Partners in UK offshore wind

MORGAN OFFSHORE WIND PROJECT: GENERATION ASSETS

Preliminary Environmental Information Report

Volume 2, chapter 17: Climate change

Image of an offshore wind farm

April 2023
FINAL

Document status

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Acronyms

Acronym	Description
BEIS	Department for Business, Energy and Industrial Strategy
DCO	Development Consent Order
EIA	Environmental Impact Assessment
GHG	Greenhouse Gas
NPS	National Policy Statements
NSIPs	Nationally Significant Infrastructure Projects
PEIR	Preliminary Environmental Information Report

Units

Unit	Description
%	Percentage
km^2	Square kilometres
MWh	Megawatt hour
kWh	Kilowatt hour
GW	Gigawatt
MW	megawatt
CO_2e	Carbon dioxide equivalent

17 Chapter 17 – Climate change

17.1 Introduction

17.1.1.1 This chapter of the Preliminary Environmental Information Report (PEIR) presents the assessment of the potential impact of the Morgan Offshore Wind Project Generation Assets (hereafter referred to as the 'Morgan Generation Assets') on climate change. Specifically, this chapter considers the potential impact of the Morgan Generation Assets on offshore environments within the climate change study area during the construction, operations and maintenance, and decommissioning phases.

17.1.1.2 Climate change in the context of EIA can be considered broadly in two parts:

- the effect of greenhouse gas emissions (GHGs) caused directly or indirectly by the Morgan Generation Assets, which may have the potential to contribute to climate change
- the potential effect of changes in climate on the Morgan Generation Assets, which could affect it directly or could modify its other environmental impacts.

17.1.1.3 This chapter also draws upon information contained within the following technical reports:

- Volume 4, annex 17.1: Technical Greenhouse gas assessment technical report of the PEIR
- Volume 4, annex 17.2: Climate change risk assessment technical report of the PEIR.

17.1.2 Purpose of chapter

17.1.2.1 The primary purpose of the PEIR is outlined in volume 1, chapter 1: Introduction of the PEIR. In summary, the primary purpose of an Environmental Statement is to support the Development Consent Order (DCO) application for Morgan Generation Assets under the Planning Act 2008 (the 2008 Act). The PEIR constitutes the Preliminary Environmental Information for the Morgan Generation Assets and sets out the findings of the EIA to date to support the pre-application consultation activities required under the 2008 Act. The EIA will be finalised following completion of pre-application consultation and the Environmental Statement will accompany the application to the Secretary of State for Development Consent.

17.1.2.2 The PEIR forms the basis for Phase 3, Stage 2 Consultation which will last for 47 days and conclude on 4 June 2023. At this point, comments received on the PEIR will be reviewed and incorporated (where appropriate) into the Environmental Statement, which will be submitted in support of the application for Development Consent scheduled for quarter four of 2023.

17.1.2.3 In particular, this PEIR chapter:

- Presents the existing environmental baseline established from desk studies and consultation.
- Identifies any assumptions and limitations encountered in compiling the environmental information.
- Presents the potential environmental effects on and from climate change, arising from and to the Morgan Generation Assets, based on the information gathered and the analysis and assessments undertaken.
- Highlights any necessary monitoring and/or mitigation measures which could prevent, minimise, reduce or offset the possible environmental effects of and to the Morgan Generation Assets on and from climate change.

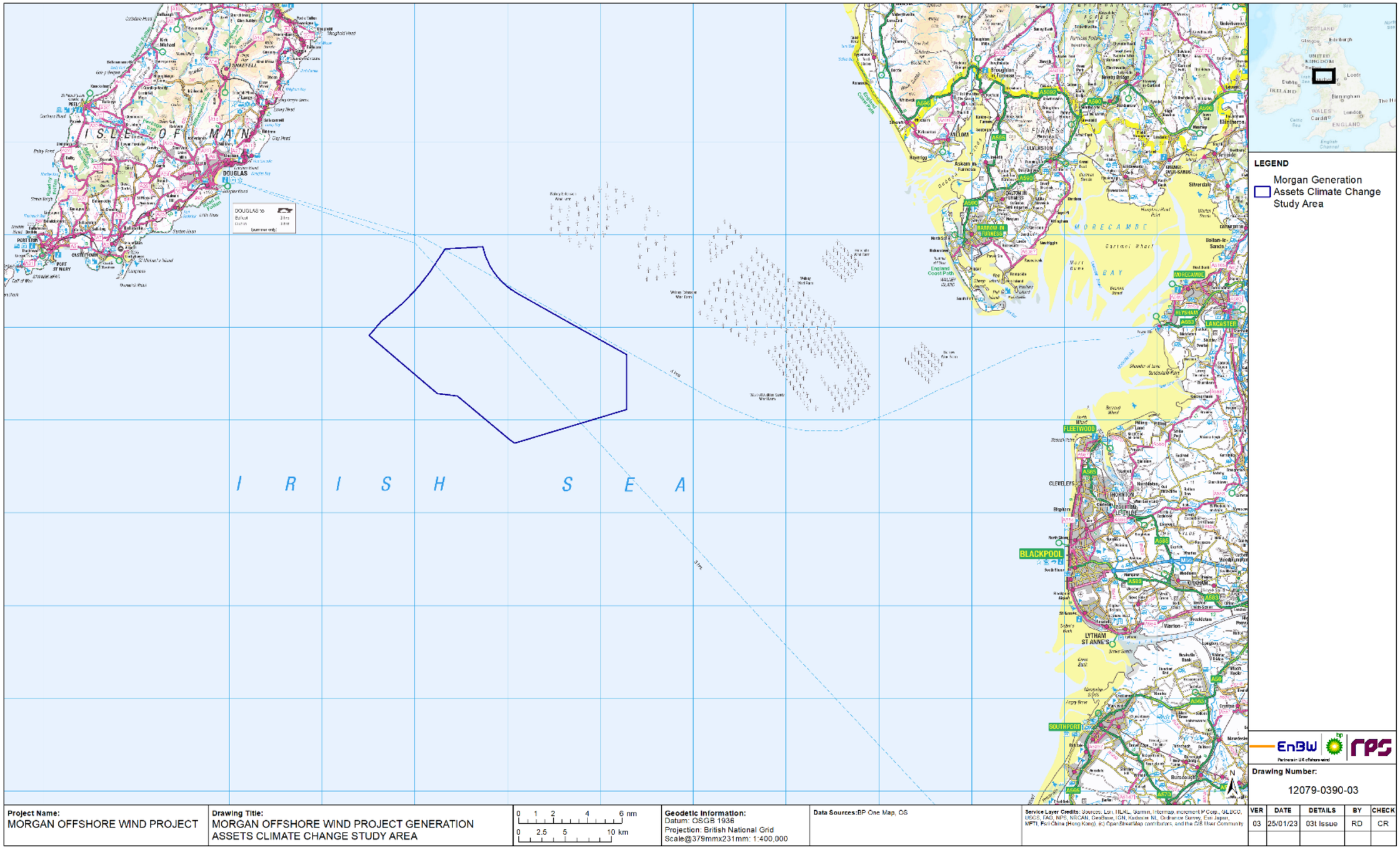
17.1.3 Study area

17.1.3.1 The Morgan Generation Assets climate change study area has been defined as the Morgan Generation Assets only (incorporating wind turbines, substation platforms, inter-array and inter-connector cabling (see Figure 17.1 below)), alongside the domestic and international scope as developed on the basis of established Institute of Environmental Management and Assessment (IEMA) guidance (IEMA, 2020 & 2022) utilised throughout this chapter. Domestic scope considers the local and national policy and targets concerning GHG and climate resilience.

17.1.3.2 GHG emissions have potential global (international) effects rather than directly affecting any specific local receptor. The impact of GHG emissions occurring due to the Morgan Generation Assets on the global atmospheric concentration of the relevant GHGs, expressed in CO_2-equivalents (CO_2e), is therefore considered within this assessment.

17.1.3.3 The climate change study area (Figure 17.1) is the redline boundary for the Morgan Generation Assets only. It does not include the transmission assets infrastructure (export cables, booster station and onshore elements) which are being included and considered as part of the Morgan and Morecambe Offshore Wind Farms Transmission Assets DCO application. Consideration of the potential additional impacts associated with the Morgan and Morecambe Offshore Wind Farms Transmission Assets DCO will be considered within the cumulative assessment of this chapter.

17.1.3.4 With regards to Cumulative Effects Assessment (CEA) all developments that emit, avoid or sequester GHGs have the potential to impact the atmospheric mass of GHGs as a receptor, and so may have a cumulative impact on climate change and upon the development. Consequently, cumulative effects due to other specific local development projects are not individually considered, with the exception of Morgan and Morecambe Offshore Wind Farms Transmission Assets DCO, as detailed above, but are taken into account when considering the impact of the Morgan Generation Assets and probabilistic projections used in the climate change risk assessment. As such, no specific study area beyond that of the Morgan Generation Assets redline boundary is relevant for the CEA for climate change.



Project Name:	Drawing Title:	Geodetic Information:	Data Sources:	Service Layer Credits:
MORGAN OFFSHORE WIND PROJECT	MORGAN OFFSHORE WIND PROJECT GENERATION ASSETS CLIMATE CHANGE STUDY AREA	Datum: OSGB 1936 Projection: British National Grid Scale@379mmx231mm: 1:400,000	BP One Map, OS	Sources: Esri, HERE, Garmin, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), (c) OpenStreetMap contributors, and the GIS User Community

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Figure 17.1: Morgan Offshore Wind Project: Generation Assets climate change study area.

