NORTH FALLS

Offshore Wind Farm

PRELIMINARY ENVIRONMENTAL INFORMATION REPORT

Chapter 33 Climate Change

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Contents

Tables

Plates

Appendices (Volume III)

Glossary of Acronyms

BEIS	Department of Business and Energy Industry Strategy
CBS	Cement Bound Sand
CCC	Climate Change Committee
CCR	Carbon Capture Readiness
CH4	Methane
CO2	Carbon dioxide
CO2e	Carbon dioxide equivalent
COP	Conference of the Parties
COP21	21st Climate Change Conference of the Parties
COP22	22nd Climate Change Conference of the Parties
COP26	26th Climate Change Conference of the Parties
COP27	27th Climate Change Conference of the Parties
COP28	28th Climate Change Conference of the Parties
CTV	Crew Transfer Vessel
DESNZ	Department for Energy Security and Net Zero
DCO	Development Consent Order
DECC	Department of Energy and Climate Change
EIA	Environmental Impact Assessment
ES	Environmental Statement
EU	European Union
GHG	Greenhouse Gas
GWP	Global Warming Potential
HFC	Hydrofluorocarbons
HGV	Heavy Goods Vehicle
ICE	Inventory of Carbon and Energy
IEMA	Institute of Environmental Management and Assessment
JUV	Jack-up installation vessels
kt	Kilotonne
kWh	Kilowatt-hour
LCA	Life Cycle Analysis
LULUCF	Land Use, Land-Use Change and Forestry

N2O	Nitrous oxide
NF3	Nitrogen trifluoride
NPS	National Policy Statements
NREL	National Renewable Energy Laboratory
NRMM	Non-road mobile machinery
NSIP	Nationally Significant Infrastructure Project
O&M	Operation and maintenance
PEIR	Preliminary Environmental Information Report
PFC	Perfluorocarbons
SF6	Sulphur hexaflouride
SOVs	Service operation vessel
UNFCCC	United Nations Framework Convention on Climate Change
WTG	Wind turbine generator

Glossary of Terminology

Array/interconnecting cables	Cables which link the wind turbine generators with each other and the offshore substation platform(s).
Cable construction compound	Area set aside to facilitate construction of the onshore cable route. Will be located adjacent to the onshore cable route, with access to the highway.
CO_2e	Carbon dioxide equivalent is a metric measure that is used to compare emissions from various greenhouse gases (GHGs) on the basis of their global warming potential by converting amounts of other GHGs to the equivalent amount of carbon dioxide (CO_2).
‘Cradle to (factory) gate’	The extraction, manufacture and production of materials to the point at which they leave the factory gate of the final processing location
g $CO_2e.kWh^{-1}$	Grams (g) of carbon dioxide equivalent (CO_2e) per kilowatt-hour (kWh) of electricity generated
Haul road	The track along the onshore cable route used by construction traffic to access different sections of the onshore cable route.
Horizontal directional drill (HDD)	Trenchless technique to bring the offshore cables ashore at the landfall. The technique will also be used for installation of the onshore export cables at sensitive areas of the onshore cable route.
Interconnector cable corridor	The corridor of the seabed between the northern and southern array areas
Jointing bay	Underground structures constructed at regular intervals along the onshore cable route to join sections of cable and facilitate installation of the cables into the buried ducts.
Landfall	The location where the offshore cables come ashore.
Link boxes	Underground chambers or above ground cabinets next to the onshore export cables housing low voltage electrical earthing links.
Offshore cable corridor	The corridor of seabed from array areas to the landfall within which the offshore export cables will be located.
Offshore export cables	The cables which bring electricity from the array areas to the landfall.
Offshore project area	The overall area of the array areas and the offshore cable corridor.
Offshore substation platform(s)	Fixed structure(s) located within the array areas, containing electrical equipment to aggregate the power from the wind turbine generators and convert it into a more suitable voltage for export to shore via offshore export cables.
Onshore cable corridor(s)	Onshore corridor(s) within which the onshore export cables and associated infrastructure will be located. A final onshore cable route for which consent will be sought will be selected from within these corridor(s).
Onshore cable route	Onshore route within which the onshore export cables and associated infrastructure would be located.
Onshore export cables	The cables which take the electricity from landfall to the onshore substation. These comprise High Voltage Alternative Current (HVAC) cables, buried underground.

Onshore project area	The boundary in which all onshore infrastructure required for the Project will be located (i.e. landfall; onshore cable route, accesses, construction compounds; onshore substation and National Grid substation extension), as considered within the PEIR.
Onshore substation	A compound containing electrical equipment required to transform and stabilise electricity generated by the Project so that it can be connected to the National Grid.
Onshore substation zone	Area within which the onshore substation will be located.
Scour protection	Protective materials to avoid sediment being eroded away from the base of the wind turbine generator foundations and offshore substation platform foundations as a result of the flow of water.
The Applicant	North Falls Offshore Wind Farm Limited (NFOW).
The Project or 'North Falls'	North Falls Offshore Wind Farm, including all onshore and offshore infrastructure.
Transition joint bay	Underground structures that house the joints between the offshore export cables and the onshore export cables
Trenchless crossing compound	Areas within the cable corridor which will house trenchless crossing (e.g. HDD) entry or exit points.
Wind turbine generator (WTG)	Power generating device that is driven by the kinetic energy of the wind

33 Climate Change

33.1 Introduction

1. This chapter of the Preliminary Environmental Information Report (PEIR) considers the likely significant effects of the North Falls offshore wind farm (hereafter 'North Falls' or 'the Project') on climate change and is comprised of a Greenhouse Gas (GHG) assessment. This chapter provides an assessment of likely significant effects for the construction, operation and maintenance (O&M), and decommissioning phases of the Project. The GHG assessment quantified the GHG savings as a result of implementation of the Project, accounting for emissions released during its lifecycle. This information was then used to determine the net effect of the provision of renewable energy to the UK grid, and how the Projects contribute to the UK's decarbonisation targets.

2. This chapter has been written by Royal HaskoningDHV. The assessment has been undertaken with specific reference to the relevant legislation and guidance, of which the primary sources are the National Policy Statements (NPS). The assessment was undertaken in accordance with Institute of Environmental Management and Assessment (IEMA) guidance *'Guide: Assessing Greenhouse Gas Emissions and Evaluating their Significance'* (2022). This guidance document provides a topic-specific methodology for the assessment of GHGs and determining the significance of emissions generated by a project, and therefore the assessment methodology differs from that presented in Chapter 6 EIA Methodology (Volume I).

3. The assessment should be read in conjunction with the following linked chapters (Volume I):

   - Chapter 15 Shipping and Navigation;
   - Chapter 20 Onshore Air Quality; and
   - Chapter 27 Traffic and Transport.

4. Additional information to support the GHG assessment includes:

   - Appendix 33.1 Greenhouse Gas Assessment Methodology (Volume III)

5. The design of the Project is currently being developed and adaptive capacity to climate change (defined as '*the potential or ability of a system to adapt to the effects or impacts of climate change*') is being incorporated into the design. At this stage of the design, there is insufficient information to undertake an assessment to determine the vulnerability and resilience of the Project to climate change. This will be considered further at the assessment stage for the Environmental Statement (ES).

6. It is worth noting that the inherent design of offshore wind farms is robust to the projected changes to the climate for both the offshore and onshore components, and the Project is being designed to be resilient to climate change. Offshore structures are resilient to flooding and water ingress and are designed to withstand severe storm conditions, including accounting for future climate change. The onshore elements are also inherently robust to future climatic changes such as flooding and heatwaves.

33.2 Consultation

7. Consultation with regard to climate change and the GHG assessment has been undertaken in line with the general process described in Chapter 6 EIA Methodology (Volume I). The key elements to date include the Scoping Opinion received on the Project in response to the Scoping Report on 26 August 2021. The feedback received has been considered in preparing the PEIR. Table 33.1 provides a summary of how the consultation responses received to date have influenced the approach that has been taken.

8. This chapter will be updated following the consultation on the PEIR in order to produce the final assessment, which will be presented in an ES that will be submitted with the Development Consent Order (DCO) application. Full details of the consultation process will also be presented in the Consultation Report, submitted as part of the DCO application.

Table 33.1 Consultation responses

Consultee	Date / Document	Comment	Response / where addressed in the PEIR
Planning Inspectorate	26/08/2021 / Scoping Opinion	The ES should include a description and assessment (where relevant) of the likely significant effects the Proposed Development has on climate (for example having regard to the nature and magnitude of greenhouse gas emissions) and the vulnerability of the project to climate change. Where relevant, the ES should describe and assess the adaptive capacity that has been incorporated into the design of the Proposed Development. This may include, for example, alternative measures such as changes in the use of materials or construction and design techniques that will be more resilient to risks from climate change. Please note that further comments are made on climate change in section 6.3 of this Scoping Opinion.	This chapter presents the GHG assessment for the Project. It should be noted that the design is currently being developed, and the ES will present any updates to the Project and reflect these in the GHG assessment. At this stage of the design, there is insufficient information to undertake an assessment to determine the vulnerability and resilience of the Project to climate change. This will be considered further at the assessment stage for the ES. However, as noted in paragraph 6, resilience to climate change is being inherently considered in the design of the Project.
		Table 4.7 Vulnerability of infrastructure to climate change during construction and decommissioning. The Scoping Report states that the vulnerability of the Proposed Development to climate change during the construction phase will not be considered as construction is planned to take place within the next	No final decision has yet been made regarding the final decommissioning policy for the onshore project infrastructure including landfall, onshore cable route and onshore substation. It is also recognised that legislation and industry best practice change over time. However, it is likely that the onshore

Consultee	Date / Document	Comment	Response / where addressed in the PEIR
		10 years and climate change impacts are not considered to be likely during that timeframe. The Inspectorate considers that there is potential for climate change impacts to have likely significant effects on the construction phase, for example in respect of increased flood risk that may require mitigation in the planning of construction compounds and temporary drainage strategies. The Scoping Report does not state what the anticipated operational lifetime of the Proposed Development is likely to be; however, the Inspectorate notes that other offshore windfarms have expected lifetimes of approximately 30 years, and on that basis would expect decommissioning to commence in around 2060 at the earliest. The decommissioning phase may be vulnerable to the impacts of climate change, particularly given the timescales involved. The ES should therefore include an assessment of these matters, albeit it is acknowledged that it may be high level and it may involve cross referencing to other assessments within the ES, eg marine geology, oceanography and physical processes, water resources and flood risk and major accidents and disasters.	project equipment, including the cables, will be removed, reused or recycled where possible and the transition bays and cable ducts being left in place. The detail and scope of the decommissioning works will be determined by the relevant legislation and guidance at the time of decommissioning and will be agreed with the regulator. At this stage of the design, there is insufficient information to undertake an assessment to determine the vulnerability and resilience of the Project to climate change. This will be considered further at the assessment stage for the ES.
		Para 809 Cumulative effects. The Scoping Report states that a cumulative assessment of greenhouse gas (GHG) emissions with other projects is proposed to be scoped out of the ES as the Proposed Development is responsible for its activities only. The ES should include a description of the likely significant cumulative effects of the Proposed Development with other projects scoped into the assessment, including those in	Standard practice for GHG assessments is to only consider the development itself, as the 'receptor' for the assessment is the global atmosphere. IEMA guidance (2022) states that *"effects of GHG emissions from specific cumulative projects… in general should not be individually assessed, as there is no basis for selecting any particular (or more than one) cumulative project that has emissions for assessment over any other."* Therefore, a

