland) Act 2019, increasing the ambition of Scotland's emissions reduction targets to Net Zero by 2045 and revising interim and annual emissions reduction targets. The amendments also update arrangements for Climate Change Plans to meet the targets.
Electricity Works (Environmental Impact Assessment) (Scotland) Regulations 2017 (Ref. 17-1)	The EIA Regulations state that an EIA (where relevant) must include: *"the impact of the development on climate (for example the nature and magnitude of greenhouse gas emissions) and the vulnerability of the development to climate change".*

17.2.2 National Planning Policy

National Planning Policy relevant to climate change is detailed in *Table 17-2 National Planning Policies Relevant to Climate Change,* below.

Table 17-2: National Planning Policies Relevant to Climate Change

Policy Reference	Policy Context
Update to the Climate Change Plan 2018 – 2032: Securing a Green Recovery on a Path to Net Zero Securing a green recovery on a path to net zero: climate change plan 2018-2032 (Ref. 17-10)	This document updates the 2018 Climate Change Plan to reflect the setting of new ambitious targets to end Scotland's contribution to climate change by 2045. It also reflects on how Scotland emerges from COVID-19, recognising that there is a chance to rebuild the economy to deliver a greener, fairer and more equal society. In line with the 2018 plan, the focus is on the period up to 2032.
Infrastructure Investment Plan (Ref. 17-11)	The 2021 Infrastructure Investment Plan (IIP) covers 2021-22 to 2025-26 and delivers the National Infrastructure Mission commitment to boost economic growth. It notes a shift in the definition of infrastructure with the Scottish Government defining infrastructure more widely than all other parts of the UK, including digital and social infrastructure and, for the first time, including 'natural infrastructure'. The IIP recognises the new challenges Scotland faces since the 2015 IIP, including economic, health and social harm from COVID-19, the UK's exit from the European Union and a number of other long-term trends, including climate change and technological and demographic change. The IIP adopts a single vision for infrastructure investment choices: "*Our infrastructure supports Scotland's resilience and enables inclusive, net zero, and sustainable growth*" (page 21). In supporting this vision, the Plan focuses on three key themes. The three themes in the IIP for guiding investment decisions are directly linked to Scotland's National Performance Framework, which sets out the Government's overall purpose, they are: "*Enabling the transition to net zero emissions and environmental sustainability: Public infrastructure investment has a critical role to play in tackling the twin crises of climate change and biodiversity loss. We will increase spending on low-carbon measures, climate resilience, and nature-based solutions.* *Driving inclusive economic growth: We can boost productivity and competitiveness and create good jobs and green jobs by enhancing our transport and digital connectivity and capacity in all areas of Scotland and by stimulating innovation. We will embed fairness and inclusion, seeking to ensure no one is left behind.* *Building resilient and sustainable places: Delivering on our ambition for a fairer Scotland starts at the local community level. We will invest in housing and improve local service delivery. With our partners, we will meet the diverse economic, social, and environmental needs of urban, rural, and island areas*" (page 21). Climate change is recognised as a long-term trend which impacts on the provision of infrastructure. In response, it is noted that there is a need to adapt current infrastructure and design future assets to be more resilient to the effects of climate change, alongside investing in nature infrastructure and nature-based solutions which help tackle biodiversity and create wider socioeconomic benefits.
National Planning Framework 4 (NPF4) (Ref. 17-12)	The National Planning Framework 4 (NPF4) was published by the Scottish Ministers on 13 February 2023. NPF4 sets out how the Scottish Governments' approach to planning and development will help to achieve a net zero, sustainable Scotland by 2045. With regards to climate change, NPF4 aims to deliver 'Sustainable Places' where we "reduce emissions, restore and better connect to biodiversity" (page 4). One of the six overarching principles set out in NPF4 to support the delivery of our future places is 'Just Transition,' which states that "*we will empower people to shape their places and ensure the transition to net zero is fair and inclusive*". Sustainable Places Policy 1 'Tackling the Climate and Nature Crises' encourages, promotes and facilitates "*development that addresses the global climate emergency and nature crisis"* (page 37). Sustainable Places Policy 2 'Climate Mitigation and Adaption' aims to "*encourage, promote and facilitate development that minimises emissions and adapts to the current and future impacts of climate change*". NPF4 goes on to state that "*development proposals will be sited and designed to adapt to current and future risks from climate change*" (page 37). NPF4 also identifies PSH as a "national" development and provides policy support for PSH projects, recognising that they can make a significant contribution to achieving net zero.

Policy Reference	Policy Context
National Policy Statement for Energy Infrastructure (Ref. 17-8)	The National Policy Statement (NPS) sets out the national policy for energy infrastructure required to ensure a secure, reliable, and affordable energy supply. Although the NPS is only applicable in England, it can be relevant in planning applications in Scotland.
Draft Energy Strategy and Just Transition Plan (Ref. 17-9)	Scotland's draft Energy Strategy and Just Transition Plan aims to achieve a zero-carbon energy system by 2045. The plan includes goals including the addition of 20 GW of renewable electricity by 2030, accelerated decarbonisation of industry, transport, and heat, and the establishment of a national public energy agency. The plan also focuses on ensuring a just transition by maximising employment, manufacturing, and export opportunities in the energy sector.

17.2.3 Local Planning Policies

Local Planning Policies relevant to climate change are detailed in *Table 17-3 Local Planning Policy and Considerations Relevant to Climate Change*, below.

Table 17-3: Local Planning Policy and Considerations Relevant to Climate Change

Policy Reference	Policy Context
Argyll and Bute Local Development Plan 2024 (Ref. 17-13)	The Argyll and Bute Local Development Plan (LDP) sets out the overarching vision statement, spatial strategy and general planning policies for the whole of Argyll and Bute council area. The LDP includes the following policies relevant to climate: • Policy 06 ‘Green Infrastructure’ • Policy 04 ‘Sustainable Development’ • Policy 09 ‘Sustainable Design’ • Policy 30 ‘The Sustainable Growth of Renewables’
Argyll and Bute – Climate Emergency Declaration (Ref. 17-14)	Argyll and Bute Council declared a climate emergency in September 2019 and pledged to take various actions to improve environmental sustainability across the Council area. This includes a commitment to make the council area carbon-neutral by 2045.

17.2.4 Guidance

The climate change assessment has been carried out in accordance with the following:

- IEMA: Environmental Impact Assessment Guide to: Assessing Greenhouse Gas Emissions and Evaluating their Significance (2022) (Ref. 17-2);
- IEMA: Environmental Impact Assessment Guide to: Climate Change Resilience and Adaptation (2020) (Ref. 17-3);
- Scottish Government Wind Farm Carbon Calculation Tool (Ref. 17-35);
- The GHG Protocol (World Resources Institute and World Business Council for Sustainable Development (WRI & WBCSD) (Ref. 17-16); and.
- PAS 2080: 2023 Carbon management in buildings and infrastructure (Ref. 17-15).

17.3 Consultation

A scoping exercise was undertaken to establish the content of the assessment and the approach and methodology to be followed.

The Scoping Report was issued on 28th September 2021 and records the findings of the scoping exercise. It also details the technical guidance, standards, best practice, and criteria to be applied in the assessment to identify and evaluate the likely significant effects of the Development on climate change.

The Scoping Opinion was received on 3rd March 2023. The feedback received from stakeholders at scoping and the Applicant’s responses in relation to climate are presented below in *Table 17-4 Summary of Consultation*, below.

Table 17-4 Summary of Consultation

Consultee	Key Issue	Summary of Response	Action Taken
NatureScot	Section 17. Climate does not appear to consider the GHG emissions associated with the change or damage to soil/ peat	As part of the s36 application, peat bog probing has been undertaken at the Development's Site to measure the carbon sink potential. The	Soil/peat damage has been considered and reported in *Table 17-17* as part of the land use change GHG Assessment. The Scottish Government

Consultee	Key Issue	Summary of Response	Action Taken
	and the carbon sequestration potential of peatland habitats.	study's outputs have been considered for the Land Use Change GHG Assessment.	Windfarm Carbon Assessment Tool was used to determine the GHG emissions from potential peat land loss, and the assumptions applied are reported in the Assumptions, Limitations and Uncertainties Section. In addition, a peat management plan has been developed and will be submitted as part of the EIAR.