17.2 Policy context

17.2.1 National Policy Statements

17.2.1.1 Planning policy on renewable energy infrastructure is presented in volume 1, chapter 2: Policy and legislation of the PEIR. Planning policy on offshore renewable energy Nationally Significant Infrastructure Projects (NSIPs), specifically in relation to Climate Change, is contained in the Overarching National Policy Statement (NPS) for Energy (EN-1; DECC, 2011a) and the NPS for Renewable Energy Infrastructure (EN-3, DECC, 2011b).

17.2.1.2 NPS EN-1 and NPS EN-3 include guidance on what matters are to be considered in the assessment and highlight a number of factors relating to the determination of an application and in relation to mitigation. These are summarised in Table 17.1 below.

17.2.1.3 Table 17.1 refers to the current NPSs, specifically NPS EN-1 (DECC, 2011a) and NPS EN-3 (DECC, 2011b). If the NPSs are updated prior to the application for Development Consent, the revised NPSs will be fully considered in relation to Climate change within the Environmental Statement.

Table 17.1: Summary of [NPS EN-1 and NPS EN-3] policy on decision making relevant to climate change.

Summary of NPS EN-1 provision	How and where considered in the PEIR
This NPS sets out how the energy sector can help deliver the Government's climate change objectives by clearly setting out the need for new low carbon energy infrastructure to contribute to climate change mitigation.	Volume 1, chapter 2: Policy and legislative context of the PEIR.
Paragraph 5.2.2 in NPS EN-1 states that *"CO_2 emissions are a significant adverse impact from some types of energy infrastructure which cannot be totally avoided"* and that *"Any ES on air emissions will include an assessment of CO_2 emissions".*	This chapter provides an assessment of CO_2 emissions and other relevant greenhouse gases of the Morgan Generation Assets.
Section 4.8 of NPS EN-1 concerns climate change adaptation. Paragraph 4.8.5 states that applicants must consider the impacts of climate change and that an Environmental Statement *"should set out how the proposal will take account of the projected impacts of climate change".*	This chapter provides an assessment of climate risk and resilience for the relevant elements of the Morgan Generation Assets.
Paragraph 4.8.7 of NPS EN-1 specifies that applicants should apply as a minimum the 10%–90% estimate range for the world's current emission scenario and relevant research based on this. Paragraph 4.8.9 specifies that where the development includes safety critical elements such as sub-stations, the high emissions scenario should be considered.	
Summary of NPS EN-3 provision	**How and where considered in the PEIR**
Provides the primary policy for decisions by the Secretary of State on applications they receive for nationally significant renewable energy infrastructure defined at Section 1.6 of this NPS.	Volume 1, chapter 2: Policy and legislative context of the PEIR.
Paragraph 2.3.4 of NPS EN-3 states that *"Offshore and onshore wind farms are less likely to be affected by flooding, but applicants should particularly set out how the proposal would be resilient to storms"*	This chapter provides an assessment of climate risk and resilience for the relevant elements of the Morgan Generation Assets. Consideration of onshore flood risk shall be addressed within the assessment of Morgan and Morecambe Offshore Wind Farms Transmission Assets DCO application which is progressing separately.

17.2.2 National energy and climate change policy

17.2.2.1 National climate change policy in relation to renewable energy infrastructure provides overarching guidance for the progression of the Morgan Generation Assets in meeting government targets. This is set out in Table 17.2 below.

Table 17.2: National energy and climate change policy

Policy	Summary
Climate Change Act 2008	• Commits the UK government to reducing greenhouse gas emissions by 100% of 1990 levels by 2050 and created a framework for setting a series of interim national carbon budgets and plans for national adaptation to climate risks.
Clean Growth Strategy 2017	• The 2017 Clean Growth Strategy for the UK (BEIS, 2017) contains a key objective of 'Delivering Clean, Smart, Flexible Power' and details specific policies through which this can be achieved: – Policy 33 of the report states the government's intention to phase out the use of unabated coal for electricity production by 2025 – Policy 35 sets government's intentions to improve the route to market for renewable technologies – Policy 36 details plans to target a total carbon price in the power sector which will give businesses greater clarity on the total price they will pay for each tonne of emissions.
Energy White Paper: Powering Our Net Zero Future 2020	• The Energy White Paper (BEIS, 2020) builds on the Ten Point Plan to set energy-related measures in a long-term strategic vision, working towards the net zero emissions target for 2050. It establishes a shift from fossil fuels to cleaner energy in terms of power, buildings and industry, whilst creating jobs and growing the economy.
National Infrastructure Strategy 2020	• The National Infrastructure Strategy (HM Treasury, 2020) focuses on the investment and delivery of infrastructure, which is fundamental to delivering net zero emissions by 2050. The strategy sets out the UK Government's plans to deliver on this target, decarbonising the economy and adapting to climate change: – Work towards meeting the net zero emissions target by 2050 – Decarbonise the UK's power, heat and transport networks, and take steps to adapt to climate change impacts. This will require increased investments in network infrastructure, storage and increased renewable and low carbon generation capacity. – It is anticipated that the bulk of the low-carbon generation needed by 2050 will be provided by low cost renewables. – Reducing emissions across whole sectors of the economy must be done in a sustainable way that minimises cost.
Net Zero Strategy: Build Back Greener, 2021	• This strategy (BEIS, 2021a) sets out the UK's long-term plans to meet net zero emissions by 2050 and gives the vision for a decarbonised economy in 2050.

Policy	Summary
British Energy Security Strategy, 2022	The offshore Wind process shall be supported by: • *"Reducing consent time from up to four years down to one year.* • *Strengthening the Renewable National Policy Statements to reflect the importance of energy security and net zero.* • *Introducing strategic compensation environmental measures, including for projects already in the system, to offset environmental effects and reduce delays to projects* • *Reviewing the way in which the Habitats Regulations Assessments are carried out for all projects making applications from late 2023 to maintain valued protection for wildlife, whilst reducing reams of paperwork.* • *Implementing a new Offshore Wind Environmental Improvement Package including an industry-funded Marine Recovery Fund and nature-based design standards to accelerate deployment whilst enhancing the marine environment.* • *Working with the Offshore Wind Acceleration Task Force; a group of industry experts brought together to work with Government, Ofgem and National Grid on further cutting the timeline.* • *Establishing a fast-track consenting route for priority cases where quality standards are met, by amending Planning Act 2008 so that the relevant Secretary of State can set shorter examination timescales (BEIS, 2022a)".*

17.3 Consultation

17.3.1.1 A summary of the key issues raised during consultation activities undertaken to date specific to climate change is presented in Table 17.3 below, together with how these issues have been considered in the production of this PEIR chapter.

Table 17.3: Summary of key consultation issues raised during consultation activities undertaken for the Morgan Generation assets relevant to climate change.

Date	Consultee and type of response	Issues raised	Response to issue raised and/or were considered in this chapter
June 2022	The Planning Inspectorate - Scoping Opinion	The Scoping Report states that the Proposed Development is proposed to incorporate engineering safety headroom into design for resilience, and evidence drawn from the Met Office (2018) states that peak wind speeds and wave heights are not likely to be increased by climate change during the Proposed Development's lifetime. Climate projections have been updated since 2018 and the Environment Agency have more up to date modelled projections that have not been considered in the Scoping Report. These indicate an increase in both wave height and wind speed. The ES should assess the vulnerability of the Proposed Development to climate change using the most up to date allowances and make effort to agree the approach with the Environment Agency. The ES should also describe and assess the adaptive capacity that has been incorporated into the design of the Proposed Development	The vulnerability of the Morgan Generation Assets to climate change will be assessed within this chapter of the PEIR and is supported by volume 4, annex 17.2: Climate Change Risk Assessment of the PEIR.
June 2022	The Planning Inspectorate - Scoping Opinion	The Scoping Report explains that inter-related effects will be assessed within each relevant aspect Chapter, assessing how climate change may affect the future baseline scenario. The Inspectorate is content with this approach. The ES should cross-reference other relevant Chapters where this is assessed in for clarity.	Addressed within relevant topic chapters within the PEIR.

17.4 Baseline environment

17.4.1 Methodology to inform baseline desktop study

17.4.1.1 Information on climate change within the climate change study area was collected through a detailed desktop review of existing studies and datasets. These are summarised at Table 17.4 below.

Table 17.4: Summary of key desktop reports.

Title	Source	Year	Author
Volume 2, chapter 7: Benthic subtidal and intertidal ecology of the PEIR	Morgan Offshore Wind Project PEIR	2022	bp/EnBW
Volume 3, chapter 20: Land use and recreation of the PEIR	Morgan Offshore Wind Project PEIR	2022	bp/EnBW
Valuation of Energy Use and Greenhouse Gas: Supplementary guidance to the HM Treasury Green Book	Department for Business, Energy and Industrial Strategy (BEIS)	2023	BEIS
UK Government GHG Conversion Factors for Company Reporting.	Department for Business, Energy and Industrial Strategy (BEIS) and Department for Environment, Food and Rural Affairs (Defra)	2022	BEIS and Defra
Wind LCA Harmonization	NREL	2013	NREL
Life Cycle Greenhouse Gas Emissions of Utility-Scale Wind Power	Dolan & Heath	2012	Dolan & Heath

17.4.1.2 No site-specific surveys have been undertaken to inform the EIA for climate change.

17.4.2 Baseline environment

17.4.2.1 To understand the impact of the Morgan Generation Assets on climate change, the baseline environment must be considered. The Morgan Generation Assets is located within the Irish Sea Region and, therefore, necessitates the consideration of the offshore climate baseline environment.