Consultee	Date / Document	Comment	Response / where addressed in the PEIR
		relation to GHG emissions where significant effects are likely to occur. The Inspectorate notes that other cumulative effects, i.e. those relating to vulnerability of the Proposed Development and other projects to climate change will be scoped into the ES as part of relevant aspects chapter including water resources and flood risk, and coastal erosion.	cumulative assessment of GHG emissions has not been carried out, in accordance with the approach detailed in IEMA guidance.
		Section 4.4.4 Assessment methodology. The Inspectorate notes that a GHG assessment will be prepared to support the assessment of effects during construction, operation and decommissioning of the Proposed Development. It is unclear from the Scoping Report as to which elements or activities will be specifically included within the GHG assessment, e.g. whether this will road traffic emissions, materials, energy used, any supporting activities or infrastructure, and which gases would be considered, given that there a range of gases that are considered to be GHGs. This should be explained in the ES and justification should be provided for any exclusions. The Inspectorate notes that paragraph 810 refers to the use of UK carbon budgets to frame the GHG assessment in the context of potential transboundary impacts. For avoidance of doubt, the Inspectorate has assumed that this applies to the assessment methodology for GHG emissions scoped into the ES. The Inspectorate notes that the sixth carbon budget as set out in the Carbon Budget Order 2021 is the most recent, but expects that the GHG assessment would be carried out by reference to the carbon budget in place at the time of submission of any DCO, reflecting targets for the relevant construction and operational (design) years.	The GHG assessment has included embodied carbon in materials, vessels, plant and equipment and road traffic during construction and road traffic and vessels during operation and maintenance (O&M). The elements included in the GHG assessment are detailed further in Section 33.4.3.3. It should be noted that the design of the Project is currently being developed, and the ES will present any updates to these parameters and will be reflected in the GHG assessment. In this assessment, the term ‘GHG’ or ‘carbon’ encompasses CO_2 and the six other gases referenced in the Kyoto Protocol (methane (CH_4), nitrous oxide (N_2O), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), sulphur hexafluoride (SF_6) and nitrogen trifluoride (NF_3)). The results are presented in carbon dioxide equivalent (CO_2e), which recognises that different gases have notably different global warming potentials (GWPs). The assessment methodology of likely significance climate change effects is presented in Section 33.4.3.

Consultee	Date / Document	Comment	Response / where addressed in the PEIR
		The ES should set out the criteria by which the assessment will determine whether the effects associated with climate change impacts are significant or not significant, and a conclusion on this should be reported in the ES.	
Essex County Council	20/08/2021 / Scoping Opinion	It is noted that updates to the EIA Regs in 2017 state this this important topic requires consideration, within Schedule 4 of the same it states at para 5 that: *A description of the likely significant effects of the development on the environment resulting from, inter alia …. (f) the impact of the project on climate (for example the nature and magnitude of greenhouse gas emissions) and the vulnerability of the project to climate change*. It is also backed up by case law which states this is now a consideration for NSIPs.	This chapter presents the GHG assessment for the Project. It should be noted that the design of the Project is currently being developed, and the ES will present any updates to the Project and reflect these in the GHG assessment. At this stage of the design, there is insufficient information to undertake an assessment to determine the vulnerability and resilience of the Project to climate change. This will be considered further at the assessment stage for the ES. However, as noted in paragraph 6, resilience to climate change is being inherently considered in the design of the Project.
		It is correct that the development of the magnitude as proposed would be subject to a number of factors in relation to climate change going forward, providing post construction a low carbon energy source to fall in with Government guidance to promote the same. It is also considered necessary that the development itself must show how it can achieve zero carbon during its lifetime from construction to implementation and contribute to net carbon gain.	This chapter provides the GHG assessment, and the GHG payback period is presented in Section 33.7.1.2.
		Measures to avoid, prevent, mitigate and to seek to offset carbon impact must be ensured, including the adaption to its effects, such as protecting communities from water shortages, flooding and heatwaves.	Mitigation with respect to climate change resilience will be presented at the assessment stage for the ES.

Consultee	Date / Document	Comment	Response / where addressed in the PEIR
		The Essex Climate Action Commission was set up and a series of Special Interest Groups (SIG) advise the Council about tackling climate change. The commission has over 30 members over a wide range of senior professionals, local councillors, academics, business's, people and 2 members of the Young Essex Assembly. The commission will run for 2 years initially and make recommendations about how we can improve the environment and the economy of Essex. The findings of the commission will not be published until Q3 2020 but the applicant should have knowledge of this initiative, their values and objectives and the implications for the future aspirations of the development.	Noted. The '*Net Zero: Making Essex Carbon Neutral*' (Essex Climate Action Commission, 2021) report has been reviewed and taken into consideration in this chapter (Section 33.4.1.3).
		Mitigation against the climate change impacts of the development will be brought through a range of issues that will need to be considered in the EIA, including, but not limited to transportation (electric vehicles and charging points, use of public transport, car sharing, sustainable low carbon traffic modes etc) the built environment, green infrastructure (planting, Sustainable Urban Drainage, greenhouse gas emissions, air quality etc).	This chapter presents the GHG assessment for the Project.
		The submitted ES should include a description and assessment (where relevant) of the likely significant effects the Proposed Development has on climate (for example having regard to the nature and magnitude of greenhouse gas emissions) and the vulnerability of the project during its construction phase, to climate change. Where relevant, the ES should describe and assess the adaptive capacity that has been incorporated into the design of the Proposed Development. This may include, for example, alternative measures such as changes in the use of materials or construction and	This chapter presents the GHG assessment for the Project. It should be noted that the design of the Project is currently being developed, and the ES will present any updates to the Project and reflect these in the GHG assessment. At this stage of the design, there is insufficient information to undertake an assessment to determine the vulnerability and resilience of the Project to climate change. This will be

Consultee	Date / Document	Comment	Response / where addressed in the PEIR
		design techniques that will be more resilient to risks from climate change.	considered further at the assessment stage for the ES.
		It is noted and recognised in part 4.4 of the submission that the applicants propose to include climate change as an important topic in their eventual EA. This is hugely welcomed and will be to the benefit of the scheme and its final consideration. The information and initiatives within this chapter are significant, the joint council's look forward to discussion this topic further with the applicants in the forthcoming schedule of stakeholder engagement.	Noted. The Climate Change topic was included as part of the Traffic and Transport, Air Quality, Climate Change, Noise and Vibration Expert Topic Group meeting in July 2021 (see below).
Essex County Council	09/07/2021 / Expert Topic Group (ETG)	Essex County Council appreciated the consideration of climate change in the Application. No comments were made on the EIA approach to climate change for the Project outlined in the ETG meeting.	The climate change chapter comprises two assessments – a GHG assessment and a climate resilience assessment. The methodology for the assessment is detailed in Section 33.4. Additional guidance (IEMA,2022) has been released since the ETG meeting and has been used in the GHG assessment. As previously stated, at this stage of the design, there is insufficient information to undertake an assessment to determine the vulnerability and resilience of the Project to climate change. This will be considered further at the assessment stage for the ES.
London Borough of Waltham Forest	10/08/2021 / Scoping Opinion	The applicants have submitted a EIA Scoping Report which has been reviewed by officers. The report covers a wide breadth of issues proportionate to the status of this application as a NSIP, and include both off-shore physical and geological issues, as well as wider socio-economic and on-shore visual and physical impacts such as air quality and wider climate change. It is not considered that there are any significant issues raised by the	Noted.

Consultee	Date / Document	Comment	Response / where addressed in the PEIR
		scoping report which would directly impact upon LBWF, and therefore no comments are made in relation to the scoping opinion.	
Natural England	16/08/2021 / Scoping Opinion	Section 2.1.1 Climate change Consideration of climate change impacts over the operational period of North Falls OWF will need to be included in the ES. These impacts will become important if they cause an alteration in the baseline conditions and become detectable above natural inter-annual variations.	This chapter presents the climate change and GHG assessment for the Project.

33.3 Scope

33.3.1 Study area

9. North Falls is an extension project to the existing Greater Gabbard offshore wind farm. The North Falls array area is located in the southern North Sea and covers a total area of 149 km^2. The Project will make landfall between Clacton-on-Sea and Frinton-on-Sea, Essex. The location of the Project infrastructure is shown in Figures 4.1 to 4.14 (Volume II) of Chapter 4 Site Selection and Assessment of Alternatives (Volume I).

10. The GHG assessment determines the change in GHG emissions as a result of the implementation of the Project, while acknowledging the replacement of electricity from fossil fuel sources with renewable offshore wind. The study area for the assessment therefore includes the UK wide electricity grid.

11. The scope of the assessment quantified GHG emissions from both the onshore and offshore components of the Project (see Chapter 5 Project Description (Volume I) for further details), and includes material extraction and manufacturing, transport and installation, Operations and Maintenance (O&M) and end of life and decommissioning. A schematic diagram of the Project's boundary is provided in Plate 33.1; emissions from activities within the pale green box is included within the assessment. The study area is defined both geographically, as the asset project area, and by the processes that create the offshore wind farm (i.e., construction), its O&M and decommissioning.

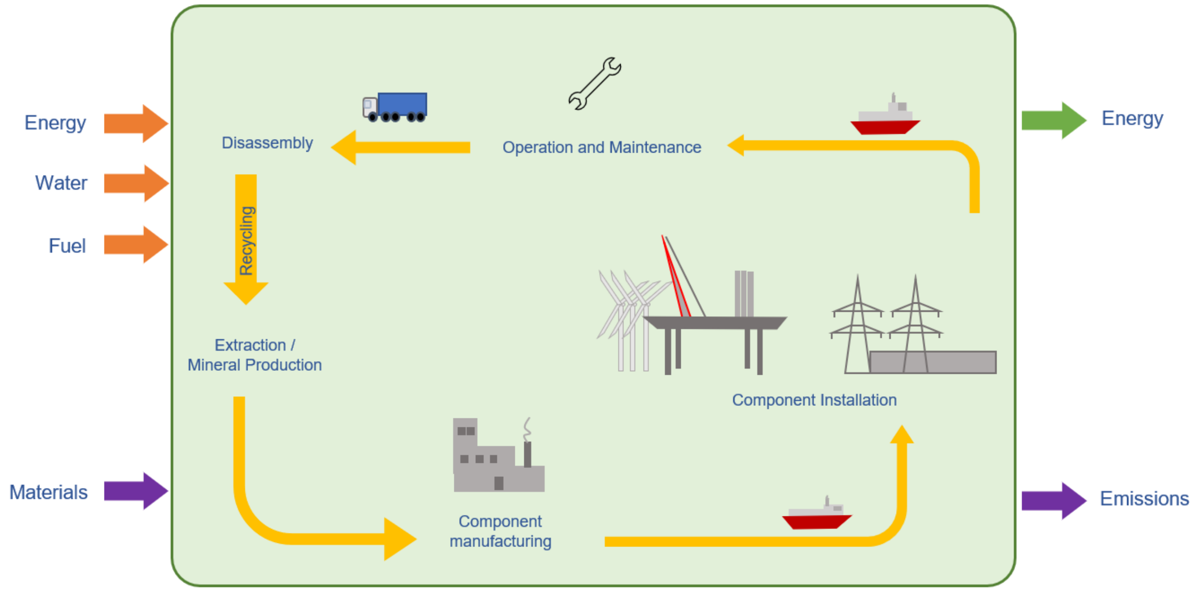

Plate 33.1 Systems boundary for the Project's GHG assessment

33.3.2 Realistic worst case scenario

12. The final design of the Project will be confirmed through detailed engineering design studies that will be undertaken post-consent and prior to the construction phase. In order to provide a precautionary but robust impact assessment at this stage of the development process, realistic worst case scenarios have been defined in terms of the potential effects that may arise. This approach to EIA, referred to as the Rochdale Envelope, is common practice for Nationally Significant Infrastructure Projects (NSIPs), as set out in Planning Inspectorate Advice Note Nine (2018). The Rochdale Envelope for a project outlines the realistic worst case scenario for each individual impact, so that it can be safely assumed that all other scenarios within the design envelope will have less impact. Further details are provided in Chapter 6 EIA Methodology (Volume I).