17.4 Study Area

17.4.1 Lifecycle GHG Impact Assessment

The Study Area for the GHG impact assessment covers all direct GHG emissions arising from activities undertaken at the Development Site during pre-construction, construction and operation (including maintenance). It also includes indirect emissions outside of the site boundary, including emissions embedded within the construction products and materials arising as a result of the energy used for their production, and emissions arising from the transportation of products and materials, waste and construction workers.

The environmental impact associated with GHG emissions is a national and global issue. Consequently, the significance of the Development's lifecycle GHG emissions will be assessed by comparing the estimated GHG emissions from the Development against the reduction targets defined in the Climate Change (Emissions Reduction Targets) (Scotland) Act 2019 (Ref. 17-6), associated 2030 and 2040 legally binding carbon reduction targets (Ref. 17-19), and the Scotland's forecast trajectory towards Net Zero by 2045.

17.4.2 Climate Change Risk Assessment

The Study Area for the CCRA is the area within the Development Site, i.e., it covers the construction and operation (including maintenance) of all assets and infrastructure which constitute the Development.

17.4.3 In-combination Climate Change Impact Assessment

The Study Area for the ICCI assessment is as identified by each environmental discipline for their individual assessments.

The methodology used by the environmental disciplines to identify ICCIs is described below, and the ICCIs themselves are summarised in *Appendix 17.2 In-combination Climate Change Impact (ICCI) Assessment (Volume 5 Appendices).*

17.5 Assessment Methodology

17.5.1 Assumptions, Limitations and Uncertainties

The climate assessment has been based on the parameters outlined in *Chapter 2: Project and Site Description*.

This chapter forms an assessment based on available information at the time of preparing the EIAR. The technology for hydro schemes continues to evolve to maintain commercial flexibility and meet the changing demands of the UK market. It is assumed that the Development has a maximum generation capacity of 1.5GW (Gigawatts), and this is the basis of the Application.

At the time the GHG Assessment was undertaken the full cycle frequency was not known as this will be dictated by the energy markets. Therefore, based on advice from the design team, it was assumed that the Development will operate on 100 full cycles per year; this is a conservative estimate.

The carbon intensity of the electricity used for pumping was assumed to be the same as the UK Grid. The UK Government Greenbook (Ref. 17-31) on grid decarbonisation data was used to forecast grid decarbonisation into the GHG Assessment.

The largest single source of GHG emissions from the Development is likely to result from construction activities and the manufacture of materials necessary to construct the Development. The GHG assessment is based on a high-level materials assessment undertaken by the Design Team. It was assumed that all materials would be sourced within 100 km of the Development and transported by Heavy Goods Vehicle (HGV). The number of vehicle

trips was based on a transport assessment. The methodology and assumptions used in this assessment are detailed in *Chapter 14: Access, Traffic and Transport*.

The Institute for Environmental Management and Assessment's (IEMA) 'Environmental Impact Assessment Guide to: Assessing Greenhouse Gas Emissions and Evaluating their Significance' (Ref. 17-2) states that a comparable baseline must be used as a reference point against which the impact of a new project can be assessed, which may be "*GHG emissions arising from an alternative project design for a project of this type*". Currently, marginal load-following generation capacity is generally provided by gas-fired Open Cycle Gas Turbine (OCGT) (Ref. 17-28). The benefit of any renewable electricity scheme is to displace fossil-fuelled power sources. It is reasonable to assume that as additional renewable energy generation capacity becomes available, such as from the Development, it will reduce demand for the marginal generator, i.e., directly displace the use of OCGT. On this basis, the GHG assessment has used the operational emissions of an OCGT as the future baseline.

As described in *Chapter 2: Project and Site Description*, construction is due to take place over a 7-year period, commencing in 2027, and it is due to be commissioned in 2034. The Development is anticipated to operate for a 100-year period.

The GHG emissions expected from peatland excavations to make way for the Development were calculated using the Scottish Government Windfarm Carbon Assessment Tool (Ref. 17-35). It was assumed that no peat would be restored> This is a worst-case scenario as a Peat Management Plan containing mitigation measures to manage peatland damage has been developed for the Section 36 Application.

As stated at the scoping stage, it is extremely rare for a large-scale pumped storage hydro project to be decommissioned due to the long operational lifespan of the facility. Therefore, decommissioning was not considered as part of the climate change assessment.

17.6 Methodology

The methodologies described in the following section have been developed in line with the relevant planning policy (see Legislation, Policy & Guidance Section) and IEMA guidance on assessing GHG emissions in EIA (Ref. 17-2) and considering climate change resilience and adaptation measures (Ref. 17-3) in EIA.

17.6.1 Lifecycle GHG Impact Assessment

Greenhouse gas emissions arising during construction are calculated in line with PAS2080:2023 Guidance (Ref. 17-15) and GHG Protocol (Ref. 17-16), and the GHG 'hot spots' (i.e. materials and activities likely to generate the largest amount of GHG emissions) have been identified. This has enabled priority areas for mitigation to be identified. This approach is consistent with the principles set out in IEMA's guidance for assessing GHGs in EIA (Ref. 17-2).

The lifecycle approach considers emissions from the following lifecycle stages of the Development: pre-construction, construction and operation (including maintenance). The decommissioning phase has been scoped out of this assessment due to the long operational lifespan of the facility. Subsequent refurbishment or decommissioning plans would be prepared as required at that time for planning applications.

Where activity data has allowed, expected GHG emissions arising from the pre-construction, construction and operational activities, and embodied carbon in materials used in the Development, have been quantified using a calculation-based methodology as per the following equation in line with the GHG Protocol (Ref. 17-16), accompanied with the conversion factors for company reporting published by the UK Government (Ref. 17-19):

Activity data x GHG emissions factor = GHG emissions value

To inform the GHG Assessment, conversion factors for company reporting published by the UK Government were used to determine the GHG emission for fuel use and construction waste. In addition to this, emissions factors from ICE V3.0 (Ref. 17-34) were used to determine the GHG emissions for the construction materials (concrete and steel etc.) and emission rates from the CESSM 4 Price Book (Ref. 17-33) were used to determine the GHG emissions from excavation work required to construct the underground Power Cavern Complex.

The Scottish Government Windfarm Carbon Assessment Tool (Ref. 17-35) was used to determine the GHG emissions that were anticipated to arise from peat excavation. UK Government Greenbook (Ref. 17-31) decarbonisation figures were applied to the GHG Assessment for operational energy usage required for pumping activities. This was applied to factor in UK Grid decarbonisation as, during the operation of the Development, fossil fuels will continue to be phased out in line with UK and Scottish Government policy.

In line with the GHG Protocol (Ref. 17-16), when defining potential impacts (or 'hot spots'), the seven Kyoto Protocol GHGs have been considered, namely:

- Carbon dioxide (CO_2);
- Methane (CH_4);
- Nitrous oxide (N_2O);
- Sulphur hexafluoride (SF_6);
- Hydrofluorocarbons (HFCs);
- Perfluorocarbons (PFCs); and
- Nitrogen trifluoride (NF_3).

These GHGs are broadly referred to in this chapter under an encompassing definition of 'GHG emissions', with the unit of tCO_2e (tonnes of CO_2 equivalent) or $MtCO_2e$ (Mega tonnes of CO_2 equivalent).

Where data is not available, a qualitative approach to addressing GHG impacts has been followed, in line with the IEMA guidance for assessing GHG emissions in EIA (Ref. 17-2).

Table 17-5 Potential Sources of GHG Emissions, below, summarises the key anticipated GHG emissions sources associated with the Development, in line with the '*Publicly Available Standard (PAS) 2080 – carbon management in infrastructure*' (Ref. 17-15).

Table 17-5: Potential Sources of GHG Emissions

Lifecycle stage	Activity	Primary emission sources
Pre-construction Stage	Any enabling works, land clearance, and disposal of waste generated during the enabling works.	Material GHG emissions are expected from fuel use, electricity use, loss of carbon sink and waste disposal.
Construction Stage	Raw material extraction, product manufacture of construction materials, electricity use, on-site fuel use, waste disposal, and transport.	Material GHG emissions are expected from embodied carbon of materials, electricity use, fuel use, and waste disposal.
Operation Stage	Raw material extraction, product manufacture for operational materials, electricity use, fuel use onsite, waste disposal, landscaping or other offsets.	Material GHG emissions are expected from embodied carbon of materials, electricity use, fuel use, waste disposal, gain of carbon sinks.