GHG emissions assessment baseline environment

17.4.2.2 To determine the greenhouse gas emissions assessment baseline environment, information has been sourced and cross referenced from volume 2, chapter 7: Benthic subtidal and intertidal ecology, of the PEIR.

17.4.2.3 The baseline consists of various subtidal habitats of stony reef, subtidal coarse, mixed sediments and diverse benthic communities. The baseline environment will be temporarily affected by the Morgan Generation Assets throughout the construction phase and through the operations and maintenance phase.

17.4.2.4 The Morgan Generation Assets will likely contribute to the abatement of the amount of fossil fuel generation within the UK Grid. As such, the current baseline with regard to UK Grid-average emission factor for electricity generation, without the Morgan Generation Assets, is 239.63 $kgCO_2e/MWh$ (including scope 3 but as-generated, excluding transmission and distribution losses) (BEIS and Defra, 2022).

Climate change risk assessment (CCRA) baseline environment

17.4.2.5 Baseline offshore climatic conditions have been sourced from observational data collated within the UK Offshore Energy Strategic Environmental Assessment (BEIS, 2022b) and Intergovernmental Panel on Climate Change's (IPCC) Sixth Assessment Reporting of the physical science (IPCC, 2021).

17.4.2.6 Mean air temperatures range from lows of 7°C in January to 14°C in July, with surface air temperatures exceeding sea surface temperatures during the spring and summer months and falling below sea surface temperatures during the autumn and winter months (BEIS, 2022b).

17.4.2.7 Precipitation generally falls for an average of 18 days per month during the winter, and 10-15 days per month during the summer. Rainfall intensity and duration varies greatly from day to day (BEIS, 2022b).

17.4.2.8 High wind speeds can be expected at the Morgan Array Area. Wind conditions are generally westerly and south-westerly throughout the year. During the winter, winds occasionally exceed 14 m/s (approximately 20%-25% of the time) in the Irish Sea to the east of the Isle of Man. During the summer, the chance of these higher wind speeds drops to 2% chance (BEIS, 2022b).

17.4.2.9 Mean sea level (MSL) is a crucial element of climate change-related risks for offshore wind farms – global MSL rose by 0.2m between 1901 and 2018, and continue to rise (IPCC, 2021). North Wales has been identified being at high risk of coastal flooding (Natural Resources Wales, 2022).

17.4.3 Future baseline scenario

17.4.3.1 The Infrastructure Planning (Environmental Impact Assessment) Regulations 2017 requires that "an outline of the likely evolution thereof without implementation of the development as far as natural changes from the baseline scenario can be assessed with reasonable effort on the basis of the availability of environmental information and scientific knowledge" is included within the Environmental Statement. In the event that Morgan Generation Assets do not come forward, an assessment of the future baseline conditions has been carried out and is described within this section.

GHG emissions assessment future baseline

17.4.3.2 The future baseline GHG emissions for existing land use (seabed) without the Morgan Generation Assets are expected to remain similar.

17.4.3.3 The future baseline for electricity generation that would be displaced by the Morgan Generation Assets depends broadly on future energy and climate policy in the UK, and more specifically (with regard to day-to-day emissions) on the demand for

operation of the Morgan Generation Assets compared to other generation sources available, influenced by commercial factors and National Grid's needs.

17.4.3.4 Several future baseline scenarios have therefore been considered, using BEIS projections of the carbon intensity of long-run marginal electricity generation during the Morgan Generation Asset's operating lifetime (BEIS, 2022a) and assumptions about specific generation sources that could be displaced. These are detailed in volume 4, annex 17.1: Technical Greenhouse Gas Assessment of the PEIR.

17.4.3.5 The carbon intensity of baseline UK Grid electricity generation is projected to reduce over time and so too would the intensity of the marginal generation source, displaced at a given time.

CCRA future baseline

17.4.3.6 It is expected that sea surface temperatures will continue to increase in the 21st Century, with global mean sea surface temperatures predicted to increase by approximately 2.9 °C by 2100 under representative concentration pathway (RCP) 8.5. It is anticipated that the north Atlantic will warm at a slower rate in comparison to other oceans (IPCC, 2021).

17.4.3.7 The average wave height is predicted to decrease around much of the UK at a factor of about 10% to 20% over the 21st Century, with average wave heights in the Irish Sea decreasing by approximately 0.1m (Jaroszweski et al. 2021). However, maximum wave heights in the Irish Sea are anticipated to increase, with projections showing a change in elevation of the height of maximum waves of up to 2m to the end of the century (Jaroszweski et al. 2021).

17.4.3.8 Further information has been presented within volume 4, annex 17.2: Climate risk of the PEIR.

17.4.4 Data limitations

17.4.4.1 There is uncertainty about future climate and energy policy and market responses, which affect the likely future carbon intensity of energy supplies, and thereby the future carbon intensity of the electricity generation being displaced by the Morgan Generation Assets. Government projections consistent with national carbon budget commitments have been used in the assessment.

17.4.4.2 The majority of the construction stage GHG emissions associated with the manufacturing of components are likely to occur outside the territorial boundary of the UK and hence outside the scope of the UK's national carbon budget, policy and governance. However, in recognition of the climate change effect of GHG emissions (wherever occurring), and the need to avoid 'carbon leakage' overseas when reducing UK emissions, emissions associated with the construction stage have been presented within the assessment and quantification of GHG emissions as part of the Morgan Generation Assets.

17.4.4.3 Additionally, due to the early stage in the development design, the specific wind turbine technology and design of associated infrastructure (including substations etc.) that would be used by the Morgan Generation Assets have not yet been confirmed. Thus, there is a degree of uncertainty regarding the construction stage GHG emissions resulting from the manufacturing and construction of wind turbines and infrastructure. We have sought to limit the impact this might have by utilising peer reviewed published data, representing a range with regards to emission intensity to present a conservative position concerning magnitude of GHG impact.

17.4.4.4 Principal sources relied upon for the quantification of GHG emissions for the Morgan Generation Assets date back to 2012 (Dolan & Heath, 2012 and RICS, 2012). It is acknowledged that the design and equipment available in the present day compared with pre-2012 is significantly different. Nevertheless, the pre-2012 benchmarks represent a conservative (worst case) assumption concerning GHG emissions for the purposes of the assessment.

17.4.4.5 Furthermore, the specific materials and operations and maintenance vehicles/vessels that would be used by the Morgan Generation Assets have not yet been specified. Thus, there is a degree of uncertainty regarding the construction and operations and maintenance-stage GHG emissions of the Morgan Generation Assets.

17.4.4.6 When assessing climate risks, uncertainty arises from both modelling uncertainty and natural variability in the potential magnitude of future changes in climate. Therefore, a high magnitude of change scenario and the high end of probabilistic projections have been used, to provide a precautionary worst case approach. This is further discussed in volume 4, annex 17.2: Climate risk of the PEIR.

17.4.4.7 The above uncertainties are integral to the assessment of climate change effects but a precautionary approach has been taken as far as practicable to provide a reasonable worst case assessment. On the basis of the above, it is considered that limitations to the assessment have been minimised and that the results provide a robust estimate of the effects of the Morgan Generation Assets.

17.4.4.8 The Morgan Generation Assets are dependent on the transmission assets and grid connection in order to realise the potential avoided emissions associated with the wind turbine generation assets. The transmission assets for the Morgan Offshore Wind Project are being taken forward separately as part of the Morgan and Morecambe Offshore Wind Farm Transmission Assets DCO. As such, a cumulative assessment is required to understand the construction emissions for both applications (Generation and transmission assets) in order to establish the whole Morgan Generation Assets net emissions.

17.5 Impact assessment methodology

17.5.1 Overview

17.5.1.1 The climate change impact assessment has followed the methodology set out in volume 1, chapter 5: EIA methodology of the PEIR. Specific to the climate change impact assessment, the following guidance documents have also been considered:

- IEMA Guidance on Climate Change Adaption and Resilience (IEMA, 2020)
- IEMA guidance on 'Assessing Greenhouse Gas Emissions and Evaluating their Significance' (IEMA, 2022).

17.5.1.2 In addition, the climate change impact assessment has considered the legislative framework as defined by:

- National climate change policies (see section 17.2).
- International climate change legislation.

17.5.1.3 In order to undertake a climate change impact assessment, information gathered in volume 4, annex 17.1: Technical Greenhouse Gas Assessment and volume 4, annex 17.2: Climate change risk assessment of the PEIR, has been utilised. This information is sourced from primary calculations and secondary sources to calculate the effect of the Morgan Generation Assets on and from climate change.