13. The realistic worst case scenarios for the likely significant effects scoped into the EIA for the GHG assessment are summarised in Table 33.2. The GHG assessment will quantify the emissions saved as a result of implementation of the Project, accounting for emissions released from activities during construction, O&M and decommissioning. Therefore, the realistic worst case scenario is based upon activities predicted to release the highest emissions quantity and are based on the Project parameters described in Chapter 5 Project Description (Volume I), which provides further details regarding specific activities and their durations.

Table 33.2 Realistic worst case scenarios

Potential impact	Parameter	Notes
Construction		
GHG emissions during construction	Offshore: • Installation of up to 72 wind turbine generators (WTGs) • Two offshore substations • WTG and offshore substation foundation types have yet to be determined, so the options with maximum construction material (i.e. jacket) and scour protection (i.e. gravity based monopile structure) quantities were used in PEIR GHG emission calculations • Total length of array/interconnecting cables = 228 km • Length of export cables = 57 km, 4 circuits (250.8 km in total (including a 10% contingency))	Maximum amount of construction materials required
	Onshore: • One onshore substation • Length of onshore cables = 24 km, 4 circuits (96 km in total) • Working hours: normally 07:00 to 19:00 Monday to Saturday, no Sunday or bank holiday working. However, 24 hour working will be required at complex horizontal directional drilling (HDD) locations.	Maximum amount of construction materials required
GHG savings or carbon offset by the North Falls	Assumed electricity supplied by the Project would be generated from gas, as this is the most common form of new plant in terms of fossil fuel combustion (see Section 33.6.2 for further details).	To help determine the carbon offset as a result of the Project
Operation		
GHG emissions during O&M	• Operational life = 30 years • Assumed O&M activities of 72 WTGs and 2 offshore substations • Nominal capacity: 1GW	This results in a higher amount of GHG emissions released during O&M
Decommissioning		
The contribution from decommissioning was scaled based on the total GHG contribution, as detailed in Section 33.4.		

33.3.3 Summary of mitigation embedded in the design

14. The IEMA GHG guidance (IEMA, 2022) notes the importance of embedded mitigation in minimising GHG emissions from a development. The IEMA GHG Management Hierarchy sets out a structure to eliminate, reduce, substitute and compensate (IEMA, 2022).

15. In response to these principles, the need for the Project in relation to achieving net zero targets by 2050 for the UK and decarbonisation of the energy sector is well established and set out within Chapter 2 Need for the Project (Volume I). Furthermore, project level GHG mitigation is being incorporated into the design development process wherever it is practicable to do so. Considering the primary purpose of the Project is to generate low carbon renewable energy, the process of reducing GHG emissions from the Project itself is guided by the hierarchy summarised in Table 33.3.

Table 33.3 IEMA GHG guidance (IEMA, 2022) – mitigation hierarchy specific to North Falls

	Hierarchy	Principle	Project Response
	Do not build (Eliminate)	Evaluate the basic need for the proposed project and explore alternative approaches to achieve the desired outcome(s).	The purpose and rationale for the Project is to tackle climate change by replacing existing high carbon energy generation. So in this case of 'do not build' could have the effect of perpetuating and exacerbating climate change.
	Build less (Reduce)	Realise potential for re-using and/or refurbishing existing assets to reduce the extent of new construction required.	Offshore wind farms by their design are efficient in their use of materials. Minimising the use of steel is a key design feature of the approach to project design and procurement.
	Build clever (Substitute)	Apply low carbon solutions (including technologies, materials and products) to minimise resource consumption and embodied carbon during the construction, operation, user's use of the Project, and at end-of-life.	The Project will use the latest, most efficient and effective turbines and offshore substation platforms.
	Construct efficiently (Compensate)	Use techniques (e.g. during construction and operation) that reduce resource consumption and associated GHG emissions over the life cycle of the Project.	Offshore construction is by its nature expensive and relies on the use of highly specialised, efficient vessels and equipment with a dedicated and highly trained workforce.

16. In response to these principles, the need for the Project in relation to achieving net zero targets for the UK and decarbonisation of the energy sector is well established and set out within Chapter 2 Need for the Project (Volume I).

33.4 Assessment methodology

33.4.1 Legislation, guidance and policy

33.4.1.1 International Agreements

33.4.1.1.1 United National Framework Convention on Climate Change (UNFCCC)

17. The United Nations Framework Convention on Climate Change (UNFCCC) is an international environmental treaty addressing climate change which entered into force on 21st March 1994. Its main objective is *'to stabilize greenhouse gas concentrations in the atmosphere at a level that will prevent dangerous human*

interference with the climate system'. In its early years it facilitated intergovernmental climate change negotiations and now provides technical expertise. Its supreme decision-making body, the Conference of the Parties (COP) meets annually to discuss and assess progress in addressing climate change.

18. The first agreement was the Kyoto Protocol, which was signed in 1997 and entered into force in 2005, and committed industrialised countries to limit and reduce GHG emissions in accordance with individual targets to reduce the rate and extent of global warming. It applies to seven GHGs: carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), sulphur hexafluoride (SF_6) and nitrogen trifluoride (NF_3) which was incorporated into the second Kyoto Protocol compliance period in 2012. The Kyoto Protocol recognises that the economic development of a country is an important determinant in the country's ability to combat, and adapt to, climate change. Therefore, developed countries have an obligation to reduce their current emissions particularly due to their historic responsibility for the current concentrations of atmospheric GHGs.

19. Subsequently, the meetings of COP have resulted in several important and binding agreements, including the Copenhagen Accord (2009), the Doha Amendment (2012), the Paris Agreement (2015) and the Glasgow Climate Pact (2022).

20. The Copenhagen Accord raised climate change policy to the highest political level and expressed a clear political intent to constrain carbon and respond to climate change in the short and long term. It introduced the potential commitment to limiting global average temperature increase to no more than 2°C above pre-industrial levels.

21. The Doha Amendment to the Kyoto Protocol in 2012 included a commitment by parties to reduce GHG emissions by at least 18% below 1990 levels in the eight-year period from 2013 to 2020. The UK Climate Change Act 2008 has an interim 34% reduction target for 2020, which would allow the UK to meet and exceed its Kyoto agreement target.

22. The United Nations Climate Change Conference in Paris in 2015 (known as 'COP21') led to the following key areas of agreement (the Paris Agreement):

- Limit global temperature increases to below 2°C, while pursuing efforts to limit the increase to 1.5°C above the pre-industrial average temperature;
- Parties to aim to reach a global peak of GHG emissions as soon as possible alongside making commitments to prepare, communicate and maintain a Nationally Determined Contribution;
- Contribute to the mitigation of GHG emissions and support sustainable development whilst enhancing adaptive capacity, strengthening resilience and reducing vulnerability to climate change;
- Commitment to transparent reporting of information on mitigation, adaptation and support which undergoes international review; and
- In 2023 and every five years thereafter, a global stocktake will assess collective progress toward meeting the purpose of the Agreement.

23. At the 22nd Climate Change Conference of the Parties (COP22) in November 2016, the UK ratified the Paris Agreement to enable the UK to *"help to accelerate global action on climate change and deliver on our commitments to create a safer, more prosperous future"* (Department for Business, Energy and Industrial Strategy (BEIS), 2016). At the COP24 meeting, held in Katowice, Poland in December 2018, a set of rules for the Paris climate process were agreed.

24. COP26 was held in 2021 in Glasgow. The four specific objectives that were aimed to be achieved for COP26 were (UK Parliament, 2022):

- Securing global net zero by mid-century and keep 1.5°C within reach by:
  - Accelerating the phase-out of coal
  - Curtailing deforestation
  - Speeding up the switch to electric vehicles
  - Encouraging investment in renewables
- Adapt to protect communities and natural habitats
- Mobilise at least $100 billion in climate finance per year
- Work together to deliver through finalising the Paris Rulebook and accelerating action to tackle the climate crisis through collaboration between governments, businesses, and civil society.

25. For the first time, nations have been called upon to 'phase down' unabated coal power and inefficient subsidies for fossil fuels (UNFCCC, 2022). The main headlines of COP26 were:

- Signing of the Glasgow Climate Pact, which is a series of decisions and resolutions that build on the Paris Agreement setting out what needs to be done to tackle climate change but does not specify what each country must do and is not legally binding; and
- Agreeing the Paris Rulebook, which gives the guidelines on how the Paris Agreement is delivered. Agreements in the finalised Rulebook include enhanced transparency framework for the reporting of emissions, common timeframes for emissions reduction targets and mechanisms and standards for international carbon markets (UK Parliament, 2022).

26. The most recent COP, COP27, was held in Egypt in November 2022. Conclusions of COP27 include the decision to establish a fund for responding to loss and damage and the inability to reach agreement on the phasing out of coal and other fossil fuels or setting emission peaking periods. COP28 will be held in Dubai, United Arab Emirates, towards the end of 2023.

33.4.1.2 National Policy Statements

27. The assessment of likely significant effects upon GHG emissions has been made with specific reference to the relevant National Policy Statements (NPS). These are the principal decision making documents for Nationally Significant Infrastructure Projects (NSIPs). Those relevant to the Project are:

- Overarching NPS for Energy (EN-1) (Department of Energy and Climate Change (DECC), 2011a);

- NPS for Renewable Energy Infrastructure (EN-3) (DECC, 2011b);
- NPS for Electricity Networks Infrastructure (EN-5) (DECC, 2011c);
- Draft Overarching NPS for Energy (EN-1) (Department of Business and Energy Industry Strategy (BEIS), 2021a);
- Draft NPS for Renewable Energy Infrastructure (EN-3) (BEIS, 2021b); and
- Draft NPS for Electricity Networks Infrastructure (EN-5) (BEIS, 2021c).

28. The UK Government announced a review of the existing NPSs within its December 2020 Energy White Paper (HM Government, 2020) and issued a draft version of Overarching NPS for Energy EN-1, NPS for Renewable Energy Infrastructure EN-3 and NPS for Electricity Networks Infrastructure EN-5 for consultation on 6th September 2021 (BEIS, 2021a; BEIS, 2021b; BEIS, 2021d). At the time of writing this PEIR chapter, final versions of the revised NPSs are not available.

29. The specific assessment requirements for the GHG assessment, as detailed in the NPS, are summarised in Table 33.4 together with an indication of the section of the PEIR chapter where each is addressed.

30. Table 33.4 includes a section for the draft version of NPS in which relevant additional NPS requirements not presented within the current version of each NPS have been included. A reference to the particular requirement's location within the draft NPS and to where within this chapter or wider PEIR it has been addressed has also been provided. Minor wording changes within the draft version which do not materially influence the NPS requirements have not been reflected in Table 33.4.

31. EN-5 (current or draft version) do not specifically include details on the assessment of greenhouse gas emissions.

Table 33.4 NPS assessment requirements

NPS Requirement	NPS Reference	PEIR Reference
Overarching NPS for Energy (EN-1)		
An increase in renewable electricity is essential to enable the UK to meet its commitments under the EU Renewable Energy Directive. It will also help improve our energy security by reducing our dependence on imported fossil fuels, decrease greenhouse gas emissions and provide economic opportunities	EN-1, Paragraph 3.3.11	The purpose of the Project is to tackle climate change by replacing existing high carbon energy generation, with a renewable form of energy, which will improve energy security and help the UK meet its net zero commitments.
New energy infrastructure will typically be a long-term investment and will need to remain operational over many decades, in the face of a changing climate. Consequently, applicants must consider the impacts of climate change when planning the location, design, build, operation and, where appropriate, decommissioning of new energy infrastructure. The ES should set out how the proposal will take account of the projected impacts of	EN-1, Paragraphs 4.8.5 and 4.8.6	The impacts of climate change to the Project will be considered in a climate change resilience assessment at the ES stage.