17.6.2 Climate Change Resilience Assessment

The EIA Regulations (Ref. 17-1) require the inclusion of information on the vulnerability of the Development to climate change. Consequently, an assessment of climate change resilience for the Development has been undertaken, identifying potential climate change impacts per the IEMA Environmental Impact Assessment Guide to Climate Change Resilience & Adaptation (Ref. 17-3).

The assessment has included all infrastructure and assets associated with the Development. It covers resilience against both gradual climate change, and the risks associated with an increased frequency of extreme weather events as per the UK Climate Projections 2018 (UKCP18) (Ref. 17-20).

The review of potential impacts and the Development's vulnerability considers the embedded mitigation measures that have been designed into the Development, discussed in the Embedded Mitigation Section.

The assessment has considered climate projections over a 100-year period from the Development's completion, assuming a construction start date of 2027.

The following key terms and definitions relating to the CCRA have been used:

- Climate hazard – a weather or climate related event, which has potential to do harm to environmental or community receptors or assets, such as increased winter precipitation;
- Climate change risk – risks associated with climatic variables, such as increased winter precipitation leading to flooding;

- Climate change impact – an impact from a climate hazard which affects the ability of the receptor or asset to maintain its function or purpose; and
- Consequence – any effect on the receptor or asset resulting from the climate hazard having an impact.

A stepped approach is used to assess the impacts of climate change on the Development:

Step 1: Identify Potential Climate Hazards and Subsequent Risks

Potential climate change hazards relevant to the location of the Development have been identified using projections from UKCP18.

Climate parameters considered in the CCRA during the pre-construction, construction and operation of the Development include the following:

- Extreme weather events;
- Flood risk;
- Forest Fire;
- Temperature change; and
- Precipitation change.

Step 2: Identify the Likelihood of a Climate Impact Occurring

Once potential climate hazards have been identified in Step 1, the criteria presented in *Table 17-6 Likelihood of a Climate Impact Occurring*, below, is used to determine the likelihood of a climate impact occurring on the Development site.

Table 17-6. Likelihood of a Climate Impact Occurring

Likelihood of event	Qualitative description	Quantitative description (probability of occurrence)
Very likely	Likely that the impact will occur many times (reoccurs frequently).	90-100% probability that the impact will occur.
Likely	Likely that the impact will occur sometimes (reoccurs infrequently).	66-90% probability that the impact will occur.
Possible, about as likely as not	Possible that the impact will occur (has occurred rarely).	33-66% probability that the impact will occur.
Unlikely	Unlikely that the impact will occur (not known to have occurred).	10-33% probability that the impact will occur.
Very unlikely	Almost inconceivable that the impact will occur.	0-10% probability that the impact will occur.

Step 3. Identify the Consequence of the Impact on the Development

Following identification of climate impacts, the consequences of climate impacts have been assessed according to *Table 17-7 Level of Consequence of a Climate Change Risk Occurring*, below. For example, permanent damage to electrical equipment from heatwaves causing complete loss of operation. The categories and descriptions provided below are based on IEMA's '*Climate Change Resilience and Adaptation guidance'* (Ref. 17-2).

Table 17-7. Level of Consequence of a Climate Change Risk Occurring

Consequence of impact	Description
High	• Permanent damage to structures/assets; • Complete loss of operation/service; • Complete/partial renewal of infrastructure; Exceptional environmental damage; and/or • Extreme financial impact.
Moderate	• Partial infrastructure damage and some loss of service; • Some infrastructure renewal; • Adverse impact on the environment; and/or • Moderate financial impact.
Low	• Localised infrastructure disruption and minor loss of service;

Consequence of impact	Description
	• No permanent damage, minor restoration work required; • Slight adverse environmental effects; and/or • Small financial losses.
Negligible	• No damage to infrastructure; • No impacts on the environment; and/or • No adverse financial impact.

Step 4. Identify the Significance of Impact (likelihood of impact occurring x consequence of impact)

This assessment was informed by the risk framework and the descriptors of likelihood and consequence adopted from the European Commission's Technical guidance on the climate proofing of infrastructure in the period 2021 – 2027 (Ref. 17-17).

The likelihood and consequence descriptors and the risk matrix are provided in *Table 17-6 Likelihood of a Climate Impact Occurring*, and *Table 17-7 Level of Consequence of a Climate Change Risk Occurring.*

The CCRA has assessed the significance of effects by evaluating the combination of the likelihood of the climate-related impact occurring, and the consequence, as per the risk assessment matrix in *Table 17-8 Risk Matrix as per the EU Technical Guidance (2021).* As evident in *Table 17-8,* any Low or Medium risks are deemed to be Not Significant to the Development, whilst any High and Extreme risks are deemed to have a Significant impact on the Development. The assessment has taken into account design and mitigation measures. Once the likelihood and consequence of an impact has been identified, this is used to determine the level of significance.

Table 17-8: Risk Matrix as per the EU Technical Guidance (2021)

		Consequence				
		Insignificant	**Minor**	**Moderate**	**Major**	**Catastrophic**
Likelihood	**Rare**	Low (NS)	Low (NS)	Medium (NS)	High (S)	Extreme (S)
	Unlikely	Low (NS)	Low (NS)	Medium (NS)	High (S)	Extreme (S)
	Moderate	Low (NS)	Medium (NS)	High (S)	Extreme (S)	Extreme (S)
	Likely	Medium (NS)	High (S)	High (S)	Extreme (S)	Extreme (S)
	Almost certain	High (S)	High (S)	Extreme (S)	Extreme (S)	Extreme (S)

NS – Not significant; S - Significant

17.6.3 In-combination Climate Change Impact Assessment

The ICCI assessment has considered the ways in which projected climate change will influence the significance of the impact of the Development on receptors in the surrounding environment.

The ICCI assessment has considered the existing and projected future climate conditions for the geographical location and assessment timeframe to identify climate hazards. It then identifies the extent to which receptors in the surrounding environment are potentially vulnerable to, and affected by, these climate impacts. Identification of impacts has been assessed in liaison with the technical specialists responsible for preparing the applicable technical chapters listed below:

- *Chapter 13: Cultural Heritage*; and
- *Chapter 10: Geology & Ground Conditions*.

Potential climate hazards impacting receptors in the surrounding environment have been assessed using the criteria presented in *Table 17-9 Level of Likelihood of the Climate-Related Hazard Occurring.*

Table 17-9. Level of Likelihood of the Climate-Related Hazard Occurring

Level of likelihood of climate hazard	Qualitative description	Quantitative description
Very likely	Likely that the event will occur many times (reoccurs frequently).	90-100% probability that the hazard will occur during the life of the project.
Likely	Likely that the event will occur sometimes (reoccurs infrequently).	66-90% probability that the hazard will occur during the life of the project.
Possible, about as likely as not	Possible that the event will occur (has occurred rarely).	33-66% probability that the hazard will occur during the life of the project.
Unlikely	Unlikely that the event will occur (not known to have occurred).	10-33% probability that the hazard will occur during the life of the project.
Very unlikely	Almost inconceivable that the event will occur.	0-10% probability that the hazard will occur during the life of the project.

Once the likelihood of a climate hazard occurring has been identified the likelihood of the hazard impacting receptors is assessed using the criteria presented in *Table 17-10 Level of Likelihood of the Climate-Related Impact Occurring.*

Table 17-10. Level of Likelihood of the Climate-Related Impact Occurring

Level of likelihood of climate impact occurring	Definition of likelihood
High	Likelihood of climate hazard occurring is high and impact is always/ almost always going to occur.
Moderate	Likelihood of climate hazard occurring is high and impact occurs often or the likelihood of climate hazard occurring is moderate and impact is likely to occur always/almost always.
Low	Likelihood of climate hazard occurring is high, but impact rarely occurs or the likelihood of climate hazard occurring is moderate and impact sometimes occurs or the likelihood of climate hazard occurring is low and impact is likely to occur always/almost always.
Negligible	All other eventualities – highly unlikely but theoretically possible.

Once the likelihood of an impact occurring has been identified, the consequence of the impact on the receptor is assessed using the criteria set out in *Table 17-10.* The ICCI consequence criteria are defined in *Table 17-11 Consequence Criteria for ICCI Assessment,* and consider the change to the significance of the impact already identified by the environmental discipline. To assess the consequence of an ICCI each discipline has assigned a level of consequence to an impact based on the criteria description and their discipline assessment methodology.