GHG emissions assessment methodology

17.5.1.4 GHG emissions have been estimated by applying published emissions factors to activities in the baseline and to those required for the Morgan Generation Assets. The emissions factors relate to a given level of activity, or amount of fuel, energy or materials used, to the mass of GHGs released as a consequence. The GHGs considered in this assessment are those in the 'Kyoto basket' of global warming gases expressed as their CO_2e global warming potential (GWP). This is denoted by CO_2e units in emissions factors and calculation results. GWPs used are typically the 100-year factors in the IPCC Fifth Assessment Report (IPCC, 2013) or as otherwise defined for national reporting under the United Nations Framework Convention on Climate Change (UNFCCC).

17.5.1.5 Additional guidance used for the quantification of GHG emissions includes:

- Valuation of Energy Use and Greenhouse Gas: Supplementary guidance to the HM Treasury Green Book (BEIS, 2023).
- UK Government GHG Conversion Factors for Company Reporting (BEIS and Department for Environment, Food and Rural Affairs (Defra), 2022).
- the Greenhouse Gas Protocol suite of documents (World Resources Institute (WRI) and World Business Council for Sustainable Development (WBCSD), 2004).

17.5.1.6 GHG emissions caused by an activity are often categorised into 'scope 1', 'scope 2' or 'scope 3' emissions, following the guidance of the WRI and the WBCSD Greenhouse Gas Protocol suite of guidance documents (WRI and WBSCD, 2004):

- Scope 1 emissions: direct GHG emissions from sources owned or controlled by the company, (e.g. from combustion of fuel at an installation)
- Scope 2 emissions: caused indirectly by consumption of purchased energy, (e.g. from generating electricity supplied through the UK Grid to an installation)
- Scope 3 emissions: all other indirect emissions occurring as a consequence of the activities of the company (e.g. in the upstream extraction, processing and transport of materials consumed or the use of sold products or services).

17.5.1.7 This assessment has sought to include emissions from all three scopes, where this is material and reasonably possible from the information and emissions factors available, to capture the impacts attributable most completely to the Morgan Generation Assets. These emissions shall not be separated out by defined scopes (scopes 1, 2 or 3) in the assessment.

17.5.1.8 Emissions resulting from the manufacturing and construction of the Wind Turbine Generators, site infrastructure (including cabling substations etc.) have been calculated via published benchmark carbon intensities and published life-cycle assessment (LCA) literature regarding wind turbine technology.

17.5.1.9 The assessment has considered:

1. The GHG emissions arising from the Morgan Generation Assets
2. Any GHG emissions that it displaces or avoids, compared to the current or future baseline
3. The net impact on climate change due to these changes in GHG emissions overall.

17.5.1.10 As previously discussed in paragraph 17.4.4.2, the majority of the construction-stage GHG emissions associated with the manufacturing of components are likely to occur outside the territorial boundary of the UK and hence outside the scope of the UK's national carbon budget. However, in recognition of the climate change effect of GHG emissions (wherever occurring) and the need, as identified in national policy, to avoid 'carbon leakage' overseas when reducing UK emissions, the full life-cycle GHG emissions of the Morgan Generation Assets, including construction-stage emissions, have been evaluated where possible when determining the significance of effects.

CCRA methodology

17.5.1.11 Baseline offshore climatic conditions have been sourced from observational data collated within the UK Offshore Energy Strategic Environmental Assessment (BEIS, 2022b) and IPCC Sixth Assessment Reporting of the physical science (IPCC, 2021).

17.5.1.12 Further detail of the approach and data input is given in volume 4, annex 17.2: Climate change risk assessment of the PEIR.

17.5.1.13 A high level screening risk assessment has been undertaken, considering the hazard, potential severity of impact on the Morgan Generation Assets and its users, probability of that impact, and level of influence the Morgan Generation Assets design can have on the risk.

17.5.1.14 Where potentially significant risks have been identified at the screening stage prior to any mitigation, further assessment has been undertaken with consideration of appropriate mitigation to determine whether significant residual risks are likely.

17.6 Impact assessment criteria

17.6.1.1 The criteria for determining the significance of effects have been divided into two categories:

- Assessment of the significance of the effect of the Morgan Generation Assets on climate change (GHG emissions)
- Assessment of the significance of the effect from climatic changes on the Morgan Generation Assets.

17.6.2 Impact assessment criteria: GHG emissions

17.6.2.1 Determining the overall significance of the effect of the Morgan Generation Assets on GHG emissions is a three-stage process that involves defining:

- Magnitude of the impact

  In accordance with the IEMA Guidance (2022) GHG emissions can be quantified directly and expressed based on their GWP as tonnes of CO_2e emitted, the

magnitude of impact is reported numerically. Where a quantifiable figure is not possible this is expressed qualitatively.

- Sensitivity of receptor

  GHG emissions have a global effect rather than directly affecting any specific local receptor to which a level of sensitivity can be assigned. The global atmospheric mass of the relevant GHGs and consequent warming potential, expressed in CO_2e, has therefore been treated as a single receptor of high sensitivity (given the importance of the global climate as a receptor).

- Significance of effect

  Assessment guidance for GHG emissions (IEMA, 2022) describes five levels of significance for emissions resulting from a development, each based on whether the GHG emission impact of the development will support or undermine a science-based 1.5°C compatible trajectory towards net zero. To aid in considering whether effects are significant, the guidance recommends that GHG emissions should be contextualised against pre-determined carbon budgets, or applicable existing and emerging policy and performance standards where a budget is not available. It is a matter of professional judgement to integrate these sources of evidence and evaluate them in the context of significance

  Taking the guidance into account, the following have been considered in contextualising the Morgan Generation Assets GHG emissions:

  - The magnitude of net GHG emissions as a percentage of national and local carbon budgets (where feasible).
  - Whether the Morgan Generation Assets contributes to, and is in line with, the UK's policy for GHG emissions reductions, where these are consistent with science-based commitments to limit global climate change to an internationally-agreed level (as determined by the UK's nationally determined contribution (NDC) to the Paris Agreement (BEIS, 2022c)).
  - Effects from GHG emissions are described in this chapter as adverse, negligible or beneficial based on the following definitions, which closely follow the examples in Box 3 of the IEMA guidance (IEMA, 2022) as detailed in Table 17.5.

Table 17.5: IEMA (2022) Guidance definitions of significance

Significance	Definition
Major adverse	The Morgan Generation Assets 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.
Moderate adverse	The Morgan Generation Assets 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.
Minor adverse	The Morgan Generation Assets GHG impacts would be fully consistent with applicable existing and emerging policy requirements and good practice design standards for projects of this type.
Negligible	The Morgan Generation Assets 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.
Beneficial	The Morgan Generation Assets 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.

17.6.2.2 Major and moderate adverse effects and beneficial effects are considered to be significant in EIA terms. Minor adverse and negligible effects are not considered to be significant in EIA terms.

17.6.2.3 GHG emissions associated with a proposed project are often reported as a whole life figure (net emissions) that takes account of all Morgan Generation Assets stages. The net whole life figure is the key element for determining Morgan Generation Assets whole life impact on climate change. However, it is noted in the IEMA guidance (2022) that due to the nature of GHG emissions, it is good practice to include a section that reports on the whole life GHG emissions associated with the Morgan Generation Assets alongside the sections that assess construction, operation and decommissioning effects in isolation.

17.6.3 Impact assessment criteria: climate change risk

17.6.3.1 IEMA guidance (IEMA, 2020) defines climate change resilience as the 'ability to respond to changes in climate. If a receptor or project has good climate change resilience, it is able to respond to the changes in climate in a way that ensures it retains much of its original function and form. A receptor or project that has poor climate change resilience will lose much of its original function or form as the climate changes'.

17.6.3.2 The climate change risk assessment differs from many other EIA topics in that it considers how the resilience of a development is affected by an external factor (climate change) and not specifically how potential environmental receptors are affected by a development's impacts. Consequentially, the climate change risk assessment cannot easily be assigned significance with respect to the severity of impacts in the same way as for the other topics. Instead, a risk-analysis based approach has been used for the assessment.

17.6.3.3 As is detailed in Climate Change Risk Assessment Technical Report (volume 4, annex 17.2: Climate change risk assessment of the PEIR) a risk assessment has been undertaken, considering the hazard, potential severity of impact on the Morgan Generation Assets and its users (including their sensitivity and vulnerability), probability of that impact, and level of influence the Morgan Generation Assets design can have on the risk. A risk score of five or more (the minimum score where more than one element of the risk assessment score is above 'one') has been defined as a risk

that could lead to a significant adverse or beneficial effect. By considering measures adopted into the Morgan Generation Assets, professional judgement is used in determining whether impacts are likely to result in significant adverse or beneficial effects, or non-significant negligible effects in EIA terms.

17.6.3.4 The criteria for defining severity, probability and influence factor in this chapter are outlined in Table 17.6 below.

Table 17.6: Severity, probability and influence factor definitions.