NPS Requirement	NPS Reference	PEIR Reference
climate change. While not required by the EIA Directive, this information will be needed by the [Secretary of State]. The [Secretary of State] should be satisfied that applicants for new energy infrastructure have taken into account the potential impacts of climate change using the latest UK Climate Projections available at the time the ES was prepared to ensure they have identified appropriate mitigation or adaptation measures. This should cover the estimated lifetime of the new infrastructure.		
NPS for Renewable Energy Infrastructure (EN-3)		
Part 2 of EN-1 covers the Government's energy and climate change strategy, including policies for mitigating climate change. Section 4.8 of EN-1 sets out generic considerations that applicants and the [Secretary of State] should take into account to help ensure that renewable energy infrastructure is resilient to climate change. 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. Section 4.8 of EN-1 advises that the resilience of the project to climate change should be assessed in the Environmental Statement (ES) accompanying an application.	EN-3, Paragraphs 2.3.1, 2.3.4 and 2.3.5	The impacts of climate change to the Project will be considered in a climate change resilience assessment at the ES stage.
NPS for Electricity Networks Infrastructure (EN-5)		
EN-5 contains relevant policy in relation to the assessment of electricity networks, however there is no information specific to this climate change chapter.		
Draft NPS for Energy (EN-1)		
Applicant's Assessment All proposals for energy infrastructure projects should include a carbon assessment as part of their ES (See Section 4.2). This should include: • A whole life carbon assessment showing construction, operational and decommissioning carbon impacts • An explanation of the steps that have been taken to drive down the climate change impacts at each of those stages • Measurement of embodied carbon impact from the construction stage	Draft EN-1, Paragraph 5.3.4	This chapter presents the GHG assessment for the Project. The elements included in the GHG assessment at this stage of the application are outlined in Section 33.4.3.3, these will be further refined before the ES if further details are available.

NPS Requirement	NPS Reference	PEIR Reference
• How reduction in energy demand and consumption during operation has been prioritised in comparison with other measures • How operational emissions have been reduced as much as possible through the application of best available technology for that type of technology • Calculation of operational energy consumption and associated carbon emission • Whether and how any residual carbon emissions will be (voluntarily) offset or removed using a recognised framework • Where there are residual emissions, the level of emissions and the impact of those on national and international efforts to limit climate change, both alone and where relevant in combination with other developments at a regional or national level, or sector level, if sectoral targets are developed.		
Secretary of State decision making The Secretary of State must be satisfied that the applicant has as far as possible assessed the GHG emissions of all stages of the development. The Secretary of State should be content that the applicant has taken all reasonable steps to reduce the GHG emissions of the construction and decommissioning stage of the development. The Secretary of State should also give positive weight to projects that embed nature-based or technological processes to mitigate or offset the emissions of construction and decommissioning within the proposed development. However, in light of the vital role energy infrastructure plays in the process of economy wide decarbonisation, the Secretary of State accepts that there are likely to be some residual emissions from construction and decommissioning of energy infrastructure. Operational GHG emissions are a significant adverse impact from some types of energy infrastructure which cannot be totally avoided (even with full deployment of CCS technology). Given the characteristics of these and other technologies, as noted in Part 3 of this NPS, and the range of non-planning policies aimed at decarbonising electricity generation such as UK ETS (see Sections 2.4 and 2.5 above), government has determined that	Draft EN-1, Paragraphs 5.3.5 to 5.3.7	The GHG assessment has considered emissions during construction, operation and decommissioning of the Project.

NPS Requirement	NPS Reference	PEIR Reference
operational GHG emissions are not reasons to prohibit the consenting of energy projects including those which use these technologies or to impose more restrictions on them in the planning policy framework than are set out in the energy NPSs (e.g. the CCR requirements). Any carbon assessment will include an assessment of operational GHG emissions, but the policies set out in Part 2, including the UK ETS, apply to these emissions. Operational emissions will be addressed in a managed, economy-wide manner, to ensure consistency with carbon budgets, net zero and our international climate commitments. The Secretary of State does not, therefore need to assess individual applications for planning consent against operational carbon emissions and their contribution to carbon budgets, net zero and our international climate commitments.		
Mitigation A carbon assessment should be used to drive down GHG emissions at every stage of the proposed development and ensure that emissions are minimised as far as possible for the type of technology, taking into account the overall objectives of ensuring our supply of energy always remains secure, reliable and affordable, as we transition to net zero. Applicants should look for opportunities within the proposed development to embed nature-based or technological solutions to mitigate or offset the emissions of construction and decommissioning. To be taken into account in Secretary of State decision making, steps taken to minimise and offset emissions should be set out in a GHG Reduction Strategy, secured under the development consent order.	Draft EN-1, Paragraphs 5.3.8 to 5.3.10	GHG mitigation has been considered as part of the design of the Project, further details are provided in Section 33.3.3.
Draft NPS for Renewable Energy Infrastructure (EN-3)		
There are no material changes to the existing EN-3 and therefore there are no new relevant paragraphs in relation to this chapter.		
Draft NPS for Electricity Networks Infrastructure (EN-5)		
There are no material changes to the existing EN-5 and therefore there are no new relevant paragraphs in relation to this chapter.		

33.4.1.3 Other legislation, policy and guidance

32. In addition to the NPS, there are a number of pieces of other legislation, policy and guidance applicable to the assessment of GHGs which are discussed in the

following sections. Further detail is provided in Chapter 3 Policy and Legislative Context (Volume I).

33.4.1.3.1 Legislative background

33. The requirement to consider climate and GHG emissions has resulted from the 2014 amendment to the EIA Directive (2014/52/EU) resulting in the Infrastructure Planning (Environmental Impact Assessment) Regulations 2017 ('EIA Regulations') as relevant to the Project. This includes the requirement to include an estimate of expected emissions and the impact of a project on climate, including consideration of the nature and magnitude of the release of GHGs during construction and operation.

34. The Climate Change Act 2008 established a legally binding target to reduce the UK's GHG emissions by at least 80% in 2050 from 1990 levels, and a system of carbon budgets were introduced in order to drive progress towards this target.

35. On 12 December 2015, the UK along with 195 other parties signed the 'Paris Agreement', a legally binding international treaty on climate change committing all parties to the goal of limiting global warming to well below 2 degrees Celsius, preferably to 1.5 degrees Celsius, compared to pre-industrial levels. The Agreement requires all parties to submit plans to reduce their emission (along with other climate action) every 5-years, starting in 2020. The Carbon Budgets are set by the Climate Change Committee (CCC) and provide a legally binding five-year limit for GHG emissions in the UK. The six carbon budgets that have been placed into legislation and will run up to 2037, are identified in Table 33.5.

Table 33.5 The six UK Carbon Budgets

Budget	Carbon Budget (Mt CO_2e)	Reduction below 1990 level	
		UK Targets	Achieved by the UK
1st Carbon Budget (2008 to 2012)	3,018	25%	30%
2nd Carbon Budget (2013 to 2017)	2,782	31%	38%
3rd Carbon Budget (2018 to 2022)	2,544	37% by 2020	44%
4th Carbon Budget (2023 to 2027)	1,950	51% by 2025	-
5th Carbon Budget (2028 to 2032)	1,725	68% by 2030	-
6th Carbon Budget (2033 to 2037)	965	78% by 2035	-

36. The UK outperformed its emission reduction targets set by the first, second and third Carbon Budgets, achieving a 30%, 38% and 44% reduction compared to 1990 levels in 2011, 2015 and 2020 respectively.

37. In December 2020, the UK set a Sixth Carbon Budget, recommending a reduction in UK GHG emissions of 78% by 2035 relative to a 1990 baseline (a 63% reduction from 2019) (CCC, 2020). This target which has already been enshrined in UK law, has been set in line with the UK commitments in relation to the Paris Agreement and with the goal of achieving a target of reaching net zero GHG emissions by 2050.

38. As part of this budget, the role of the offshore wind sector and the construction industry are both the focus of action to contribute to meeting these targets.

39. The CCC publishes annual progress reports on the UK's progress against GHG emissions reduction targets to 2050. The most recent published report 'Progress in reducing emissions: 2022 Report to UK Parliament' (CCC, 2022) identifies that emissions in 2021 rose to some extent after the Covid-19 pandemic but remain 10% below 2019 levels. This report also reiterates the Government's commitment to electricity generation being 95% low-carbon by 2030 and fully decarbonised by 2050. The report also acknowledges the Government's ambition for offshore wind generation by 2030 has increased from 40GW to 50GW.

33.4.1.3.2 Local policy

40. The onshore project area falls within the area of jurisdiction of Tendring District Council and Essex County Council. Any local planning policy documents and/or policies of relevance to this GHG assessment are detailed below.

41. In 2019, Tendring District Council declared a climate emergency, committing it to the preparation of an action plan with the aim of making its own activities carbon neutral by 2030. The 'Tendring District Local Plan 2013-2033 and Beyond: Section 2' was formally adopted on 25th January 2022 and Policy SPL 3 Sustainable Design states that *"All new development (including changes of use), should incorporate climate change adaptation measures and technology from the outset including reduction of emissions, renewable and low carbon energy production, passive design, and through green infrastructure techniques, where appropriate."*

42. The Essex Climate Action Commission, as referenced in Table 33.1, was set up to advise Essex County Council with respect to tackling climate change. The Commission published its '*Net Zero: Making Essex Carbon Neutral'* report in July 2021 (Tendring District Council, 2021), which encourages large-scale renewable energy installations such as wind farms to be embraced in Essex. The Commission also advises that residents and businesses should be supplied with 100% renewable energy, and to see Essex produce enough renewable energy within the county to meet its own needs by 2040.

33.4.1.3.3 Guidance

43. Recently published IEMA '*Assessing Greenhouse Gas Emissions and Evaluating their Significance'* guidance (2022) has been used in this PEIR chapter for the evaluation and significance of GHG emissions from the Project. This guidance is a revision of the first iteration of the guidance released in 2017 (IEMA, 2017).

44. The 2022 IEMA guidance presents guidelines for undertaking GHG assessments and to distinguish different levels of significance. The guidance does not update the IEMA's position that all emissions contribute to climate change, however it now provides relative significance descriptions to assist assessments specifically in the EIA context (detailed further in Section 33.4.3.5).

33.4.2 Data and information sources

33.4.2.1 Site specific

45. No site specific surveys were undertaken for this PEIR chapter.

33.4.2.2 Other available sources

46. The sources that have been used to inform the assessment are listed in Table 33.6.

Table 33.6 Available data and information sources

Data Set	Data Source	Spatial Coverage	Year	Notes
Conversion factors for reporting of GHG emissions	BEIS, 2022d	UK	2022	Emission factors for use in the GHG assessment, in particular for fuel consumption
Life Cycle Greenhouse Gas Emissions of Utility Scale Wind Power	Dolan and Heath, 2012	N/A	2012	Benchmarking of results from the GHG assessment
Inventory of Carbon and Energy (ICE)	Jones & Hammond, 2019	International	2019	Emission factors for embodied carbon in materials used in construction
Life Cycle Costs and Carbon Emissions of Offshore Wind Power	Thompson & Harrison, 2015	UK (plus some international considerations)	2015	Benchmarking of results from the GHG assessment and likely contribution of decommissioning activities to the overall Project footprint

33.4.3 Impact assessment methodology

47. Chapter 6 EIA Methodology (Volume I) explains the general impact assessment methodology applied to the Project. The purpose of this chapter is to consider the implications on GHG emissions associated with the Project. The following sections describe the methods used to assess any likely significant effects on climate change and GHG emissions, both offset and created by the Project.