Table 17-11: Consequence Criteria for ICCI Assessment

Consequence	Consequence Criteria
High	The climate change parameter in-combination with the effect of the Development causes the significance of the impact of the Development on the resource/receptor, as defined by the topic, to increase from negligible, low, or moderate to major.
Moderate	The climate change parameter in-combination with the effect of the Development causes the effect defined by the topic to increase from negligible or low, to moderate.
Low	The climate change parameter in-combination with the effect of the Development, causes the significance of effect defined by the topic, to increase from negligible to low.
Negligible	The climate change parameter in-combination with the effect of the Development does not alter the significance of the effect defined by the topic.

17.7 Data Sources

In preparation of this chapter, the following sources of published information have been used to inform the climate change assessment:

- Historic climate data obtained from the Met Office website at the closest meteorological station to the Development (Lephinmore, approximately 16 miles south of the Development) (Ref. 17-25) to determine the existing baseline conditions;
- UKCP18 (Ref. 17-20) to determine the future baseline conditions;

- Think Hazard (Ref. 17-26) were also used for other projected trends/impacts, and the UK Climate Change Risk Assessment (Ref. 17-27) analysed for the current state of nationwide climate change risks;
- Civil Engineering Standard of Measurement 4 (CESMM 4) Price Book (Ref. 17-33) emissions factors to determine the GHG emissions for the underground excavations;
- Bath Inventory of Carbon and Energy (ICE V3) (Ref. 17-34) emission factors to determine the carbon emissions from building materials;
- Department of Energy Security & Net Zero (DESNZ) 2023 (Ref. 17-19) emission factors to determine the GHG emissions from fuel usage and waste;
- Scottish Government Windfarm Carbon Assessment Tool (Ref. 17-35) to determine the GHG emissions associated with the excavation of peat; and
- UK Government Green Book (Ref. 17-31) for projections of future grid decarbonisation.

17.8 Baseline Conditions

17.8.1 Lifecycle GHG Impact Assessment

Existing Baseline

For the GHG assessment, the existing baseline is the current position at the Development Site. The existing baseline comprises the carbon stock and sources of GHG emissions within the boundary of the existing activities on-site.

The current land use within the Site and the local area consists predominantly of woodland, grassland, peatlands, and farm access tracks. The abundance of vegetation within the Development Site suggests carbon sink potential.

Future Baseline

The future baseline provides an estimate of the GHG emissions that would occur at the Development Site in the future if the Development does not proceed.

17.8.2 CCRA and ICCI Assessments

Existing Baseline

The existing baseline for the CCRA and ICCI assessments is based on historic observational climate data recorded by the closest meteorological station to the Development (Lephinmore, located approximately 16 miles south of the Development) for the 30-year period of 1981-2010. This has been obtained from the Met Office website (Ref. 17-25), and is summarised in *Table 17-12.*

Past Extreme Events

The following events are examples of extreme climatic conditions experienced at the site location in the past:

- Highest recorded temperature recorded was 34.8°C on the 19th July 2022 (Ref. 17-29);
- Lowest recorded temperature recorded was -15.9°C on the 29th December 1995 (Ref. 17-29);
- Highest 24-hour rainfall total for a rainfall day was 238 mm and was recorded on 17th January 1974 (Ref. 17-29);
- The highest gust speed recorded was 142 mph and was recorded on 13th February 1989 (Ref. 17-29); and
- In October 2023, torrential rainfall, up to a month's rainfall accumulating within a 24-hour period, led to significant flooding and landslips across the west coast of Scotland, affecting the region's road network (Ref. 17-30).

Future Baseline

The future baseline is expected to differ from the existing baseline described above. UKCP18 (Ref. 17-20) provides probabilistic climate change projections for pre-defined 30-year periods for annual, seasonal, and monthly changes to mean and extreme climatic conditions over land areas. For the purposes of the assessments, UKCP18 probabilistic projections for the following average climate variables have been obtained:

- Mean annual temperature;
- Mean summer temperature;

- Mean winter temperature;
- Maximum summer temperature;
- Minimum winter temperature;
- Mean annual precipitation;
- Mean summer precipitation;
- Mean winter precipitation; and
- Extreme weather events (e.g. heat waves & storm events).

Projected temperature and precipitation variables are presented in *Table 17-12 Climate Data Projections for Balliemeanoch.* UKCP18 probabilistic projections have been analysed for the 25 km^2 (square kilometres) grid square within which the Development is located. These figures are expressed as temperature/precipitation anomalies in relation to the 1981-2010 baseline.

UKCP18 uses a wide range of possible scenarios, classified as Representative Concentration Pathways (RCP), to inform differing future emission trends. These RCPs *"… specify the concentrations of greenhouse gases that will result in total radiative forcing increasing by a target amount by 2100, relative to preindustrial levels*". RCP8.5 has been used for the purposes of this assessment as a worst-case as this predicts a high-emissions or 'business-as-usual' scenario.

As the design life of the Development is at least 100 years, the CCRA has considered a scenario that reflects a high level of GHG emissions at the 10%, 50% and 90% probability levels up to 2099 to assess the impact of climate change over the assessed lifetime of the Development.

Construction risks are assessed against the 2020-2049 projection data, while operation risks are assessed against 2020-2049, 2040-2069 and 2070-2099 projection data as a conservative worst-case scenario.

The following data are proposed to be used to inform the climate change assessment and are detailed in the Data Sources section.

Table 17-12: Climate Data Projections for Balliemeanoch

Climate Variable	Baseline (1981–2010)	Climate change projection RCP 8.5				Projected Trend	Climate Source	Projection
		2020–2049	2040–2069	2070–2099	Beyond 2100			
Temperature								
Mean annual maximum daily temperature (°C)	12.42°C	+0.82°C (+0.22°C to + 1.42°C)	+1.44°C (+0.54°C to +2.34°C)	+2.81°C (+1.36°C to +4.32°C)	No projection data is available, trend towards increasing temperatures is expected to continue	↑	*UKCP18 RCP8.5*	
Mean summer maximum daily temperature (°C)	17.76°C	+0.86°C (+0.10°C to + 1.64°C)	+1.63°C (+0.42°C to +2.89°C)	+3.53°C (+1.42°C to + 5.76°C)		↑	*UKCP18 RCP8.5*	
Mean winter minimum daily temperature (°C)	1.89°C	+0.81°C (-0.05°C to + 1.73°C)	+1.38°C (+0.18°C to + 2.65°C)	+2.39°C (0.41°C to +4.47°C)		↑	*UKCP18 RCP8.5*	
Maximum summer air temperature (°C)	18.64°C (July)	+0.82°C (-0.40°C to + 1.75°C)	+1.65°C (0.14°C to + 3.18°C)	+3.72°C (1.06°C to + 6.41°C)		↑	*UKCP18 RCP8.5*	
Minimum winter air temperature (°C)	1.82°C (January)	+0.98°C (-0.05°C to +2.03°C)	+1.56°C (+0.14°C to + 3.10°C)	+2.58°C (0.29°C to + 5.15°C)		↑	*UKCP18 RCP8.5*	
Rainfall								
Mean annual rainfall (mm)	1957.45	+3.32% (–2.63% to +9.68%)	+5.86% (–2.76% to +15.37%)	+7.03% (–5.57% to +21.27%)	No projection data available, but there is potential for the overall trend in increased rainfall to continue.	↑	*UKCP18 RCP8.5*	
		2020–2049	2040–2069	2070–2099	Beyond 2100			
Mean summer rainfall (mm)	119.65	-8.11% (–22.18% to +7.32%)	–11.88% (–31.73% to +10.93%)	–25.77% (–49.91% to +5.41%)	No projection data is available. It is possible for the decrease in summer rainfall trend to continue.	↓	*UKCP18 RCP8.5*	
Mean winter rainfall (mm)	207.97	+9.00% (–3.40% to +23.72%)	+15.18% (–1.33% to +35.73%)	+25.61% (–0.07% to +58.29%)	No projection data is available, an increase in winter rainfall is possible.	↑	*UKCP18 RCP8.5*	

Climate Variable	Baseline (1981–2010)	Climate change projection RCP 8.5				Projected Trend	Climate Source Projection
Wettest month on average (mm)	242.84 (January)	+9.3% (-9.5% to 29.8%)	+17.9% (-9.1% to +48.1%)	+32.4% (-6.6% to +78.0%)	No projection data is available.	↑	*UKCP18 RCP8.5*
Driest Month on average (mm)	93.65 (May)	+8.2% (-8.7% to +24.5%)	+10.8% (-13.5% to +33.7%)	+6.6% (-27.6% to +39.6)	No projection data is available.	↑	*UKCP18 RCP8.5*
Other							
Droughts	The Met Office has projected a trend towards drier summers on average, with the trend being stronger under a high GHG emission scenario compared to a low one. However, it is the distribution of rainfall throughout the seasons that will determine UK drought risk.					↑	Met Office
Storms	Climate change is expected to lead to more frequent and intense winter storms across the UK, with higher wind speeds and wetter winters, while summers may become drier.					↑	Met Office
Wildfires	The wildfire hazard is classified as medium according to the information that is currently available to the Think Hazard tool. This means there is between a 10% and 50% chance of experiencing weather that could support a hazardous wildfire that may pose some risk of life and property loss in any given year.					↑	Think Hazard

17.9 Significance Criteria

17.9.1 Lifecycle GHG impact assessment

For the lifecycle GHG impact assessment, the magnitude of impact considers the output of the GHG quantification process, i.e. the Development's GHG lifecycle footprint, in the context of its contribution to Scotland's annual percentage reduction targets and the possible impact of the Development on Scotland meeting its Net Zero target. Emissions from the Development will be presented as a percentage of the carbon reduction period under which they fall.