Factor	Score definitions
Severity: the magnitude and likely consequences of the impact should it occur.	**1 =** unknown or low impact: for example, low-cost and easily repaired property damage; small changes in occupiers' behaviour.
	2 = moderate impacts with greater disruption and/or costs
	3 = severe impact, (e.g. risk to individual life or public health, widespread property damage or disruption to business)
Probability: reflects both the range of possibility of climatic parameter changes illustrated in CP18 projections and the probability that the possible changes would cause the impact being considered.	**1 =** unknown or low probability of impact; impact would occur only at the extremes of possible change illustrated in projections
	2 = moderate probability of impact, plausible in the central range of possible change illustrated in projections
	3 = high probability of impact, likely even with the smaller changes illustrated as possible in the projections
Influence: the degree to which design of the proposed development can affect the severity or probability of impacts.	**1 =** no or minimal potential to influence, outside control of developer, (e.g. reliance on national measures or individuals' attitudes/actions; or hypothetical measures would be impracticable)
	2 = moderate potential to influence, (e.g. a mixture of design and user behaviour or local and national factors; measures may have higher costs or practicability challenges)
	3 = strong potential to influence through measures that are within the control of the developer and straightforward to implement

17.7 Key parameters for assessment

17.7.1 Maximum design scenario

17.7.1.1 The maximum design scenarios (MDSs) identified in Table 17.7 have been selected as those having the potential to result in the greatest effect on an identified receptor or receptor group. These scenarios have been selected from the Morgan Generation Assets Design Envelope provided in volume 1, chapter 3: Project description of the PEIR. Effects of greater adverse significance are not predicted to arise should any other development scenario, based on details within the Morgan Generation Assets Design Envelope (e.g. different infrastructure layout), to that assessed here be taken forward in the final design scheme.

17.7.1.2 This assessment will be used to inform stakeholders of the costs and benefits of the Morgan Generation Assets in relation to climate change risk and GHG emissions respectively.

Table 17.7: GHG: MDS considered for the assessment of potential impacts on climate change.

[a] C=construction, O=operations and maintenance, D=decommissioning

Potential impact	Phase[a]			MDS	Justification
	C	O	D		
The impact of GHG emissions arising from the consumption of materials and activities required to facilitate the operation and maintenance	×	✓	×	**Operations and maintenance phase** • The greatest number of maintenance vehicles and machinery across the lifetime of the Morgan Generation Assets • The greatest volume of consumables and frequency of replacement.	The greatest number of wind turbines, foundations and maximum inter-array and inter-connector cable lengths represent the greatest potential for GHG emissions from the consumption of materials and activities required to facilitate operation and maintenance.
The impact of GHG emissions arisings from land-use change during the construction, operation and maintenance decommissioning phases	✓	✓	✓	**Construction, operation and maintenance and decommissioning phases** • The total array area is 322.2km^2 • The maximum length of the inter-array cables is 500km • The maximum extent of the inter-connector cables is 60km • There are four Offshore Substation Platforms (OSPs) of 375MW capacity; the substations are 70m high, 80m long 60m wide (excluding towers, helipads, masts and cranes). There are foundations for four substations that will be constructed using piling or drilling methods.	The greatest number and size of the generation structures will result in the greatest consumption of fuel and materials representing the greatest potential for GHG emissions.
The impact of GHG emissions arising from the manufacturing and installation of the generation assets.	✓	×	×	**Construction phase** • There are up to 107 wind turbines, with a blade tip of 324m and a tower diameter of 5.5 to 8m. There are foundations for 107 wind turbines that will be constructed using piling or drilling methods • There are four offshore substation platforms of 375MW capacity; the substations are 70m high, 80m long 60m wide (excluding towers, helipads, masts and cranes). There are foundations for four substations that will be constructed using piling or drilling methods • The maximum length of the inter-array cables is 500km • The maximum length of the inter-connector cables is 60km.	The greatest number of wind turbines, offshore substation platforms and foundations and greatest length of the inter-array and inter-connector cables represent the greatest potential for GHG emissions from the construction and installation of the generation assets.
The impact of GHG emissions from decommissioning works (plant, fuel and vessel use) and recovery or disposal of materials	×	×	✓	**Decommissioning phase** • There are up to107 wind turbines, with a blade tip of 324m and a tower diameter of 5.5 to 8m. There are foundations for 107 wind turbines that will be constructed using piling or drilling methods • There are four offshore substation platforms of 375MW capacity; the substations are 70m high, 80m long and 60m wide. There are foundations for four substations that will be constructed using piling or drilling methods • The maximum length of the inter-array cables is 500km • The maximum length of the inter-connector cables is 60km • Greatest number of maintenance vehicles and machinery across the decommissioning period.	The greatest number and size of structures and maximum length of the inter-array and inter-connector cables will result in the greatest consumption of fuel and materials representing the greatest potential for GHG emissions from the decommissioning works.
The impact of estimated abatement of UK Grid emissions during the operation and maintenance phase.	×	✓	×	**Operations and maintenance phase** The potential generating capacity of the Morgan Generation Assets is 1.5GW.	The greatest generating capacity represents the greatest abatement of fossil fuels from the UK Grid.

Table 17.8: Climate change risk: MDS considered for the assessment of potential impacts on climate change.

Potential impact	Phase			MDS	Justification
	C	O	D		
Impact of the effects of climate change on the Morgan Generation Assets	×	✓	×	**Operation and maintenance phase** • Consistently heightened temperatures, changes to rainfall patterns, increased wind speeds and increased frequency of extreme events such as floods and storms could lead to efficiency losses due to overheating, the failure of electrical equipment or damage to infrastructure which would result in an increase in operation and maintenance activities.	The worst case scenario of the effects of climate change on the offshore infrastructure.

17.7.2 Impacts scoped out of the assessment

17.7.2.1 On the basis of the baseline environment and the description of development outlined in volume 1, chapter 5: Project description of the PEIR, a number of impacts are proposed to be scoped out of the assessment for climate change. These impacts are outlined, together with a justification for scoping them out, in Table 17.9 below.

Table 17.9: Impacts scoped out of the assessment for climate change.

Potential impact	Justification
The impact of GHG emissions arising from the consumption of materials and activities required to facilitate the operation and maintenance of the Morgan Generation Assets during the construction and decommissioning phases.	Only applicable to the operation and maintenance phase of the Morgan Generation Assets.
The impact of estimated abatement of UK Grid emissions during the construction and decommissioning phases.	Only applicable to the operation and maintenance phase of the Morgan Generation Assets. No abatement of fossil fuels will be possible throughout the decommissioning or construction phases.
The impact of the effects of climate change on the Morgan Generation Assets through construction and decommissioning	Due to the length of the programme for construction and decommissioning phases, variations in climatic parameters would be minimal compared to the present day baseline. Construction work practices are adapted to existing climate conditions and weather in the UK. It is assumed that construction work practices would likely evolve with time with climatic variations. Such impacts are assessed within the operations and maintenance stage only.

17.8 Measures adopted as part of the Morgan Generation Assets

17.8.1.1 For the purposes of the EIA process, the term 'measures adopted as part of the project' is used to include the following measures (adapted from IEMA, 2016):

- Measures included as part of the project design. These include modifications to the location or design of the Morgan Generation Assets which are integrated into the application for consent. These measures are secured through the consent itself through the description of the development and the parameters secured in the DCO and/or marine licences (referred to as primary mitigation in IEMA, 2016).

17.8.1.2 A number of measures (primarily in relation to climate change) have been adopted as part of the Morgan Generation Assets to reduce the potential for impacts on climate change. These are outlined in Table 17.10 below.

17.8.1.3 As there is a commitment to implementing these measures, they are considered inherently part of the design of the Morgan Generation Assets and have therefore been considered in the assessment presented in section 17.9 below (i.e. the determination of magnitude and therefore significance assumes implementation of these measures).

Table 17.10: Measures adopted as part of the Morgan Generation Assets.

Measures adopted as part of the Morgan Generation Assets	Justification	How the measure will be secured
Primary measures: Measures included as part of the Morgan Generation Assets design		
Safety margin within the turbine design to be fitted with automatic shutdowns/lockdowns with regards to spinning too fast	Overheating and higher winds/extreme weather pose a risk of increased degradation and need for replacement. In addition to inhibition and potential export capacity.	Committed to through the Morgan Generation Assets design (see volume 1, chapter 5: Project Description of the PEIR).
Application of anti-corrosion protective coatings and integrated scour protection to offshore equipment.	The potential increased temperatures and ocean acidification may lead to accelerated corrosion of submerged structures, including export cables and as such appropriate measures are required to reduce the potential effect.	Committed to through the Morgan Generation Assets design (see volume 1, chapter 5: Project Description of the PEIR).
The substation will house auxiliary equipment e.g. appropriate cooling plant for an in building substation solution to account for a range of temperature conditions.	Consistently heightened temperatures could lead to efficiency losses due to overheating, or the failure of electrical equipment.	Committed to through the Morgan Generation Assets design (see volume 1, chapter 5: Project Description of the PEIR).

17.8.1.4 Where significant effects have been identified, further mitigation measures (referred to as secondary mitigation in IEMA (2016)) have been identified to reduce the significance of effect to acceptable levels following the initial assessment. These are measures that could further prevent, reduce and, where possible, offset any adverse effects on the environment. These measures are set out, where relevant, in the assessment sections below.

17.9 Assessment of significant effects

17.9.1.1 The impacts of the construction, operation and maintenance, and decommissioning phases of the Morgan Generation Assets on and from climate change have been assessed. The potential impacts arising from the construction, operation and maintenance and decommissioning phases of the Morgan Generation Assets are listed in Table 17.7, along with the MDS against which each impact has been assessed.

17.9.1.2 The assessment of significant effects relating to climate change is divided into the effects of GHG emissions on climate change and the effects of climate change risk.