33.4.3.1 Context

33.4.3.1.1 GHG Emission Sources for Offshore Wind Farms

48. The construction, O&M and decommissioning of wind farm projects results in the generation of GHG emissions, both from the standpoint of:

- Embodied carbon and GHGs from both onshore and offshore components
  - Emissions caused by the extraction and refinement of raw materials and their manufacture into the commodities and products that make up the onshore and offshore components such as WTGs (and their associated physical infrastructure), cables, etc.
- Carbon and other GHG emissions arising from the combustion of fuels and energy used in constructing, operating and maintaining the Project components over its lifetime and in decommissioning
  - These emissions are associated with marine vessels, helicopters, road transport vehicles and onshore plant and equipment.

49. The release of emissions from these sources are small in comparison to emissions from fossil fuel generation of energy, and the emissions saved during the generation of electricity from wind (when compared to fossil fuel sources) outweigh those released from construction, O&M and decommissioning activities.

50. There are inherent uncertainties associated with carrying out GHG footprint assessments for offshore wind energy projects, although the approach to determine emissions from individual source groups is well defined.

51. A report published by the University of Edinburgh in 2015 (Thomson & Harrison, 2015) examined the lifecycle costs and GHG emissions associated with offshore wind energy projects, comparing data obtained from the analysis of some 18 studies carried out over the period 2009 to 2013 (Thomson & Harrison, 2015). This report provided useful context for the Project's GHG assessment and benchmark figures which were used to verify the outcomes of the assessment. It is acknowledged that advancements and efficiencies have been gained in the offshore wind sector since this study was undertaken, however, the figures and details within this study still provide useful context for the GHG assessment.

52. Table 33.7 provides a summary of the percentage of total GHG emissions associated with the different phases of an offshore wind farm development as provided within the report (Thomson & Harrison, 2015).

Table 33.7 Summary of offshore wind farm GHG emissions (Thomson & Harrison, 2015)

Phase	% of total GHG emissions
Manufacture and Installation	78.4
O&M	20.4
Decommissioning	1.2

53. The report highlighted that the greatest proportion of emissions are associated with the manufacture and installation of the wind farm components. Decommissioning accounted for the smallest proportion, only 1.2%, of total life cycle GHG emissions. A more detailed breakdown of emissions is given in Thomson & Harrison (2015) for an offshore wind farm with steel foundations. This is reproduced in Plate 33.2.

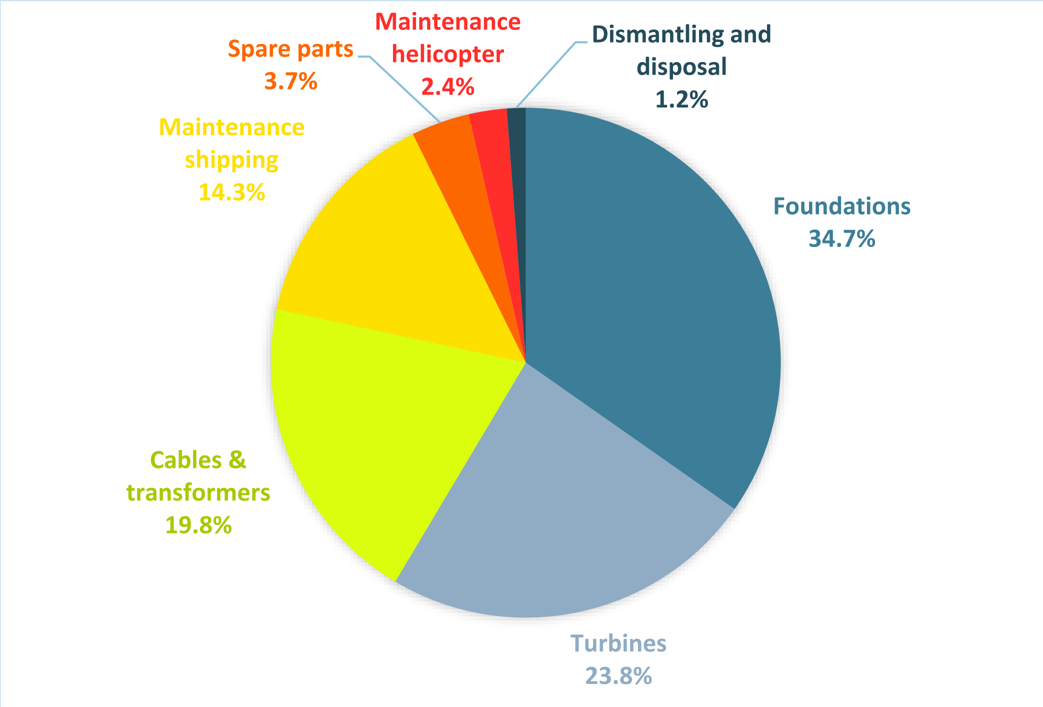

Plate 33.2 Summary of offshore wind farm GHG emissions (Thomson & Harrison, 2015)

54. Of the components or phases shown in Plate 33.2, GHG emissions associated with foundation fabrication and installation accounted for the largest proportion of emissions (34.7%), followed by manufacture and installation of the turbines (23.8%) and the cables and transformers (19.8%).

55. GHG emissions from shipping movements during maintenance operations over the operational lifetime of the example wind farm contributed 14.3%. This value may appear to be unexpectedly high, but the vessel movements contribution is associated with an assumed 20-year operational lifespan of the wind farms considered in the studies. Emissions derived from spare parts (3.7%), helicopter movements (2.4%) and dismantling and disposal (1.2%) are all small in comparison. The O&M phase of the Project is anticipated to be 30 years and is therefore longer than the wind farms considered in these studies.

56. A recent report by Catapult (Spyroudi, 2021) investigated the carbon and GHG implications of end-of-use management after decommissioning and provided some context to carbon Life Cycle Analysis (LCA) of offshore wind farms. Within the studies, turbines were predicted to contribute to 50% of the total GHG footprint of materials used in wind farm components. The Catapult report references the National Renewable Energy Laboratory (NREL) report (NREL, 2015) which states that WTGs are predominantly made of steel (71-79% of total turbine mass), fibreglass, resin or plastic (11-16%), iron or cast iron (5-17%), copper (1%) and aluminium (0-2%). The Catapult report (Spyroudi, 2021) advises that recycling can save, on average, at least 35% of CO_2e (carbon dioxide equivalent) per kWh of generation from assets in an offshore wind farm (operating 6 MW and 10 MW turbines), as opposed to new manufacturing of components.

33.4.3.1.2 GHG Intensity of Offshore Wind Energy

57. In the University of Edinburgh report (Thomson & Harrison, 2015), additional analysis of the data extracted from the 18 technical studies expressed the GHG emissions as grammes (g) of CO_2e per kilowatt-hour (kWh) of electricity generated (expressed as "g $CO_2e.kWh^{-1}$"). These were found to vary quite widely, between approximately 5 and 33 g $CO_2e.kWh^{-1}$. There was no clear relationship between the metrics for either turbine rating (in MW) or capacity factor.

58. A further study in 2012 (Dolan & Heath, 2012), amassed the results of over 200 studies of carbon emissions from wind energy and attempted to "harmonise" the results to use only the most robust and reliable data and to align methodological inconsistences. The harmonised results of this study revealed that the range in GHG emissions per kWh of electricity generated varied between approximately 7 and 23 g $CO_2e.kWh^{-1}$, with a mean value of around 12 g $CO_2e.kWh^{-1}$.

59. It is noted that these studies were undertaken in 2012 and 2015, and since then there have been significant advances in the technology, infrastructure and components used for offshore wind farms. Therefore, other available published sources were reviewed to evaluate average the GHG intensity of energy produced offshore wind farms, and these are presented in Table 33.8. As shown, the range of energy intensities for offshore wind farms across the various studies is 7.8 to 25.5 g $CO_2e.kWh^{-1}$.

Table 33.8 Review of average carbon emissions per kWh

Wind farm sizes	Energy intensity (g $CO_2e.kWh^{-1}$)	Source
12x 5 MW	32	Chen *et al*. (2011), referenced in Bhandari *et al*. (2020)
N/A	6	IEA World Energy Outlook (2012), referenced in Siemens Gamesa (no date) and Orsted (2021)
100x 2.5 MW	13.7	Arvesen & Hertwich (2012), referenced in Bhandari *et al*. (2020)
80x 4 MW	10.9*	Bonou *et al*. (2016), referenced in Bhandari *et al*. (2020)
100x 6 MW	7.8*	Bonou *et al*. (2016), referenced in Bhandari *et al*. (2020)
28x 3.6 MW	25.5*	Yang *et al*. (2018), referenced in Bhandari *et al*. (2020)
*offshore wind farm studies published from 2016 onwards		

60. To place these metrics into context, comparable values for electricity generation by gas are around 372 g $CO_2.kWh^{-1}$ (31 times that of offshore wind, using the mean value from Dolan & Heath (2012)) and, for coal, approximately 1,002 g $CO_2.kWh^{-1}$ (83.5 times that of offshore wind, using the mean value from Dolan & Heath (2012)) (BEIS, 2022b). These values are unlikely to take account of the construction materials (e.g. concrete) required for the power stations.

61. Although robust and fit for the purposes of an EIA, this assessment should not be taken to be a comprehensive, detailed LCA of the Project. The reasoning behind this is it is not possible to fully define the supply chain for the Project and undertake the relevant detailed assessments at this stage in the Project. Therefore, assumptions and simplifications to the methodology were made in

certain areas and a precautionary approach was adopted for the assessment to allow for this. These assumptions and simplifications are referred to in Section 33.4.6 and the worst-case scenario is set out in Table 33.2.

33.4.3.2 Assessment approach

62. In this assessment the term 'GHG' or 'carbon' encompasses CO_2 and the six other gases as referenced in the Kyoto Protocol (CH_4, N_2O, HFCs, PFCs, SF_6 and NF_3). The results in this assessment are expressed in carbon dioxide equivalent (CO_2e), which recognises that different gases have notably different global warming potentials (GWP).

63. GHG emissions arising from activities in the construction, O&M and decommissioning phases of the Project were predicted within a defined 'project boundary' (see Section 33.3.1), in accordance with the GHG Protocol (World Resources Institute and World Business Council on Sustainable Development, 2015).

64. To assist with the determination of the significance of the Project in relation to GHG emissions (as discussed in Section 33.4.3.5), three parameters were calculated to contextualise the GHGs emitted during the life cycle of the Project in relation to the benefits of providing renewable energy. These include:

- The emissions saved as a result of the Project when compared to fossil generated sources;
- The GHG intensity of the energy produced by the Project, which takes into account the amount of energy generated by the Project over its lifetime in relation to its total GHG emissions; and
- GHG 'payback' period, which is the time it would take for electricity generated by fossil fuels to be displaced.

33.4.3.3 Emission calculations

65. GHG emission sources arising from the Project were categorised into five main source groups, as detailed in Table 33.9.