According to the IEMA guidance on assessing GHG emissions in EIA (Ref. 17-2), "*GHG emissions have a combined environmental effect that is approaching a scientifically defined environmental limit, as such any GHG emissions or reductions from a project might be considered to be significant*".

The IEMA guidance describes five distinct levels of significance which are not solely based on whether a project emits GHG emissions alone, but how the project makes a relative contribution towards achieving a science-based 1.5°C aligned transition towards Net Zero.

Table 17-13 Definition of Levels of Significance presents the different significance levels as per the latest version of the IEMA guidance, which emphasises that *"…a project that follows a 'business-as-usual' or 'do minimum' approach and is not compatible with the UK's net zero trajectory, or accepted aligned practice or area-based transition targets, results in a significant adverse effect. It is down to the practitioner to differentiate between the 'level' of significant adverse effects e.g. 'moderate' or 'major' adverse effects*."

Table 17-13: Definition of Levels of Significance

Effect	Significance Level	Description in the IEMA guidance	Example in the IEMA guidance
Major adverse	Significant	A project that follows a 'business-as-usual' or 'do minimum' approach and is not compatible with the UK's Net Zero trajectory or accepted aligned practice or area-based transition targets, results in a significant adverse effect. It is down to the practitioner to differentiate between the 'level' of significant adverse effects; e.g., 'moderate' or 'major' adverse effects.	The project's GHG impacts are not mitigated or are only compliant with do-minimum standards set through regulation, and do not provide further reductions required by existing local and national policy for projects of this type. A project with major adverse effects is locking in emissions and does not make a meaningful contribution to the UK's trajectory towards Net Zero.
Moderate adverse			The project's GHG impacts are partially mitigated and may partially meet the applicable existing and emerging policy requirements but would not fully contribute to decarbonisation in line with local and national policy goals for projects of this type. A project with moderate adverse effects falls short of fully contributing to Scotland's trajectory towards Net Zero.
Minor adverse	Not significant	A project that is compatible with the budgeted, science based 1.5°C trajectory (in terms of rate of emissions reduction) and which complies with up-to-date policy and 'good practice' reduction measures to achieve a minor adverse effect that is not significant. It may have residual emissions but is doing enough to align with and contribute to the relevant transition scenario, keeping the Scotland on track towards Net Zero by 2045.	The project's GHG impacts would be fully consistent with applicable existing and emerging policy requirements and good practice design standards for projects of this type. A project with minor adverse effects is fully in line with measures necessary to achieve the Scotland's trajectory towards Net Zero.
Negligible		A project that achieves emissions mitigation that goes substantially beyond the reduction trajectory, or substantially beyond existing and emerging policy compatible with that trajectory, and has minimal residual emissions, is assessed as having a negligible effect that is not significant. This project is playing a part in achieving the rate of transition required by nationally set policy commitments.	The project's GHG impacts would be reduced through measures that go well beyond existing and emerging policy and design standards for projects of this type, such that radical decarbonisation or Net Zero is achieved well before 2050. A project with negligible effects provides GHG performance that is well 'ahead of the curve' for the trajectory towards Net Zero and has minimal residual emissions.
Beneficial	Significant	A project that causes GHG emissions to be avoided or removed from the atmosphere. Only projects that actively reverse (rather than only reduce) the risk of severe climate change can be judged as having a beneficial effect.	The project's net GHG impacts are below zero and it causes a reduction in atmospheric GHG concentration, whether directly or indirectly, compared to the without-project baseline. A project with beneficial effects substantially exceeds Net Zero requirements with a positive climate impact.

Moderate and major adverse impacts and beneficial impacts are considered to be 'significant', while minor adverse and negligible significance levels are deemed to be 'not significant'.

A minor adverse or negligible non-significant effect conclusion does not necessarily refer to the magnitude of GHG emissions being carbon neutral (i.e. zero on balance); but refers to the likelihood of avoiding severe climate change, aligning project emissions with a science-based 1.5°C compatible trajectory and achieving Net Zero by 2045.

A project's impact can shift from significant adverse to non-significant effects by incorporating mitigation measures that substantially improve on business-as-usual and meet or exceed the science-based emissions trajectory of ongoing but declining emissions towards Net Zero.

The IEMA guidance also states it is down to the professional judgement of the practitioner to determine how best to contextualise a project's GHG impact and assign the level of significance. It is suggested that sectoral, local, or national carbon budgets can be used, as available and appropriate, to contextualise a project's GHG impact and determine the level of significance. The approach adopted for the purposes of this assessment is outlined below.

Where available, Scotland's carbon reduction targets have been used for the purposes of this assessment to represent future emissions inventory scenarios for Scotland (Ref. 17-22). These legally-binding targets outline the total amount of GHGs that Scotland can emit on a yearly basis.

To identify and assess the magnitude of impact of GHG emissions arising from the Development, these are first calculated and put into the context of Scotland's carbon reduction targets. The IEMA guidance and criteria (Ref. 17-2) is then used to test the significance of the magnitude.

Table 17-14 Scotland's Annual Carbon Reduction Targets outlines Scotland's annual carbon reduction targets that are used to contextualise the Development's GHG emissions. These targets are derived from annual percentage reductions relative to Scotland's 1990 emissions baseline (Ref. 17-23).

Table 17-14: Scotland's Annual Carbon Reduction Targets

Year	Percentage reduction from 1990 baseline	Scotland Government Annual Targets (Mt CO_2e)
2021	51.1%	35.84
2022	53.8%	34.23
2023	56.4%	32.61
2024	59.1%	30.99
2025	61.7%	29.37
2026	64.4%	27.76
2027	67.0%	26.14
2028	69.7%	24.52
2029	72.3%	22.90
2030 (Interim target)	75.0%	21.28
2031	76.5%	20.01
2032	76.5%	18.73
2033	78.0%	17.45
2034	79.5%	16.18
2035	81.0%	14.90
2036	82.5%	13.62
2037	84.0%	12.35
2038	85.5%	11.07
2039	87.0%	9.79
2040 (Interim Target)	88.5%	8.51
2041	92.0	6.81

Year	Percentage reduction from 1990 baseline	Scotland Government Annual Targets (Mt CO_2e)
2042	94.0%	5.11
2043	96.0%	3.41
2044	98.0%	1.70
2045 (net-zero emissions)	100%	0.0

In April 2024, the Scottish Government (Ref. 17-37) announced that it intended to remove the statutory 2030 target for emissions reductions, and to replace the existing annual percentage reduction targets with a series of multi-year carbon budgets. These changes would require an amendment to primary legislation which, at the time of drafting this chapter, has not yet been implemented. The Scottish Government reiterated its commitment to reach net zero by 2045.

In addition to using Scotland's emission reduction targets to test the significance of the Development, the Climate Change Committee (CCC) also provides sector-specific decarbonisation pathways (Ref. 17-24). *Table 17-15 Sector-Specific Electricity Generation Carbon Budgets Based Upon the CCC's Balanced Net Zero Pathway* presents the electricity generation sector specific carbon budgets as further context to the GHG emissions; however, it should be noted that these are not contained in legislation unlike the national-level budgets. The sector-specific carbon budget periods begin in 2020.