17.10 Assessment of significant effects: GHG emissions

17.10.1.1 The impacts of the construction, operation and maintenance and decommissioning phases of the Morgan Generation Assets on GHG emissions have been assessed below in line with the GHG emissions impact assessment criteria:

- Magnitude of the impact
- Sensitivity of receptor
- Significance of effect.

17.10.1.2 The operation and maintenance of the Morgan Generation Assets would lead to consumption of fuel and replacement of materials throughout the operational lifetime of the Morgan Generation Assets. This would result in the greatest potential for GHG emissions. In volume 4, annex 17.1: Technical Greenhouse Gas Assessment of the PEIR, the life cycle assessment embodied carbon is divided into:

- Materials and construction (A1-A5)
- Operations and maintenance (B1-B5)
- Decommissioning (C1-C4).

17.10.2 The impact of GHG emissions arisings from land-use (seabed) change during the construction, operation and maintenance decommissioning phases of the Morgan Generation Assets

Construction, Operations and Maintenance and Decommissioning

Magnitude of impact

17.10.2.1 The impact is predicted to be of regional spatial extent, long term duration, intermittent and medium reversibility. It is predicted that the impact will affect the receptor indirectly. The habitat along the Morgan Generation Assets red line boundary would be impacted for the duration of the construction (excavation, cable route and construction compounds) and in some cases operations and maintenance phases primarily through the land take for turbines, and substations. However, through the decommissioning process it is anticipated that the existing baseline environment, which was not a carbon store, would be restored. As such, the quantify of change in a tCO_2e owing to land use and sea bed change across the Morgan Generation Assets' whole life is considered to be **negligible.**

Sensitivity of receptor

17.10.2.2 The receptor is deemed to be of high vulnerability, low recoverability and high value. The sensitivity of the receptor is therefore, considered to be **high**.

Significance of effect

17.10.2.3 Overall, the magnitude of the impact is deemed to be negligible and the sensitivity of the receptor is considered to be high. The effect will, therefore, be of **negligible** effect, which is not significant in EIA terms.

17.10.3 The impact of GHG emissions arising from the manufacturing and installation of the Morgan Generation Assets and consumption of materials

17.10.3.1 Consideration has been given to the embodied carbon emissions associated with materials for offshore elements (WTG, offshore substations, inter-array and inter-connector cabling) This impact entails an assessment of the greatest number of wind turbines and foundations representing the greatest potential for GHG emissions from the construction and installation of generation assets as a conservative estimate of impact. Up to four offshore substation platforms (OSPs), maximum length of inter-array cables and inter-connector cables will result in the greatest consumption of fuel and materials representing the greatest potential for GHG emissions from the construction and installation phase.

Construction

17.10.3.2 As detailed in paragraph 17.10.1.2 and volume 4, annex 17.1: Technical greenhouse gas assessment of the PEIR, the life cycle assessment embodied carbon is divided into three stages. The GHG emissions arising from the consumption of materials and activities required to construct the Morgan Generation Assets are presented in Table 17.11 below.

Table 17.11: Construction stage wind turbine GHG emissions.

LCA Stage	Intensity ($kgCO_2e/MWh$)	35 year output (MWh)	Morgan Generation Assets emissions (tCO_2e)
A1-A5	9.46	122,221,092	1,156,212

17.10.3.3 The potential impact of the proposed offshore substations has been estimated using an intensity for the manufacturing GWP of 2,190 $kgCO_2e$ per MW (ABB, 2003). This was scaled by the Morgan Generation Assets output capacity of 1,500 MW to give an estimated embodied emission value of 3,285 tCO_2e.

17.10.3.4 At this stage of design, materials estimates have some uncertainty in terms of the amounts and in how they are grouped in main categories. It is not possible to specify all products to be used in the final, detailed design, at this early stage in the design process. As a means of comparison, a published benchmark (RICS, 2012) has therefore also been used to estimate possible emissions from the substation buildings.

17.10.3.5 The benchmark data is expressed in kg CO_2e/m^2 of floorspace as an intensity which is applied against the total floor area for all four substations (19,200 m^2). When using the RICS intensity for other Industrial/utilities/specialist uses with the substation floor area we result in an estimated embodied carbon emission of **10,464 tCO_2e**.

Magnitude of impact

17.10.3.6 The impact is predicted to be of international spatial extent, short term duration, intermittent and low reversibility. It is predicted that the impact will affect the receptor indirectly. The magnitude is therefore, considered to be 1,169,961 tCO_2e for the construction period.

Sensitivity of receptor

17.10.3.7 In accordance with 17.6.2.1, the receptor is deemed to be of high vulnerability, low recoverability and high value. The sensitivity of the receptor is therefore, considered to be **high**.

Significance of effect

17.10.3.8 Overall, the magnitude of the impact is deemed to be 1,169,961 tCO_2e and the sensitivity of the receptor is considered to be high. The effect will, therefore, be of **moderate adverse** effect, which is significant in EIA terms.

Further mitigation

17.10.3.9 A moderate adverse effect is predicted for GHG emissions produced as a result of construction activity associated with the Morgan Generation Assets. This is significant in EIA terms. In order to mitigate this effect the Morgan Generation Assets is committed to exploring options to reduce construction related emissions. Areas to be explored by the Morgan Generation Assets could include:

- Optimization of construction activity to reduce emissions (e.g. potentially related to vessel scheduling, co-ordination of shipping/delivery of materials and the identification energy efficiency mechanisms)
- Identification of opportunities to reduce emissions in the supply chain
- Inclusion of low carbon criteria within procurement activities.

17.10.3.10 Any further risk controls will be explored through engagement with the relevant stakeholders, where necessary, to ensure they are appropriate for reducing risks to as low as reasonably practicable (ALARP).

17.10.3.11 With these commitments to look at opportunities to reduce construction related emissions, the impact magnitude is predicted to reduce to minor and the residual effect will be of minor adverse effect, which is not significant in EIA terms

17.10.4 The impact of GHG emissions from decommissioning works (plant, fuel and vessel use) and recovery or disposal of materials

17.10.4.1 The number and size of structures and maximum length of the inter-array and interconnector cables will result in the greatest consumption of fuel and materials, representing the greatest potential for GHG emissions from the decommissioning works.

17.10.4.2 The GHG emissions arising from the consumption of materials and activities required to facilitate the decommissioning of the Morgan Generation Assets are presented in Table 17.12 below. Further detailed consideration can be found in volume 4, annex 17.1: Technical greenhouse gas assessment of the PEIR.

Table 17.12: Decommissioning stage GHG emissions.

LCA Stage	Intensity ($kgCO_2e$/MWh)	35 year output (MWh)	Morgan Generation Assets Emissions (tCO_2e)
C1-C4	0.55	122,221,092	67,222

17.10.4.3 The majority of decommissioning emissions relate to the use of plant for Morgan Generation Assets decommissioning, disassembly, transportation to a waste site, and ultimate disposal and/or recycling of the equipment and other site materials. The components of the wind turbines are considered to be highly recyclable. When disposing of wind turbines, recycling is the preferred solution. This not only prevents the materials from being sent to landfills, but also reduces the need for the extraction of primary materials. Material which cannot be recycled might be used for incineration or energy from waste. Additionally, the carbon emissions associated with use of plant and fuel is expected to have achieved good levels of decarbonisation at the decommissioning phase of the Morgan Generation Assets. As such, the above quantified emissions is anticipated to be a conservative, worst case estimate.

Decommissioning

Magnitude of impact

17.10.4.1 The impact is predicted to be of international spatial extent, medium term duration, intermittent and low reversibility. It is predicted that the impact will affect the receptor indirectly. The magnitude is therefore, considered to be **67,222 tCO_2e.**

Sensitivity of receptor

17.10.4.2 In accordance with 17.6.2.1, the receptor is deemed to be of high vulnerability, low recoverability and high value. The sensitivity of the receptor is therefore, considered to be **high**.

Significance of effect

17.10.4.3 Overall, the magnitude of the impact is deemed to be 67,222 tCO_2e, and the sensitivity of the receptor is considered to be high. The effect will, therefore, be of **minor adverse** effect, which is not significant in EIA terms.

17.10.5 The impact of GHG emissions arising from the consumption of materials and activities required to facilitate the operation and maintenance of the Morgan Generation Assets and impact of estimated abatement of UK Grid emissions

17.10.5.1 The greatest generating capacity represents the greatest abatement of fossil fuels from the UK Grid. The primary purpose of the operational stage of a wind farm is to generate electricity which avoids the need for fossil fuel generated electricity and reduces the UK Grid carbon intensity. The avoided emissions associated with the displacement of projected marginal generation of the UK Grid should be considered in combination with the impact of GHG emissions arising from the consumption of materials and activities required to facilitate the operations and maintenance of the Morgan Generation Assets.

17.10.5.2 The GHG emissions arising from the consumption of materials and activities required to facilitate the operation and maintenance of the Morgan Generation Assets are presented in Table 17.13 below.

Table 17.13: Operations and maintenance stage GHG emissions.

LCA Stage	Intensity ($kgCO_2e/MWh$)	35 year output (MWh)	Morgan Generation Assets emissions (tCO_2e)
Ongoing (B1-B5)	0.99	122,221,092	120,999

17.10.5.3 It should be noted that when considering the Morgan Generation Assets impact on climate change, the emissions as a result of operations and maintenance activities must be considered alongside the displacement marginal alternative sources of electricity generation. This element is further considered in the assessment sections below.