Table 33.9 Emission source groups considered in the assessment

Source Name	Phase	Onshore or Offshore	Definition	Project Sources
Embodied emissions in materials (onshore and offshore)	Construction and O&M	Both	Embodied emissions within materials comprise GHGs released throughout the supply chain, and includes the extraction of materials from the ground, transport, manufacturing, assembly and its end-of-life profile.	Embodied emissions were quantified for the main construction materials to be used for the onshore and offshore components of the Project including foundations, WTGs (tower, nacelle, rotor, blades), scour protection, cables (onshore and offshore), offshore electrical platforms and the onshore project substation. The requirement for spare (or replacement) parts during operation is not known at this stage, therefore the likely composition of emissions in terms of the

Source Name	Phase	Onshore or Offshore	Definition	Project Sources
				overall footprint of the Project was obtained from existing literature.
Marine vessels (offshore)	Construction and O&M	Offshore	GHG emissions are released in exhaust gases from the combustion of fossil fuels on marine vessels.	Emissions associated with the movement of marine vessels for the offshore component of the Project were calculated. Emissions from vessels associated with installation of foundations, WTGs and cables, as well as supply and support, accommodation and commissioning vessels were also quantified. Emissions from marine vessel movements during the O&M phase were also quantified.
Road traffic vehicles	Construction and O&M	Onshore	GHG emissions are released from the combustion of fossil fuels by road vehicles.	Emissions associated with the movement of Heavy Goods Vehicles (HGVs) and staff travel during construction and operation were included within the assessment.
Plant and equipment	Construction	Onshore	GHG emissions are released from Non-Road Mobile Machinery (NRMM) as a result of fuel combustion.	Emissions from the use of NRMM during construction of the onshore component of the Project were quantified. This included the landfall, trenchless crossings, cable installation, main onshore compounds and substation works.
Helicopter	Construction and O&M	Offshore	GHG emissions are released in exhaust gases arising from the combustion of fossil fuels on helicopters.	Emissions associated with helicopters movements during construction and O&M were quantified in the assessment.

66. Details on all the activities that will take place during the construction, O&M and decommissioning phases are not fully known at this stage, therefore some assumptions have been made in order to quantify GHG emissions at PEIR stage, as detailed Section 33.4.6. These assumptions are based on indicative data from similar projects provided by the Project's design team or professional judgement.

67. It is not anticipated that significant updates to the GHG assessment will be required at the ES stage. However, additional or more specific information related to these phases or further refined Project information (i.e. refinements of the worst case parameters outlined in Table 33.2) may be available and provided for the assessment at the ES stage. This will enable a refinement of GHG emissions calculations to be undertaken, where required. It is anticipated

that any refinement to the GHG assessment between PEIR and ES would not change the significance of the effect outcome concluded in this assessment.

68. Emissions from decommissioning were derived from previous studies (Thomson & Harrison, 2015), where it was established that this phase would contribute approximately 1.2% of the carbon footprint.

69. The approach to quantifying GHG emissions for each of the source groups detailed in Table 33.9 is provided in Appendix 33.1 (Volume III). The total operational life of the Project is anticipated to be 30 years.

33.4.3.3.1 Embodied emissions in materials

70. Emissions of 'cradle to (factory) gate', a term which includes the extraction, manufacture and production of materials to the point at which they leave the factory gate of the final processing location, were calculated for the Project. GHG emissions were derived from quantities or volumes of known materials that will be used in construction, including the following infrastructure:

- The key offshore components of the Project comprise:
  - WTGs (i.e. tower, nacelle, rotor, blades);
  - Offshore substation platforms and structures;
  - WTG and offshore substation foundations (e.g. monopiles, jackets, gravity based, etc.);
  - Scour protection (i.e. rock); and
  - Offshore export and interconnecting cables.
- The key onshore components comprise:
  - Imported material for construction at landfall and along the onshore cable route, such as stone, asphalt, kerbs, concrete, pipe, cement bound sand (CBS), ducting, geogrid/geotextile, bentonite, water and steel reinforcement;
  - Onshore export cables installed underground from landfall to the onshore substation; and
  - Onshore substation.

71. The approach to determining embodied emissions from materials used for the Project is detailed in Appendix 33.1 (Volume III).

33.4.3.3.2 Marine vessels

72. Marine vessels will be used to bring materials and components to the wind farm site, install infrastructure (WTGs, offshore substation platforms, substructure and cables), provide crew accommodation and support during construction, commissioning and for O&M activities. The current working assumptions for offshore vessel logistics during construction and O&M have been supplied by the Projects design team. Full details of the approach undertaken to determine GHG emissions from marine vessels is detailed in Appendix 33.1 (Volume III).

33.4.3.3.3 Helicopters

73. Helicopter movements associated with the construction phase (i.e. during commissioning) and O&M phases of the Project will result in the release of GHG emissions. There is potential that technicians will be transported to turbines

using helicopters during the commissioning of the Project and unplanned maintenance tasks will be undertaken via helicopters during the O&M phase, when CTV access is not possible. The volume of GHG emissions from helicopters was calculated by determining the expected fuel consumption using trip data provided by the Project team.

74. The methodology for determining GHG emissions from helicopter movements associated with the Project is provided in Appendix 33.1 (Volume III).

33.4.3.3.4 Road traffic vehicles

75. Road traffic vehicle movements associated with the construction and O&M phases of the Project will result in the release of GHG emissions. GHG emissions were calculated from current estimations of the total kilometres travelled by HGVs and staff transport to and from the onshore construction sites, and also during the O&M phase, based upon the assessment presented in Chapter 27 Traffic and Transport (Volume I). Full details of the methodology are provided in Appendix 33.1 (Volume III).

33.4.3.3.5 Plant and equipment

76. Fuel consumption associated with the operation of NRMM for the onshore components of the Project were calculated based on the estimated use of each item of plant and equipment, with representative plant types provided by the Project team. Indicative construction plant and equipment for construction activities at landfall and along the onshore cable route were provided by the design team for the Project and are specific to North Falls. The onshore substation is not currently at the outline design stage, therefore, estimates for the numbers and type of construction plant and equipment at the onshore substation are based on other projects of a similar nature to North Falls.

77. The approach to determining emissions construction plant and equipment is detailed in Appendix 33.1 (Volume III).

33.4.3.4 Definitions of sensitivity, value and magnitude

78. This assessment was undertaken in accordance with the general methodology presented within Chapter 6 EIA Methodology (Volume I); however, a topic-specific assessment methodology and approach to determining impact significance is provided within IEMA guidance (IEMA, 2022), as set out in the following sections.

33.4.3.4.1 Sensitivity

79. The receptor for the GHG assessment is the global atmosphere. As such, it is affected by all global sources of GHGs, and is therefore considered to be of ‘high’ sensitivity to additional emissions.

33.4.3.5 Impact significance

80. Guidance on the assessment of GHG emissions was first released by IEMA in 2017 (IEMA, 2017), which stated that “…in the absence of any significance criteria or defined threshold, it might be considered that all GHG emissions are significant…”. However, the recently updated IEMA guidance (IEMA, 2022) recognises “when evaluating significance, all new GHG emissions contribute to a negative environmental impact; however, some projects will replace existing development or baseline activity that has a higher GHG profile. The significance of a project’s emissions should therefore be based on its net impact over its lifetime, which may be positive, negative or negligible”.

81. Significance can be evaluated in a number of ways depending on the context of the assessment, i.e. sector-based, locally, nationally, policy goals or against performance standards. The IEMA guidance recommends that significance criteria align with Paris Agreement, the UK's Carbon Budgets up to 2037 and net zero commitments: *"the crux of significance 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"* (IEMA, 2022).

82. The updated IEMA guidance provides relative significance descriptions to assist assessments, specifically in the EIA context. Section VI of the updated IEMA guidance (IEMA, 2022) 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. These are presented below in Table 33.10.

Table 33.10 Assessment significance criteria

Significance	Definition
Major adverse	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 the UK's trajectory towards net zero.
Minor adverse	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 UK's trajectory towards net zero.
Negligible	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	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.

83. Likely significant effects identified within the assessment as major/moderate adverse or beneficial are deemed to be significant in EIA terms within this chapter. Whilst only one level of significance criteria is provided where there is a net reduction in emissions, further context with respect to the level of emissions offset compared to the baseline scenario is provided in Section 33.7.2.

33.4.4 Cumulative effects assessment methodology

84. The global atmosphere is the receptor for the GHG assessment, therefore there are no common receptors between this assessment and other disciplines considered in the PEIR. GHG emissions have the potential to contribute to climate change, and therefore the effects are global and cumulative in nature. This is taken into account in defining the receptor (i.e. the global atmosphere) as high sensitivity.

85. The IEMA guidance (IEMA, 2022) states that effects of GHG emissions from specific cumulative projects should therefore not be individually assessed, as there is no basis for selecting which projects to assess cumulatively over any other. The GHG assessment is therefore considered to be inherently cumulative, and no additional consideration of cumulative impacts is required.

33.4.5 Transboundary effects assessment methodology

86. As noted above for cumulative impacts, the receptor for the GHG assessment is the global atmosphere, and therefore emissions of GHGs have an indirect transboundary impact. As the GHG emissions are assessed in context of the UK carbon budgets and the aspirations to reduce GHG emissions in line with climate agreements, the cumulative transboundary impacts of GHGs emitted by the Project are not considered to require specific consideration.

33.4.6 Assumptions and limitations

87. A number of assumptions were made in the GHG assessment, as set out in Table 33.11. Further details of the methodology adopted to quantify GHG emissions from the Project are presented in Appendix 33.1 (Volume III).

Table 33.11 Assumptions and limitations of the GHG assessment

ID	Assumption/ Limitation	Discussion
1	Quantities for all materials to be used during construction were not available at the time of the assessment	Quantities of the main and most GHG intensive materials were included in the assessment. Furthermore, precautionary assumptions were adopted for quantities of known materials (i.e., using the maximum quantity).
2	Recycled content of construction materials	As an example, it has been assumed that all steel used on the Project is virgin steel to provide a conservative assessment. It is likely that materials that will be used in construction such as steel will have a high recycled content, and thus a lower embodied carbon content than has been assumed in this assessment.
3	Lack of emission factors for future year activities, such as fuel consumption and material extraction.	The most recent and available emissions factors were used in the assessment to provide a precautionary assessment.
4	The specific nature and composition of some materials, such as the type of concrete or steel to be used, was unknown which may	If there was variation across different compositions of the same material, the 'General' option within the ICE database was chosen, if available, or the median value if not.

ID	Assumption/ Limitation	Discussion
	affect the embodied carbon within a material.	
5	Where there are multiple options for possible project parameters, the worst-case was selected in terms of material quantities (e.g. turbine substructures)	This approach provides a conservative assessment as there may be unrealistic combinations of project parameters which were used in determining the worst-case scenario.
6	Data for the movement of marine vessels on site during construction and the O&M phases of the Project were not available at the time of assessment.	The number of vessel movements during construction and O&M has yet to be defined in detail. Vessel logistics used within this assessment were provided by the Project's design team based on assumptions about the likely number of vessel movements required and may be further refined for ES. The duration that construction and O&M vessels would be on site is not known at this stage, so assumptions for these periods have been made using information available in the indicative programme, and where possible estimated from projects of a similar nature (proportionate to the size of the Project). These will be further refined where information is available for the ES.
7	The origin port of some of the marine vessels was not known at the time of the assessment, which affects how far the vessels have to travel to the site, and subsequently the quantity of emissions released.	As the majority of emissions will be released from vessels whilst at the site during installation, changes to the transit time for marine vessels will have a limited effect in terms of the overall GHG footprint. The most likely origin ports known at the time of the assessment were used to derive GHG emissions during vessel transit.
8	Emissions from vessels associated with transporting scour protection or undertaking dredging activities were not included in this assessment.	It is assumed that scour layer vessels originate from Norway and only include one-way transit in the GHG assessment, as the Project has no control over where scour layer vessels go after visiting the windfarm site. Emissions associated with dredging activities during construction and O&M have not been quantified, as this level of information is not known at this stage of the Project.
9	Helicopter trips	It is feasible that some work during the construction/ commissioning and O&M phases would be undertaken using helicopters. Helicopter movements for the Project have yet to be defined, therefore these have been estimated by the Project's design team based on an indication project of a similar size to North Falls. It has been assumed that the type of helicopter used for these activities would be a AW139 model. The project team indicated that the originating location during construction or commissioning for these helicopter trips would be confirmed in advance of ES submission, and at this stage as a worst case an indicative airport in