Table 17-15: Sector-Specific Electricity Generation Carbon Budgets Based Upon the CCC's Balanced Net Zero Pathway

Carbon budget period	Recommended Carbon Budget ($MtCO_2e$)
2023–2027	189.16
2028–2032	92.56
2033–2037	35.74
2038–2042	23.22
2043–2047	12.36
2048–2050	4.03

17.10 Climate Change Risk Assessment

17.10.1 CCR Assessment

The significance of impacts in the CCR Assessment is determined as a function of the likelihood of a climate change impact occurring and the consequence to the receptor if the impact occurs. The significance is detailed in *Table 17-8 Risk Matrix as per the EU Technical Guidance (2021)* . The assessment takes into account confirmed design and mitigation measures (referred to the Embedded Mitigation section).

17.10.2 ICCI Assessment

The significance of potential effects is determined using the matrix in *Table 17-16 ICCI Significance Criteria.* Where an effect has been identified as moderate or high, against the matrix in *Table 17-16*, these will be classed as a significant ICCI effect. If significant ICCI effects are assessed, then appropriate additional mitigation measures (secondary mitigation) are identified.

Table 17-16. ICCI Significance Criteria

		Likelihood of climate-related impact occurring			
		Negligible	Low	Moderate	High
Level of consequence of climate impact occurring	**Negligible**	NS	NS	NS	NS
	Low	NS	NS	NS	S
	Moderate	NS	NS	S	S
	High	NS	S	S	S

Note: S = significant; and NS = not significant

17.11 Embedded Mitigation

Where possible, mitigation measures have been incorporated into the Development design and construction. Through iterative assessment, potential impacts have been predicted and opportunities to mitigate them identified with the aim of preventing or reducing impacts as much as possible. This approach provides the opportunity to prevent or reduce potential adverse impacts from the outset. This embedded mitigation approach has been taken into account when evaluating the significance of the potential impacts.

Once these measures are incorporated into the design, they are termed 'embedded measures'. Embedded measures relevant to the construction phase are described within each technical chapter of this EIAR. For the operational phase, such embedded measures will be represented primarily in the design, e.g. the choice of infrastructure components. Embedded measures are therefore either incorporated into the design from the outset or identified through the assessment process.

Along with any measures required for legislative compliance, the Development will also incorporate industry standard control measures, which are common practice on construction sites, into the embedded measures. These are described in each technical chapter of this EIAR. Embedded measures include (but are not limited to) the monitoring of weather forecasts and receipt of Scottish Environmental Protection Agency (SEPA) flood alerts by contractors to allow works to be planned and carried out accordingly to manage extreme weather conditions, such as storms and flooding, infrastructure design, and flood resilience measures.

17.11.1 GHG Mitigation Measures

An Outline construction environmental management plan (CEMP) is included within the Section 36 Application. This identifies various mitigation measures to be embedded within the Development to reduce the GHG impact, including:

- Adopting the Considerate Constructors Scheme (CCS) to assist in reducing pollution, including GHG emissions, from the Development by employing good industry practice measures which go beyond statutory compliance;
- Implementing a Construction Traffic Management Plan (CTMP) to reduce the volume of construction trips to the Site;
- Liaising with construction personnel on the potential to implement staff minibuses and car-sharing options;
- Switching vehicles and plant off when not in use and ensuring construction vehicles conform to European Union (EU) vehicle emissions standards for the types of plant and vehicles to be used;
- Conducting regular planned maintenance of the plant and machinery to optimise efficiency;
- Increasing recyclability by segregating construction waste to be re-used and recycled where reasonably practicable;
- Designing, constructing and implementing the Development in such a way as to minimise the creation of waste;
- Where practicable, maximise the use of alternative materials with lower embodied carbon, such as locally sourced products and materials with a higher recycled content; and
- A Peat Management Plan has been developed for the Development. This contains measures to reduce the impact of damaged peat lands as a result of the Development. Measures include reusing excavated peat for Access Tracks.

17.11.2 CCRA Adaptation Measures

Further climate change resilience measures embedded within the Development, particularly in relation to flood risk, are included in the Outline CEMP**.** The specific flood risk impacts and associated adaption measures are discussed in more detail in *Chapter 11: Water Environment* and *Chapter 12: Water Resources and Flood Risk***.**

The following adaption measures are included within the Outline CEMP;

- Storing topsoil, construction plant and construction materials outside of high-risk flood risk areas;
- Named person(s) – likely the Safety, Health and Environment Manager/ Ecological Clerk of Works (ECoW) – to monitor weather forecasts and receive SEPA flood alerts to allow works to be planned and carried out in order to manage extreme weather conditions, such as storms and flooding; and

- Health and safety plans developed for construction activities will be required to account for potential climate change impacts on workers, such as flooding and heatwaves. Measures such as Toolbox Talks to educate workers on the dangers of extreme weather conditions should be included.

17.12 Assessment of Likely Impacts and Effects

17.12.1 Lifecycle Greenhouse Gas Assessment

Within this section, GHG emissions arising as a result of the Development are identified and assessed for each lifecycle stage individually (construction and operation).

It is important to understand the GHG impacts at each individual lifecycle stage, as well as to understand the net lifecycle GHG impact of the Development due to the long-term, cumulative nature of GHG emissions over their lifetime.

Therefore, the net impact of the Development is also identified and assessed, taking into account the renewable energy generation and the benefit of this in the context of the wider energy generation sector and the National Grid average GHG intensity. The overall assessment, which will account for all GHG emissions over the lifetime of the Development, has also compared the GHG intensity of the Development with the GHG intensity of other likely grid energy generation sources.

17.12.2 Pre-construction and Construction Effects

The GHG emissions emitted during the pre-construction and construction phase are detailed below in *Table 17-17 GHG Emissions Resulting from the Pre-Construction and Construction Phase.*

The greatest GHG impacts occur during the pre-construction and construction phase (2027 - 2034) as a result of land use change through the excavation of peat to make way for the Development. Land use change emissions were calculated using bespoke peatland emission factors within the Scottish Government Windfarm Carbon Assessment Tool (Ref. 17-35). The reported GHG impacts for land use change are a worst-case scenario as it was assumed in the GHG Assessment that no measures are taken to reduce peatland loss. The Peat Management Plan includes measures that are likely going to significantly reduce the GHG impact of peatland loss due to the Development.

The other significant GHG impacts are from the manufacture of the materials and components required and the enabling work (underground excavations) required to construct the necessary infrastructure. Construction material quantities were provided by the design team and the GHG emissions were derived using emission factors from ICE V3 (Ref. 17-34) and the CESSM 4 Pricebook (Ref. 17-33).

The construction phase is estimated to account for 1,795,023 tCO_2e. *Table 17-17* summarises the emissions resulting from the pre-construction and construction phase of the Development.

Table 17-17. GHG Emissions Resulting from the Pre-Construction and Construction Phase

Emissions source	Construction and pre-construction emissions (tCO_2e)	Proportion of total construction and pre-construction emissions
Land use change (Peat Excavations)	619,943	35%
Materials	578,447	32%
Enabling Work	449,711	25%
Construction Activities (includes fuel use)	25,183	6%
Transport of materials	39,227	2%
Commuting	5,588	<1%
Waste	3,138	<1%
Preconstruction and Construction total	**1,795,023**	

The annual emissions of each phase have been compared to the relevant Scottish Net Zero Carbon Targets and are detailed in *Table 17-18 Scottish Net-Zero Targets Relevant to the Construction Period.*

Table 17-18. Scottish Net-Zero Targets Relevant to the Construction Period

Relevant Carbon Reduction Period	Carbon Reduction Allowance (tCO_2e)	Estimated total (tCO_2e) over carbon reduction period	% of carbon reduction period
2021-2030	285,641,192	1,025,727	0.35910%
2031-2040	142,607,749	769,295	0.53945%
2041-2044[1]	17,027,791	0	0.0%

The overall significance of GHG emissions in the context of the Scottish Carbon Reduction Targets and the national policy environment has been assessed in the Overall GHG Impact and Significance Section.

17.12.3 Operational Effects

The operational phase of the Development is assumed to cover the period from 2034 to 2133 (i.e. 100 years). The Development is estimated to have a storage capacity of 45 GWh based on a 1.5 GW capacity and a 30-hour maximum run time. It was assumed that the Development has a round-trip efficiency of 80%.

This round-trip efficiency value means that in order to generate 45 GWh of electricity, 56.25 GWh of electricity would be required to pump water from the lower reservoir to the upper reservoir during periods of low electricity demand (e.g. at night) or when there is a surplus electricity generation from renewable sources like wind or solar. Pumping water from the lower to the upper reservoir at periods of high renewable generation means that the carbon intensity of this phase of the operation is very likely to be lower than the grid average.