Table 17.14: Energy flows from Morgan Generation Assets

Parameter	Value	Unit	Source
Input parameter - rated power	1,500	MW	Project Description
Input parameter – capacity factor	34.5*	%	BEIS (2022d)
Input parameter – degradation factor	1.6	%	Staffell & Green (2014)
Input parameter – total annual operating hours	8,760	hrs	Morgan Generation Assets PDE
Output parameter - annual energy output (year one)	4,533,300	MWh	Morgan Generation Assets PDE

* It should be noted that the BEIS Allocation Framework for Rounds 3 (BEIS, 2019) and 4 (BEIS 2021b) states that all new offshore wind projects shall achieve a load factor of 58.4% and 63.1% respectively. Use of higher load factors would result in higher output and subsequent avoided emissions. As such, a lower capacity factor (based on average actual offshore wind load factors between 2004 & 2021 as opposed to forward looking projected factors) represents a conservative assumption for this assessment. Further detail can be found in Volume 4, annex 17.1: Technical Greenhouse gas assessment technical report of the PEIR.

17.10.5.4 The input and output figures for the operational stage of the Morgan Generation Assets (Table 17.14) have been calculated against the assumptions stated within the BEIS long-run marginal emissions factor. This allows for a direct presentation of the cumulative GHG emissions avoided throughout the operational lifetime of the Morgan Generation Assets and therefore, how the Morgan Generation Assets contribute towards reaching the UK's net zero targets.

17.10.5.5 The resulting estimated avoided emissions associated with the operation of the Morgan Generation Assets would be 2,377,416 tCO_2e avoided emissions associated with the abatement of the UK Grid emissions factor.

Sensitivity analysis

17.10.5.6 The long run marginal carbon intensity figures, which have been used in the assessment are dynamic and show year-on-year decarbonisation of UK electricity Grid towards the UK's committed net zero 2050 pledge. The long run marginal carbon intensity figures account for variations over time for both generation and consumption activity reflecting the different types of power plants generating electricity across the day and over time, each with different emissions factors. However, the long run marginal figures are projections and cannot be taken with absolute certainty. Furthermore, the long-run marginal includes assumed abatement of fossil fuel generation sources within the UK electricity Grid. As such it is likely that the true value of the avoided emissions displaced as a result of the Morgan Generation Assets' contribution to the UK electricity Grid would be higher than that of avoided emissions detailed above in paragraph 17.10.5.5.

17.10.5.7 Although the use of the current UK electricity Grid average and BEIS 'non-renewable fuels' carbon intensities would conclude greater avoided emissions (Table 17.15) and an ultimate reduction in carbon payback period, these are static baselines and do not account for future UK electricity Grid decarbonisation. As such, the long run marginal provides a conservative quantification of avoided emissions for the purpose of this assessment.

Table 17.15: Whole life avoided emissions sensitivity test

Operating years	Output (MWh)	BEIS long-run marginal avoided emissions (tCO_2e)	Current UK Grid average avoided emissions (tCO_2e)	BEIS 'non-renewable fuels' avoided emissions (tCO_2e)
35	122,221,092	2,377,416	29,287,840	52,799,512

Operations and Maintenance

Magnitude of impact

17.10.5.8 The impact is predicted to be of international spatial extent, long term duration, continuous and low reversibility. It is predicted that the impact will affect the receptor directly. The magnitude is therefore, considered to be GHG emissions reductions from displacement of projected typical marginal generation sources at approximately **2,256,417 tCO_2e** avoided emissions.

Sensitivity of receptor

17.10.5.9 In accordance with section 17.6.2.1, the receptor is deemed to be of high vulnerability, low recoverability and high value. The sensitivity of the receptor is therefore, considered to be **high**.

Significance of effect

17.10.5.10 Overall, the magnitude of the impact is deemed to be 2,256,417 tCO_2e, and the sensitivity of the receptor is considered to be high. The effect will, therefore, be of **beneficial effect**, which is significant in EIA terms.

17.11 Assessment of significant effects: climate change risk

17.11.1.1 The risks identified in volume 4, annex 17.2: Climate change risk assessment of the PEIR, are summarised in this section in relating to their impact upon the construction, operations and maintenance and decommissioning phases of the Morgan Generation Assets, in accordance with the following assessment criteria:

- Severity of the impacts
- Probability of the potential impacts

- Influence factor.

17.11.2 The impact of the effects of climate change on the Morgan Generation Assets through the operations and maintenance phase

17.11.2.1 This issue summarises the worst-case scenarios identified in volume 4, annex 17.2: Climate change risk assessment of the PEIR and the effects of climate change on the offshore infrastructure.

Operations and Maintenance

17.11.2.2 Consistently heightened temperatures, changes to rainfall patterns, increased wind speeds and increased frequency of extreme events such as floods and storms could lead to efficiency losses due to overheating, the failure of electrical equipment or damage to infrastructure which would result in an increase in operation and maintenance activities.

17.11.2.3 The impact is predicted to be of national spatial extent, long term duration, continuous and low reversibility. It is predicted that the impact will affect the receptor indirectly. Volume 4, annex 17.2: Climate change risk assessment of the PEIR summarises the potential climatic changes in the coming decades and considers the potential consequences for the Morgan Generation Assets in a risk assessment format.

17.11.2.4 The risk assessment in volume 4: annex 17.2: Climate change risk assessment of the PEIR considers in its scoring the level of influence the design, construction and operation of the Morgan Generation Assets can have upon the risks, in addition to its severity and probability. Those risks over which the developer has little or no influence are therefore, typically not considered significant effects of the Morgan Generation Assets, save where the severity and/or probability are highest.

17.11.2.5 The greatest risks to the Morgan Generation Assets due to climate change have been identified as those arising from high temperatures affecting operational equipment and storms affecting power transmission, wind turbines and offshore substation platform damage. Three of the identified risk issues were screened with a score of five or more (the minimum score where more than one element of the risk assessment score is above 'low') before mitigation.

17.11.2.6 As the three potentially significant effects will be mitigated through the incorporation of good practice design measures, the effect on the Morgan Generation Assets has been determined to be **negligible**. Good practice design measures include the following:

- Consideration of external location of offshore substation platforms and use of appropriate cooling plant designed to account for a range of temperature conditions for in building design.
- Safety margin within the turbine design to be fitted with automatic shutdowns/lockdowns with regards to spinning too fast.
- Application of anti-corrosion protective coatings and more frequent inspection routine as increased sea surface temperatures are observed.

17.12 GHG Emissions – net effects

17.12.1.1 As detailed in section 17.6.2.3, consideration of the Morgan Generation Assets' whole life impact is an important consideration when assessing the Morgan Generation Assets' impacts and subsequent effects on climate change. As such, the consideration of the Morgan Generation Assets net emissions in the context of existing and emerging policy commitments and UK Carbon budgets is important.

17.12.1.2 Over the lifetime of the Morgan Generation Assets, it would result in 1,019,235 tCO_2e of avoided emissions. The Morgan Generation Assets would likely have a carbon payback period[1] of 4 years when accounting for 1,169,961 tCO_2e construction stage emissions and -2,256,417 tCO_2e operational avoided emissions.

17.12.1.3 Consideration of the Morgan Generation Assets net emissions performance can be considered with the following contextualisation:

- It contributes to reducing carbon budget expenditure at a national and local level
- It is in keeping with local and UK energy and climate policy.

17.12.1.4 The Morgan Generation Assets net emissions accounting form both construction and operations and maintenance stages up to the end of the Sixth Carbon Budget are detailed in the below Table 17.16. When accounting for the total Morgan Generation Assets construction stage GHG emissions (1,169.961 tCO_2e) against the operational and maintenance avoided emissions (-1,572,861 tCO_2e) from full operating year (2030) to the end of the Sixth Carbon Budget (2037) net emissions would be -402,901 tCO_2e, approximately -0.022% of the UK Carbon Budget for the same period.

[1] The period of time for which a wind turbine needs to be in operation before it has, by displacing generation from fossil-fuelled power stations, avoided as much carbon dioxide as was released in its lifecycle.

Table 17.16: GHG impacts in the context of the UK's Carbon Budgets.

*represents only two years of the defined budget for 2030-2032 in line with Morgan Generation Assets opening year.

LCA Stage	2028-2032*	2033-2037	Total
UK Carbon Budget (tCO_2e)	865,000,000	960,000,000	1,825,000,000
Morgan Generation Assets GHG impacts (tCO_2e)	427,316.11	-830,217.00	-402,900.89
Development avoided emissions as percentage of UK carbon budget	0.049%	-0.086%	-0.022%

17.12.1.5 The Morgan Generation Assets is in line with the NPS EN-3's principle of supporting new renewable and low carbon energy developments, in addition to their associated infrastructure, in order to contribute to reductions in GHG emissions.

17.12.1.6 Further, the Morgan Generation Assets is supported by national energy and climate change policy (including the National Infrastructure Strategy, Sixth Carbon Budget, Net Zero Strategy) which highlight the need for an end to the use of unabated fossil fuel generation, whilst also significantly ramping up electricity generation capacity in order to meet the demands of increased electrification of transport, heat and industry. As such, government policy dictates that large-scale deployment of renewable energy generators such as the Morgan Generation Assets are necessary in order to meet GHG reduction targets.