ID	Assumption/ Limitation	Discussion
		the South East of England[1] has been used in the assessment. It has also been assumed that O&M activities would originate at this example airport, as the O&M base has yet to be determined.
10	O&M emissions	Many sectors are anticipated to decarbonise over the next 30 years and, during O&M, it is likely that the emissions intensity of producing materials and the movement of marine vessels will be less than the present day. Therefore, emissions associated with the O&M phase of the Project are likely to be a significant overestimation.
11	Expected operational requirements of construction plant and equipment for the onshore components.	As the onshore substation is not currently at the detailed design stage, the project design team has estimated likely construction plant and equipment based on an indicative project of a similar size to North Falls. The duration plant and equipment will be present at the onshore substation is approximately 30 months. However, some assumptions (as detailed in Section 33.4.3.3.5 and Appendix 33.1, Volume III) have been made in order to quantify associated GHG emissions with specific activities at the onshore substation (e.g. site preparation, civils, groundwork, etc.).
12	Energy displaced by the Project would otherwise be produced by gas supplied electricity	The approach advocated by RenewableUK (2023) was used to determine emissions for the 'without Project' scenario, using the BEIS (now Department for Energy Security and Net Zero (DESNZ) emission factor for gas supplied electricity (BEIS, 2022b). This may change in the future, but it considered a valid approach for determining the emissions saved from renewable energy projects.
13	Further work to be undertaken at ES	It is not anticipated that significant updates to the GHG assessment will be required at the ES stage. However, additional or more specific information related to activities during construction or O&M phases or further refined Project information (i.e. refinement of the worst case parameters outlined in) may be available and provided for the assessment, which will enable a refinement of GHG emissions calculations to be undertaken at the ES stage, where required. It is anticipated that any refinement to the GHG assessment between PEIR and ES would not change the significance of the effect outcome concluded in this assessment. At this stage of the design, there is insufficient information to undertake an assessment to determine the vulnerability and resilience of the Project to climate change. This will be considered further at the assessment stage for the ES.

[1] Shoreham Airport was used in the assessment as a worst case. This assumption will likely be revised and updated for the ES.

33.6 Existing environment

33.6.1 Regional GHG emissions

88. The BEIS *'UK local authority and regional greenhouse gas emissions national statistics'* (BEIS, 2022c) database provides a breakdown of local, regional and national GHG emissions. The UK's CO_2e emissions were estimated to be 377,680 kilotonnes (kt) CO_2e in 2020. CO_2e emissions from the Tendring District Council region were 618.5 kt, a contribution of less than 0.2% of the UK's total. Plate 33.3 displays CO_2e emissions within the Tendring District Council region from 2005 to 2020 and Plate 33.4 shows local, regional and national CO_2e emissions per capita.

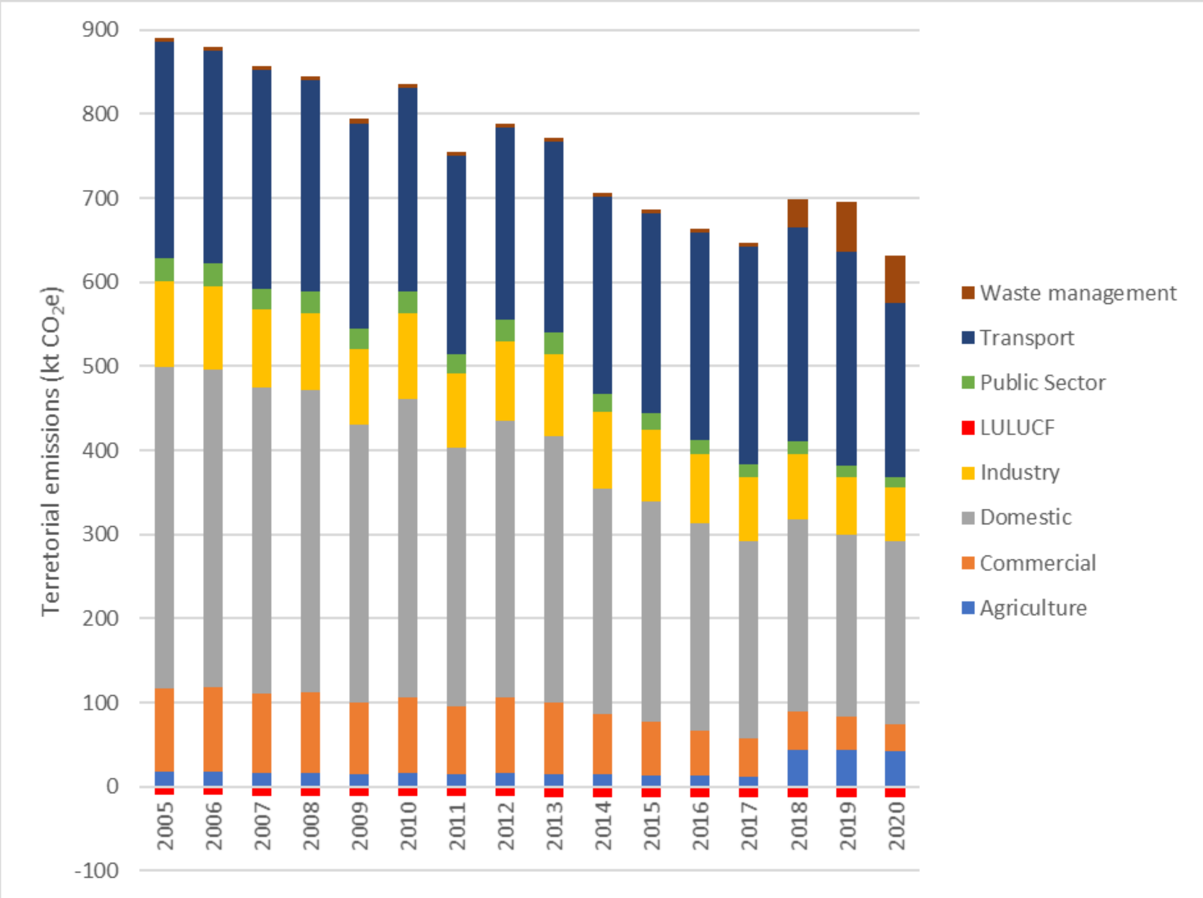

Plate 33.3 Tendring territorial emissions (kt CO_2e) – 2005 to 2020 (BEIS, 2022c)[1]

89. As shown in Plate 33.3, in general, GHG emissions have steadily declined in the Tendring District Council region. Annual CO_2e emissions within the Tendring District Council region have decreased by 30% between 2005 and 2020, with reductions in the domestic and commercial sectors largely driving this change.

90. The data shows that there was an increase in agriculture and waste management emissions from 2018 onwards, which was likely to be a result of the inclusion of additional agriculture (i.e. livestock and soils) and waste management (landfill) sources. The 'domestic' and 'transport' sectors account for the most GHG emissions in the Tendring District Council region, both contributing approximately one third of total emissions in 2020.

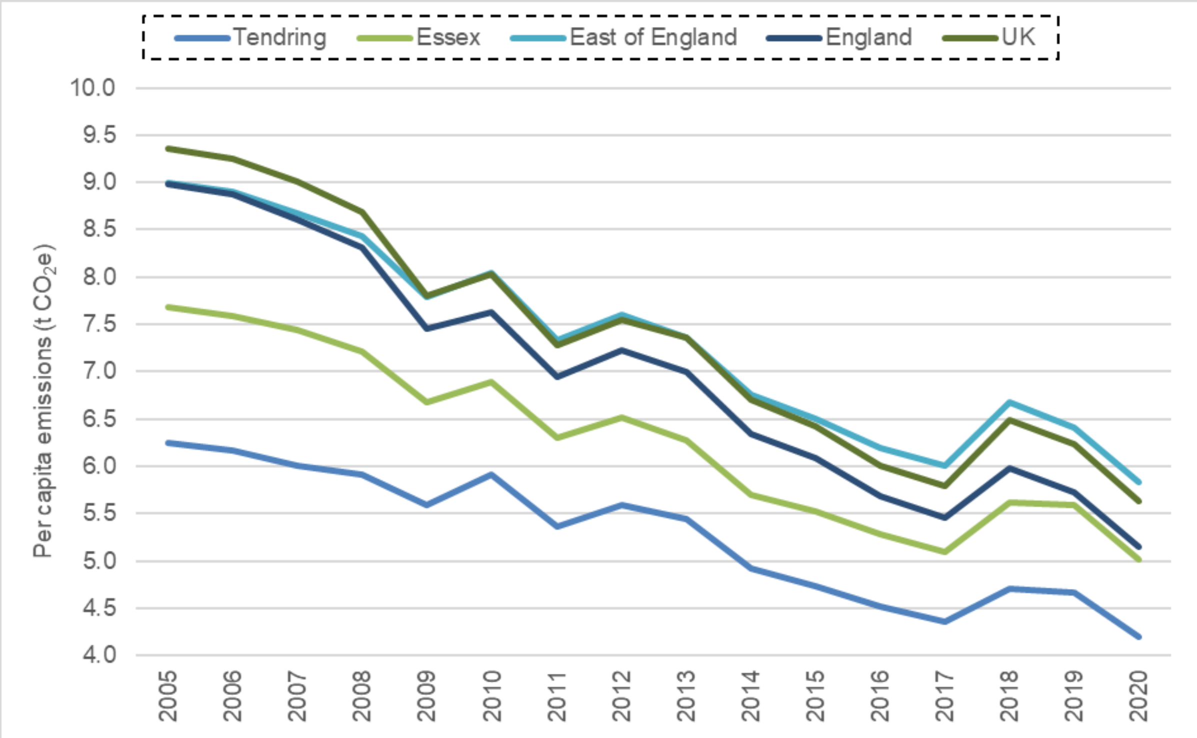

Plate 33.4 Per capita emissions (tonnes CO_2e) – locally, regionally and nationally

91. As shown in Plate 33.4, GHG emissions per capita have in general decreased over the 15 year period at local, regional and national scales. The increase in emissions from 2018 onwards is due to the inclusion of additional agriculture and waste management categories, as previously mentioned.

33.6.2 Baseline 'do nothing' scenario

92. To help determine the significance and contextualise the outcomes of the GHG assessment, consideration of a baseline or 'without development' scenario is required. The UK electricity grid mix currently includes a number of different energy sources, including gas, nuclear, onshore and offshore wind, coal, bioenergy, solar and hydroelectric.

93. The growth of renewable energy is key to the UK's Energy Strategy and net zero targets, and a transition away from electricity generated by fossil fuels. Therefore, to evaluate the impact of the Project, it was assumed that electricity produced by fossil fuels is displaced, as detailed in Section 33.6.2.1.

33.6.2.1 Energy produced by the Project

94. The approximate quantity of energy produced by the Project both annually and over the lifetime of the Project was quantified from the approach advocated by RenewableUK (2023), where the installed capacity (assumed to be a maximum of 1 GW) was multiplied by the hours in the year (8,760) and by the appropriate average load or capacity factor for the Project. For new build offshore wind farms, BEIS advises that the load factor is 63.1% (BEIS, 2021d).

95. The anticipated energy produced by the Project is:

- Approximately: 5,527,560 MWh/year

- Approximately: 165,826,800 MWh over the 30 year lifetime of the Project

33.6.2.2 GHG emissions from 'do nothing' scenario

96. In the 'do nothing' scenario, where the Project is not constructed, it has been assumed that the energy produced by the Project would be produced using natural gas, as this is the most common form of new plant in terms of fossil fuel combustion (BEIS, 2022b). An alternative approach would be to use the future electricity emission factors of the UK grid, for which projections are available from BEIS (2021e). However, these projections will account for renewable energy projects such as North Falls becoming operational and decarbonizing the UK electricity grid. Therefore, the use of the future projection of the UK grid is not considered to be reasonable approach when determining a 'do nothing' or without project baseline scenario.