It is not, however, possible to accurately determine the carbon intensity of the electricity used for pumping activities due to the exact source of the surplus electricity not being known. Future projections of grid carbon intensity from the UK Government Greenbook (Ref. 17-31) were therefore used; these carbon factors represent the average carbon intensity for all electricity supplied via the UK grid for a given year, and can be taken to be a worst-case for the carbon impact of pumping operations.

GHG emissions sources within the scope of the operational emissions include energy use (for pumping of water from the lower to upper reservoir and auxiliary services) and fuel use for the transportation of workers to the Development and maintenance activities.

As presented in *Table 17-19 Emissions Resulting from the Operational Phase* the operational emissions over the design life of the Development are estimated at 3,269,787 tCO_2e. A total of 99% of this figure results from the pumping activities to move water from the lower to the upper reservoir between cycles. To calculate the greenhouse gas emissions for the Development's operation over its lifetime, it was assumed that there will be 100 cycles each year. The total electricity consumption value (GWh) for each cycle was multiplied by the total number of cycles and the Greenbook Grid Decarbonisation Values for each corresponding year, from 2034 to 2133. The result of this calculation was an emissions value for the operation of the Development each year, which were added together to get the total emissions for the Development's operation over its lifetime. The remaining GHG emissions result from operational worker commuting and maintenance activities.

Table 17-19. Emissions Resulting from the Operational Phase

Emissions source	Operational emissions (tCO_2e)	Proportion of total construction emissions
Electricity Usage (Pumping)	3,231,738	99%
Maintenance	22,770	1%
Vehicle Journeys	15,279	<1%
Operation design life total	**3,269,787**	
Annual total	**32,698**	

The annual emissions of each phase have been compared to the relevant Scottish Carbon reduction targets as detailed in *Table 17-20 Scottish Carbon Reduction Targets Relevant to the Operational Period.* To improve the robustness of the assessment and allow for temporal flexibility, the annual operational emissions have also been compared to the sector specific carbon budgets for electricity generation based on the CCC's Balanced Net Zero Pathway, these are detailed in *Table 17-21 Sector Specific Electricity Generation Carbon Budgets Relevant to the Operational Period.*

Table 17-20. Scottish Carbon Reduction Targets Relevant to the Operational Period

Relevant carbon reduction Period	Carbon reduction Allowance (tCO_2e)	Estimated total (tCO_2e) over carbon reduction period	% of carbon reduction period
2021-2030	285,641,192	0	0%
2031-2040	142,607,749	228,885	0.16050%
2041-2044[1]	17,027,791	130,791	0.76810%

Table 17-21: Sector Specific Electricity Generation Carbon Budgets Relevant to the Operational Period

Relevant UK Carbon Budget	Annualised UK Carbon Budget (tCO_2e)	Estimated total (tCO_2e) over the carbon budget period	% of Sectoral Budget for Electricity Generation.
2033-2037	35,740,000	89,919	0.25159%
2038-2042	23,330,000	163,489	0.70077%
2043-2047	12,360,000	163,489	1.32273%
2048-2050	4,030,000	65,396	1.62272%

The overall significance of GHG emissions in the context of the Scotland's carbon reduction targets and the national policy environment has been assessed in the Overall GHG Impact and Significance Section.

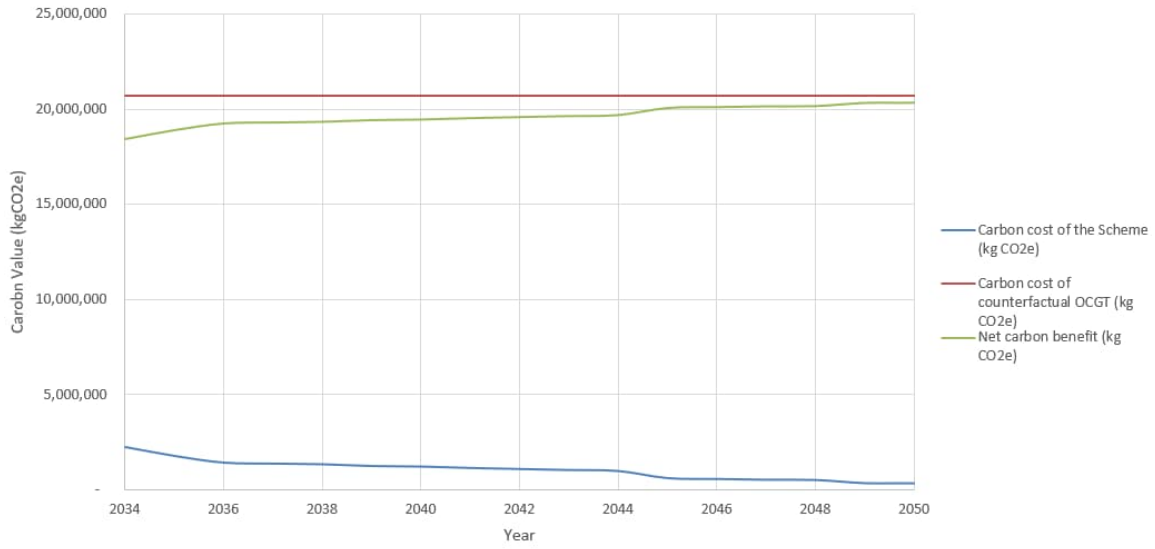
17.12.4 Carbon Intensity of the Development

The UK grid carbon intensity in 2023 is 0.207 $kgCO_2e/kWh$ (Ref. 17-19), however, these figures cannot be directly compared to the Development as the published UK grid carbon intensity figure only takes into account operational GHG emissions from the generation of electricity, overwhelmingly from the fossil fuels used to power gas-fired and occasionally coal-fired power stations (Ref. 17-28). For a meaningful comparison to be made between the Development and the UK grid, the operational carbon intensity of the Development must only include emissions from the operations of the Development and exclude emissions from construction.

The carbon intensity of the Development varies during the anticipated operational lifespan of the Development due to the Development's reliance on electricity from the UK Electricity Grid to pump water from the lower to the upper reservoir. In 2034, the first year of operation, the carbon intensity of the Development was calculated to be 0.04 $kgCO_2e/kWh$ for the GHG Assessment for the Development. In 2045, the year Scotland is due to reach Net Zero, the carbon intensity is anticipated to be 0.01 $kgCO_2e/kWh$. Therefore, comparing the Development against a counterfactual gas-fired Open Cycle Gas Turbine (OCGT) generating facility, a representative figure for the carbon intensity of an OCGT is 0.46 kgCO2e/kWh has been applied (Ref. 17-25). It can be determined that considerable GHG savings can be achieved from implementing the Development over the continued use of a counterfactual OCGT as shown in Figure 17-1 below.

[1] Excludes 2045 as no GHG emissions can be emitted from 2045 onwards.

Figure 17-1: GHG Savings of Development in comparison to the Counterfactual OCGT



The estimated operational GHG emissions from the Development, based on the DESNZ UK Grid Decarbonisation trajectory (Ref. 17-30), indicate a potential GHG saving of 203,768,262 tCO_2e across the anticipated 100-year operational period. This is in comparison to the counterfactual OCGT with identical energy generation capacity to the Development. It is important to note that this figure probably overestimates the GHG savings of the Development. This is because it is likely that energy generation from OCGT plants without carbon capture technology will be phased out before Scotland reaches Net Zero in 2045. The overall savings assume that the OCGT plant would continue to operate throughout the entire anticipated 100-year operational period.

17.12.5 Overall GHG Impact and Significance

Accounting for Scotland's climate objective to achieve net-zero carbon by 2045, and in line with IEMA guidance for assessing GHGs (Ref. 17-2), Scotland's 2030, 2040 and 2045 Carbon reduction targets have been used to contextualise emissions from the Development.

Pre-construction & Construction

Annual emissions from the pre-construction and construction phases of the Development (and their magnitude) are compared to the significance definitions outlined in *Table 17-20 Scottish Carbon Reduction Targets Relevant to the Operational Period* and *Table 17-21 Sector Specific Electricity Generation Carbon Budgets Relevant to the Operational Period*. In line with IEMA criteria for assessing the significance of GHG impacts (Ref. 17-2), construction of the Development can be assumed to be consistent with applicable existing and emerging policy requirements. GHG emissions from construction are therefore determined to be **minor adverse** and **not significant**.