17.12.1.7 By facilitating the expansion of renewable energy supply, the Morgan Generation Assets would assist both the UK Government target of achieving a fully decarbonised power system by 2035, and to become net zero by 2050.

17.12.1.8 When considering the above magnitude of avoided emissions across the whole life time of the project (1,019,235 tCO_2e of avoided emissions), in addition to, the contribution toward the UK achieving its net zero goals and policy, and the high sensitivity of the climate as a receptor, the Morgan Generation Assets would have a beneficial net effect which would be significant in EIA terms.

17.13 Cumulative effects

17.13.1.1 All developments that emit, avoid or sequester GHGs have the potential to impact the atmospheric mass of GHGs as a receptor, and so may have a cumulative impact on climate change. Consequently, cumulative effects due to other specific local development projects are not individually considered but are taken into account when considering the impact of the Morgan Generation Assets by defining the atmospheric mass of GHGs as a high sensitivity receptor. The construction, operations and maintenance and decommissioning phase effects of the assessment of the Morgan Generation Assets takes account of cumulative changes in greenhouse gas emissions from other energy generation sources.

17.13.1.2 However, consideration of the net impact of the offshore wind turbines and infrastructure will be necessary to ensure the whole life carbon and net emissions associated with both the onshore and offshore elements of the Morgan Offshore Wind Project. The Scoping report for the Morgan and Morecambe Offshore Wind Farms Transmission Assets was submitted to the Planning Inspectorate in October 2022, however this does not present sufficient information to be able to complete the cumulative impact assessment for the Morgan Generation Assets. As such, the cumulative assessment will be completed within the Morgan Generation Assets Environmental Statement which will incorporate information from the PEIR of the Morgan and Morecambe Offshore Wind Farms Transmission Assets which is expected to be submitted to the Planning Inspectorate in 2023.

17.14 Inter-related effects

17.14.1.1 The assessment of inter-related effects with climate change is provided in each topic chapter of the PEIR. The main areas where there is a potential for inter-related effects, subject to assessment, are considered to be:

- Volume 2, chapter 7: Benthic subtidal and intertidal ecology of the PEIR – potential changes in the sensitivity of habitats or species to development impacts in the future due to the effects of climate change.

17.15 Transboundary effects

17.15.1.1 A screening of transboundary impacts has been carried out and any potential for significant transboundary effects with regard to climate change from the Morgan Generation Assets upon the interests of other states has been assessed as part of this PEIR. The potential transboundary impacts screening is set out within volume 3, annex 5.2: Transboundary impacts screening of the PEIR.

17.15.1.2 All developments which emit GHGs have the potential to impact the atmospheric mass of GHGs as a receptor, and so may have a transboundary impact on climate change. Consequently, transboundary effects due to other specific international development projects are not individually identified but would be taken into account when considering the impact of the Morgan Generation Assets by defining the atmospheric mass of GHGs as a high sensitivity receptor. Each country has its own policy and targets concerning carbon and climate change which are intended to limit GHG emissions to acceptable levels within that county's defined budget and international commitments.

17.16 Summary of impacts, mitigation measures and monitoring

17.16.1.1 Information on climate change within the climate change study area was collected through desktop review.

17.16.1.2 The potential impact of GHG emissions due to the Morgan Generation Assets, resulting in an effect on the global atmospheric GHG concentration that contributes to climate change, has been assessed and reported in this chapter. The impacts of climate change on the Morgan Generation Assets have also been assessed and reported.

17.16.1.3 Table 17.17 presents a summary of the potential impacts, measures adopted as part of the Morgan Generation Assets and residual effects in respect to climate change. The impacts assessed include:

- The impact of GHG emissions arisings from land-use (sea bed) change.
- The impact of GHG emissions arising from the manufacturing and installation of the generation assets.

- The impact of GHG emissions from decommissioning works (plant, fuel and vessel use) and recovery or disposal of materials.
- The impact of GHG emissions arising from the consumption of materials and activities required to facilitate the operations and maintenance of the Morgan Generation Assets and of estimated abatement of UK Grid emissions during the operation and maintenance phase.
- Impact of the effects of climate change on the Morgan Generation Assets offshore infrastructure.

17.16.1.4 Overall, it is concluded that there will be the following significant effects arising from the Morgan Generation Assets during the construction, operations and maintenance or decommissioning phases.

- Construction stage: emissions from the manufacturing the onshore and offshore infrastructure would result in supply chain emissions of up to 1,169,961 tCO_2e. This would be a significant moderate adverse effect (in EIA Terms) with a residual effect of minor adverse, which is not significant in EIA terms, when accounting for further mitigation. The construction phase must also be evaluated in terms of whole life time emissions from the Morgan Generation Assets
- Operations and maintenance stage: The operational phase of the Morgan Generation Assets would enable the use of excess renewable electricity (avoiding generation curtailment) and the displacement of fossil fuels. This would result in a positive GHG impact. When considering the avoided emissions, in addition to operational/maintenance emissions, the operational impact results in the order of approximately 2,256,417 tCO_2e savings by 2064. This would result in a significant beneficial effect in EIA terms:

17.16.1.5 Despite the high GHG emissions resulting from the construction-stage of the development, the magnitude of avoided emissions resulting from the operational-stage of the development allows the Morgan Generation Assets to enable avoided emissions from the end of the third year of operation (carbon payback period).

17.16.1.6 Over the lifetime of the Morgan Generation Assets it would result in 1,019,235 tCO_2e of avoided emissions.

17.16.1.7 Consideration of the Morgan Generation Assets' net emissions performance can be considered with the following contextualisation:

- it contributes to reducing carbon budget expenditure at a national and local level; and
- it is in keeping with local and UK energy and climate policy.

17.16.1.8 The Morgan Generation Assets is in line with the NPS EN-3's principle of supporting new renewable and low carbon energy developments, in addition to their associated infrastructure, in order to contribute to reductions in GHG emissions.

17.16.1.9 Further, the Morgan Generation Assets is supported by national energy and climate change policy (including the National Infrastructure Strategy, Sixth Carbon Budget, Net Zero Strategy, and Net Zero Wales) which highlight the need for an end to the use of unabated fossil fuel generation, whilst also significantly ramping up electricity generation capacity in order to meet the demands of increased electrification of transport, heat and industry. As such, government policy dictates that large-scale deployment of renewable energy generators such as the Morgan Generation Assets are necessary in order to meet GHG reduction targets.

17.16.1.10 By facilitating the expansion of renewable energy supply, the Morgan Generation Assets would assist the UK Government target of achieving a fully decarbonised power system by 2035, and both the UK and Welsh Government's aim to become net zero by 2050.

[a] C=construction, O=operations and maintenance, D=decommissioning

Table 17.17 Summary of potential environmental effects, mitigation and monitoring.

Description of impact	Phase[a] C	O	D	Measures adopted as part of the Morgan Generation Assets	Magnitude of impact	Sensitivity of the receptor	Significance of effect	Further mitigation	Residual effect	Proposed monitoring
The impact of GHG emissions arisings from land-use (seabed) change during the construction, operation and maintenance decommissioning phases	✓	✓	✓	None	C: Negligable O: Negligable D: Negligible	C: High O: High D: High	Neglible (Not Significant)	None	C: Negligable O: Negligable D: Negligible (Not Significant)	None
The impact of GHG emissions arising from the manufacturing and installation of the Morgan Generation Assets and consumption of materials	✓	X	X	None	1,169,961 tCO_2e	High	Moderate adverse effect (Significant)	The Morgan Generation Assets is committed to exploring options to reduce construction related emissions. Areas to be explored by the Morgan Generation Assets could include: • Optimization of construction activity to reduce emissions (e.g. potentially related to vessel scheduling, co-ordination of shipping/delivery of materials and the identification energy efficiency mechanisms) • Identification of opportunities to reduce emissions in the supply chain • Inclusion of low carbon criteria within procurement activities.	Minor adverse effect (Not Significant)	None
The impact of GHG emissions from decommissionoing works (plant, fuel and vessel use) and recovery or disposal of materials during decommissioning	X	X	✓	None	67,222 tCO_2e	High	Minor adverse effect (Not Significant)	None	Minor adverse effect (Not Significant)	None
The impact of GHG emissions arising from the consumption of materials and activities required to facilitate the operation and maintenance of the Morgan Generation Assets and estimated abatement of UK Grid emissions	X	✓	X	None	2,256,417 tCO_2e avoided emissions	High	Beneficial effect (Significant)	None	Beneficial effect (Significant)	None
Impact of the effects of climate change on the Morgan Generation Assets infrastructure through the operation and maintenance phase	X	✓	X	• Application of anti-corrosion protective coatings and integrated scour protection to offshore equipment. • Wind turbine design to incorporate control of blade speed/braking and power backup system, retro fits to improve airflow and reduce drag and to be fitted with automatic shutdowns/lockdowns to prevent spinning too fast from storms.	N/A	N/A	Negligible (Not Significant)	None	Negligible (Not Significant)	None

17.17 Next steps

17.17.1.1 Where additional information concerning materials, transportation and other variations becomes available throughout the design evolution, updated calculations would be completed and presented within the Environmental Statement, where required. This would also consider potential further mitigation measures to reduce the significant adverse effects presented within the PEIR.

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