97. GHG emissions produced from the generation of electricity that the Project would provide by gas in the 'do nothing' scenario is presented in Table 33.12. This has been quantified by multiplying the anticipated energy generated by the project by the estimated CO_2 emissions from gas supplied electricity (372 tonnes $CO_2.GWh^{-1}$) (BEIS, 2022b). It is noted that the electricity supplied by gas emission factor is in units of CO_2 rather than CO_2e, however CO_2 is likely to form the main contribution to generation of electricity from gas and the factor is likely higher, were other GHGs to be included.

Table 33.12 Do nothing scenario baseline GHG emissions

Timeframe	Anticipated energy produced by project	GHG emissions from electricity generated from gas (tonnes CO_2)
Per year	5,527.56 GWh per year	2,057,639
Duration of project (30 years)	165,827.8 GWh over 30 years of project	61,729,159

33.7 Assessment of significance

33.7.1 Potential effects during construction, operation and decommissioning

98. This section presents the GHG emissions associated with the construction, O&M and decommissioning of North Falls. The carbon benefits of the Project are then listed, including the amount of GHG emissions saved (or offset) and the GHG intensity of the electricity produced by the Project, and the carbon payback period.

33.7.1.1 Quantification of the Projects GHGs

99. The results of the GHG assessment for the Project are shown in Table 33.13. These values include emissions associated with the Project lifetime, including construction, an operational lifetime of 30 years and decommissioning.

Table 33.13 GHG emissions for the Project (based upon an O&M period of 30 years)

Phase	Source	GHG emissions (tonnes CO_2e)*	% of phase GHG footprint*	Total GHG emissions per phase (tonnes CO_2e)*	% of overall GHG footprint
Construction	Embodied emissions in materials: offshore	2,293,147	88.4%	2,592,626	55.5%
	Embodied emissions in materials: onshore	71,488	2.8%		
	Marine vessels: transit	42,008	1.6%		
	Marine vessels: activity on site	162,722	6.3%		
	Helicopters	554	0.02%		
	Plant and equipment: landfall and onshore cable corridor(s)	2,833	0.1%		
	Plant and equipment: onshore substation	14,408	0.6%		
	Road traffic vehicles	5,465	0.2%		
O&M	Marine vessels	1,941,757	96.1%	2,021,607	43.3%
	Helicopters	5,043	0.2%		
	Road traffic vehicles	11	<0.001%		
	Spare parts	74,796	3.7%		
Decommissioning	1.2% of total**	56,063	100.0%	51,063	1.2%
Total		4,670,296			

*Figures presented in this table have been rounded to the nearest whole number, therefore if GHG emissions per source are summed using the figures in the third column, they may not exactly match the per phase or overall totals.

Phase	Source	GHG emissions (tonnes CO_2e)*	% of phase GHG footprint*	Total GHG emissions per phase (tonnes CO_2e)*	% of overall GHG footprint
**Similarly to the above, percentages have been included in the table to a one decimal place (with the exception of construction helicopter and O&M road traffic vehicle emissions as these sources are <0.5%), therefore if source percentages in the fourth column are summed, they may not exactly match the per phase or overall percentages. ***refer to Table 33.7.					

100. The results in Table 33.13 show that construction phase of the Project is anticipated to have the highest emissions contribution. Embodied carbon in construction materials is expected to be the largest source of emissions to the overall project footprint, contributing approximately 91% of overall construction phase emissions for both onshore (2.8%) and offshore (88.4%) components. As stated in Appendix 33.1 (Volume III) and Section 33.4.6, there is likely to be an overestimation of embodied carbon in materials, and some of the assumptions adopted in this preliminary assessment will be refined at the ES stage.

101. Emissions from the sources considered in the assessment are predicted to be approximately 4.67 million tonnes CO_2e. Contextualisation of the results are presented in Section 33.7.1.1.1 to 33.7.1.2.2.

102. Emission factors used in the assessment such as for manufacturing of materials and the movement of marine vessels are representative of present-day conditions. It is highly likely that the emission factors would reduce as sectors within the UK decarbonise over the temporal scope of approximately 30 years considered in the assessment. The results from the assessment are therefore considered to be conservative.

33.7.1.1.1 GHG intensity of electricity production

103. The GHG intensity per unit of electricity produced by the Project was determined by dividing the predicted quantity of emissions (4.67 million tonnes CO_2e, as set out in Table 33.13) by the anticipated energy produced over its lifespan.

104. The approach to estimating the amount of energy produced by the Project was derived from the approach advocated by RenewableUK (2023), where the installed capacity (assumed to be up to 1 GW) was multiplied by the hours in the year and by the appropriate average load or capacity factor for the Project. For new build offshore wind farms, BEIS advises that the load factor is 63.1% (BEIS, 2021d).

105. The approach and calculations estimating the amount of energy produced by the Project is presented in Section 33.6.2.1. The anticipated levels and associated GHG intensity of electricity generated by the project is presented in Table 33.14.

Table 33.14 Electricity generation and GHG intensity for the Project

Project	Annual electricity generation (GWh p.a.)	Electricity generated by project (GWh)	GHG intensity of electricity produced by project (g $CO_2e.kWh^{-1}$)
North Falls	5,528	165,827	28.2

106. The GHG intensity of the electricity produced by the Project is therefore 28.2 g $CO_2e.kWh^{-1}$. As noted in Section 33.4.3 and Section 33.4.6, a number of very conservative assumptions were adopted in the assessment, therefore the GHG footprint of the Project, particularly during the O&M phase, is likely to be an overestimation. Some of these assumptions will be refined at the ES stage.

33.7.1.2 GHG emission savings or carbon offset

107. In the 'do nothing' scenario, it was assumed that the electricity generated by the Project would be produced using gas, as this is the most common form of new

plant in terms of fossil fuel combustion. The quantity of GHG emissions produced from the generation of electricity from gas is presented in Table 33.15, along with the GHG footprint of the Project as presented in Section 33.7.1.1. These values are used to derive the total carbon offset by the Project. It is noted that the emission factor for electricity supplied by gas is in units of CO_2 rather than CO_2e, however, CO_2 is likely to form the main contribution to the generation of electricity.

Table 33.15 GHG savings from the Project

Project	Anticipated energy produced by the Project (GWh)	GHG emissions from electricity generated from gas (tonnes CO_2)	Project GHG emissions (tonnes CO_2e)	GHG emission saved (tonnes CO_2e)
North Falls	165,827	61,729,159	4,670,296	57,058,863

108. The data presented in Table 33.15 shows that the estimate level of GHG savings over the lifespan of the Project would be approximately 57 million tonnes CO_2e. The Project would therefore support the UK's transition to a low to zero-carbon energy generation mix.

33.7.1.2.1 GHG payback period

109. To estimate the 'GHG payback' of the Project, it was assumed that electricity produced by gas is displaced (as detailed in the 'do nothing' scenario in Section 33.6.2). Using this approach, the GHG payback of the Project is 2.27 years from the time when the Project becomes fully operational, as set out in Table 33.16.

Table 33.16 GHG 'payback' period

Parameter	Value	Unit
Energy produced by project	5,528	GWh/year
CO_2* intensity of electricity generated by natural gas	372	tonnes CO_2/GWh
Yearly CO_2* from gas-generated electricity (i.e. saved per year)	2,057,639	tonnes
Total CO_2e released by the Project (total: construction/30 year O&M/decommissioning)	4,670,296	tonnes
Time taken for Project-generated CO_2e to be paid back	2.27	years
*As detailed in Section 33.6.2.2, it is noted that the electricity supplied by gas emission factor is in units of CO_2 rather than CO_2e, however CO_2 is likely to form the main contribution to generation of electricity from gas and the factor is likely higher, were other GHGs to be included.		

33.7.1.2.2 Comparison to UK Carbon Budget

110. The provision of renewable energy will play an important role in meeting the UK Carbon Budgets (see Section 33.4.1.3.1 and Table 33.5) and contributing to net zero aspirations.

111. During construction, total GHG emissions from the Project (2,592,626 tonnes CO_2e) were predicted to contribute approximately 0.13% of the 4^{th} UK Carbon Budget (between 2023 and 2027) over the five year period. This assumes that

all of the construction activities take place within the period 2023 – 2027, which is likely to be an overestimation as some emission activities will take place beyond 2027. GHG emissions during construction are temporary and form a relatively small component of the 4th UK Carbon Budget.

112. The total GHG saving associated with the Project is estimated to be 57 million tonnes CO_2e. For context, this GHG saving (over a 5 year period equates to approximately 9,509,811 tonnes CO_2e) as a result of the Project equates to 0.99% of the 6th UK Carbon Budget (2033-2037).

33.7.2 Significance of effect

113. As noted in Section 33.4.3.5, the significance of a project in relation to GHG emissions is dependent on the net GHG impacts and comparisons to the without project or 'do nothing' baseline and net zero aspirations.

114. As noted above, the Project would result in a reduction in the release of GHG's to the atmosphere by approximately 57 million tonnes CO_2e, compared to the without-project baseline (i.e. electricity produced by gas). The Project will provide a renewable source of electricity which beneficially contributes to the UK's goal of achieving net zero emissions by 2050. It is therefore considered that the effects would be of beneficial significance in relation to reducing GHG emissions, when compared to the relevant baseline scenario, in accordance with IEMA guidance (2022). This is considered significant in EIA terms.

115. Due to the extent of GHG emissions saved, the Project and the wider offshore wind sector, is anticipated to make a large contribution towards the UK meeting its emission reduction targets set out in the Carbon Budgets and Climate Change Act 2008.

33.8 Potential monitoring requirements

116. There are not anticipated to be any specific monitoring requirements for the Project with respect to GHG emissions.

33.9 Cumulative effects

117. As noted in Section 33.4.4, the global atmosphere is the receptor for the GHG assessment (which is of high sensitivity) and IEMA guidance (2022) states that effects of GHG emissions from specific cumulative projects should therefore not be individually assessed, as there is no basis for selecting which projects to assess cumulatively over any other. The impact of GHG assessment is therefore inherently cumulative, and no specific cumulative assessment is required to be undertaken.

33.10 Transboundary effects

118. As described in Section 33.4.5, emissions of GHGs have an indirect transboundary impact. However, the cumulative transboundary impacts of GHGs emitted by the Project are not considered to require specific consideration.

33.11 Interactions

119. The global atmosphere is the receptor for the GHG assessment, therefore the impacts identified and assessed in this chapter do not have the potential to interact with each other. No further assessment of interactions was therefore undertaken.

33.12 Inter-relationships

120. The receptor for the GHG assessment is the global atmosphere. There are no other topics which have direct effects on this receptor, and therefore there are no inter-relationships with this topic.

33.13 Summary

121. A summary of the effects on climate change identified in the assessment are provided in Table 33.17.

Table 33.17 Summary of potential likely significant effects on climate change

Potential impact	Receptor	Sensitivity	Magnitude of impact	Pre-mitigation effect	Additional Mitigation measures proposed	Residual effect
Construction, O&M and decommissioning						
GHG emissions during construction, O&M and decommissioning	Global atmosphere	High	N/A*	Beneficial	Not required as effect is beneficial	N/A
Cumulative						
Cumulative impacts in relation the GHGs do not require an assessment.						
Transboundary						
Transboundary impacts were not explicitly considered within the assessment.						
**not defined as part of the assessment methodology*						

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