Operation

The Development results in some operational emissions associated with electricity storage, maintenance and worker travel. However, the benefits of generating renewable energy from the Development far outweigh the associated emissions as demonstrated in the Carbon Intensity of the Development section. Annual emissions from the operation of the Development (and their magnitude) are compared to the significance definitions outlined in *Table 17-13 Definition of Levels of Significance.*

As stated in the IEMA guidance on assessing GHG emissions (Ref. 17-2), "…*the crux of significance, therefore, is not whether a project emits GHG emissions, nor even the magnitude of GHG emissions alone, but whether it contributes to reducing GHG emissions relative to a comparable baseline consistent with a trajectory towards net zero by 2050".*

The Development's operational phase results in a reduction of GHG emissions compared to the without-project baseline. Operational emissions also align with Scotland's trajectory towards Net Zero. The GHG impact of the operational phase is therefore considered to be **Beneficial** and **Significant** when compared to the future baseline 'business-as-usual' scenario as described in *Table 17-13 Definition of Levels of Significance.*

Summary

The Development directly supports the Scottish Government's ambition to decarbonise electricity generation in line with Scotland's 2045 net-zero Target. Therefore, it is considered to be consistent with achieving Scotland's overall trajectory to Net Zero. It is also required by National Grid as part of their strategy to decarbonise electricity generation (Ref. 17-36).

17.13 Climate Change Resilience Assessment

The CCRA identified 21 risks, 11 related to pre-construction and construction, and 10 related to operation. The complete list of climate change risks can be found in the register presented in *Appendix 17.1 Climate Change Risk Register (Volume 5 Appendices);.*

Future climate projections have been reviewed, and the sensitivity of assets has been examined before commenting on the adequacy of the embedded climate change adaption measures built into the Development.

17.13.1 Pre-Construction and Construction Effects

The risks assessed in the CCRA at the pre-construction and construction phase of the Development predominantly cover workforce exposure to dangerous working conditions and damage to physical structures/asset damage.

Major climatic variables contributing to these risks include, but are not limited to, increased temperatures, flooding, and storms.

As a result of the embedded climate change mitigation measures (as presented in Embedded Mitigation Section), it is concluded that all climate change risks during the construction phase have been identified to be **low to medium** and **not significant**.

17.13.2 Operation Effects

The risks assessed in the CCRA at the operational phase of the Development predominantly encapsulate asset damage from extreme weather conditions and changes in annual precipitation and temperatures, as well as workforce exposure to dangerous working conditions.

Major climatic variables contributing to these risks are temperatures, precipitation, and extreme weather events.

As a result of the embedded climate change mitigation measures, it has been concluded that all climate change risks during the operation phase have been identified to be **low** to **medium** and **not significant**.

17.14 ICCI Assessment

The significance of potential ICCIs, are detailed in *Appendix 17.2 In-combination Climate Change Impact (ICCI) Assessment (Volume 5 Appendices).*

The ICCI Assessment has been considered by all other technical disciplines within the EIAR. The following disciplines did not identify any ICCIs as part of their assessment:

- Chapter 5: Landscape & Visual
- Chapter 6: Terrestrial Ecology
- Chapter 7: Aquatic Ecology
- Chapter 8: Marine Ecology
- Chapter 9: Ornithology
- Chapter 11: Water Environment
- Chapter 12: Water Resources and Flood Risk
- Chapter 14: Access, Traffic & Transport
- Chapter 15: Noise and Vibration
- Chapter 16: Social Economics, Recreation & Tourism
- Chapter 18: Marine Physical Environment & Coastal Processes
- Chapter 19: Shipping & Navigation

- Chapter 20: Commercial Fisheries

Future climate projections have been reviewed and the sensitivity of receptors to both climate change and the Development have been examined before commenting on the adequacy of the climate change resilience measures built into the Development.

As a result of the embedded mitigation and good practice measures (as presented in the Embedded Mitigation and the respective sections in the technical chapters) it is concluded that all ICCIs during the preconstruction, construction and operation phase have been identified to be **not significant**.

17.15 Additional Mitigation Measures and Monitoring

Additional mitigation measures are only required where significant effects are identified following the application of embedded mitigation measures. No significant adverse effects have been identified in this assessment therefore no additional mitigation or enhancement measures are proposed.

As no potential significant effects have been identified for climate change, no monitoring of significant effects is required and/or proposed.

17.16 Residual Effects

Table 17-22 Summary of Effects: Pre-Construction & Construction and *Table 17-23 Summary of Effects: Operation* provide a summary of the residual effects for pre-construction, construction and operation.

Table 17-22 Summary of Effects: Pre-Construction & Construction

Receptor	Description of Effect	Effect	Additional Mitigation	Residual Effects	Significance
Global atmosphere	Impact of GHG emissions arising during construction of the Development on the climate.	Minor adverse	Not required	During the pre-construction and construction of the Development, there will be unavoidable GHG emissions due to the use of materials, energy, fuel, and transportation. However, additional GHG savings are expected to be achieved by implementing the GHG Mitigation Measures listed in the Embedded Mitigation Section.	Minor adverse – Not Significant
The Development	Impact of projected future climate change on the Development.	Low to Medium	Not required	During the pre-construction and construction of the Development, the impact of climate change will be unavoidable. The mitigation measures detailed in the embedded mitigation Section could reduce the impact of climate change on the Development.	Low to medium - Not Significant
Various - identified by each discipline in their assessment	Combined impact of future climate conditions and the Development.	Negligible to Low	Not required	The impact of climate change during the Development's pre-construction and construction will be unavoidable. The mitigation measures detailed within the technical chapters that identified ICCIs could reduce this impact.	Negligible to Low - Not Significant

Table 17-23 Summary of Effects: Operation

Receptor	Description of Effect	Effect	Additional Mitigation	Residual Effects	Significance
Global atmosphere	Impact of GHG emissions arising during the operation of the Development on the climate	Beneficial	Not required	During the operation of the Development, there will be unavoidable GHG emissions due to the use of materials, energy, fuel, and transportation. However, additional GHG savings are expected to be achieved by implementing the GHG Mitigation Measures listed in the Embedded Mitigation Section.	Beneficial – Significant

Receptor	Description of Effect	Effect	Additional Mitigation	Residual Effects	Significance
The Development	Impact of projected future climate change on the Development	Low to Medium	Not required	During the operation of the Development, the impact of climate change will be unavoidable. The mitigation measures detailed in the embedded mitigation Section could reduce the impact of climate change on the Development.	Low to medium - Not Significant
Various identified by each discipline in their assessment	Combined impact of future climate conditions and the Development	Negligible to Low	Not required	During the operation of the Development, the impact of climate change will be unavoidable. The mitigation measures detailed within the technical chapters that identified ICCIs could reduce the impact of climate change on the Development.	Negligible to Low - Not Significant

17.17 Cumulative Effects

According to IEMA Guidance on assessing GHG emissions in EIA (Ref. 17-2), the concentration of GHGs in the atmosphere and their impact on climate change are influenced by all sources and sinks globally, whether they are human-caused or not. Unlike many topics in EIA that only focus on projects within a specific geographical area, GHG emissions and their effects are global in nature. For example, air pollutant emissions primarily affect nearby areas, but GHGs disperse globally due to their persistence in the atmosphere. Therefore, when assessing the cumulative effects of GHGs, it's essential to consider all global sources rather than just focusing on individual projects. This is because a specific local impact of GHG emissions does not have a greater local climate change effect. When considering GHG emissions, it is crucial to account for the cumulative contributions of all GHG sources that contribute to the overall context. If the assessment is limited to a specific geographic or sectoral boundary, then the consideration of cumulative contributions will also be within that boundary.

The GHG assessment provided within this chapter is considered inherently cumulative as it presents the impact of the Development in the context of Scotland's GHG reduction targets, used to represent the key sensitive receptor (i.e. the global atmosphere). This includes the provision of legally binding limits of GHG emissions that can be emitted by Scotland if it is to meet its net-zero targets by 2045. This assessment is considered comprehensive and includes a worst case within the defined assessment parameters.

The ICCI assessment, by nature, should be considered cumulatively in line with each discipline's assessment. The identified effects are detailed in *Appendix 17.2 In-combination Climate Change Impact (ICCI) Assessment (Volume 5 Appendices).*

As the CCRA is only concerned with the assets of the Development and a broader consideration of existing interdependent infrastructure, a cumulative assessment is not required.

17.18 References

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