10 AIR QUALITY AND CLIMATE

10.1 INTRODUCTION

This chapter assesses the impacts of the Project (**Figure 1.2**) on air and on climate in Section 10.2 and 10.3 respectively. The Project refers to all elements of the application for the construction of Inchamore Wind Farm (**Chapter 2: Project Description**). Where negative effects are predicted, the chapter identifies appropriate mitigation strategies therein. The assessment considers the potential effects during the following phases of the Project:

- Construction of the Project;
- Operation of the Project, and
- Decommissioning of the Project.

Common acronyms used throughout this EIAR can be found in **Appendix 1.2.** This chapter of the EIAR is supported by Figures provided in Volume III and by the following Appendix documents provided in Volume IV of this EIAR:

- **Appendix 10.1 Scottish Government – Carbon Calculator Input and Output Data**

10.1.1 Statement of Authority

This chapter has been prepared by Jennings O'Donovan & Partners Limited. It was prepared jointly by Mr. David Kiely and Ms. Sarah Moore, with the assistance of Ms. Shirley Bradley.

Mr. David Kiely has undertaken EISs/ EIARs for wind farms throughout Ireland. He has 39 years' experience in the civil engineering and environmental sector and has obtained a Bachelor of Engineering Degree in Civil Engineering and a Master of Science degree in Environmental Protection. David has overseen the development of over 50 wind farms from feasibility, planning and environmental assessment through to construction including air and climate assessments for other wind farms.

Ms. Sarah Moore is a Senior Environmental Consultant and holds a Bachelor (Hons.) Degree in Environmental Science from University of Limerick and a MSc (Dist) in Environmental Engineering from Queen's University, Belfast. She has worked in environmental consultancy for over fourteen years and has prepared AA Screenings, Environmental Reports and EIARs and air and climate assessments for other wind farms.

Ms. Shirley Bradley is a Graduate Environmental Scientist with a First-Class Honours Degree (BSc. Hons) in Environmental Science from the Institute of Technology, Sligo. She was also awarded with the Governing Body award for a BSc in Environmental Protection. Shirley's key capabilities are in report writing, assisting Senior Consultants and GIS.

10.1.2 Assessment Structure

In line with the revised EIA Directive and current EPA guidelines listed in **Chapter 1**, **Section 1.6** the structure of this Air and Climate chapter is as follows:

- Assessment Methodology and Significance Criteria;
- Description of baseline conditions at the Site;
- Identification and assessment of impacts to air and climate associated with the Project, during the construction, operational and decommissioning phases of the Project;
- Mitigation measures to avoid or reduce the impacts identified;
- Identification and assessment of residual impact of the Project considering mitigation measures, and
- Identification and assessment of cumulative impacts if and where applicable.

The desktop study as outlined in Section 10.2 and 10.3 together with the other assessments detailed in this chapter are considered adequate to allow the Local Authority to carry out an adequate assessment of the Project.

10.2 AIR QUALITY

10.2.1 Assessment Methodology

This assessment of air quality involved the following:

- A desk study of the air quality baseline in the area of the Project and nationally;
- An evaluation of potential effects;
- An evaluation of the significance of effects, and
- The identification of measures to avoid and mitigate potential effects.

10.2.2 Relevant Legislation and Guidance

The Ambient Air Quality and Clean Air for Europe (CAFE) Directive (Directive 2008/50/EC) incorporates revised provisions for sulphur dioxide (SO_2), lead (Pb), nitrogen dioxide (NO_2), ozone (O_3), particulate matter (PM_{10} and $PM_{2.5}$), benzene (C_6H_6) and carbon monoxide (CO). This replaced the Air Quality Framework Directive (96/62/EC) and first three Daughter Directives (1999/30/EC, 2000/69/EC, 2002/3/EC). The Fourth Daughter Directive (2004/107/EC) will be incorporated into the CAFE Directive at a later date and stands alone as a separate EU Directive.

The Fourth Daughter Directive (2004/107/EC) relates to arsenic (As), cadmium (Cd), nickel (Ni), and mercury (Hg)_and polycyclic aromatic hydrocarbons (PAH) in ambient air and has been transposed into Irish legislation by the 'Arsenic, Cadmium, Mercury, Nickel and Polycyclic Aromatic Hydrocarbons in Ambient Air Regulations 2009 (S.I. No. 58 of 2009)'.

The CAFE Directive was transposed into Irish legislation by the Air Quality Standards Regulations 2011 (S.I. No. 180 of 2011) as amended by the Air Quality Standards (Amendments) and Arsenic, Cadmium, Mercury, Nickel and Polycyclic Aromatic Hydrocarbons in Ambient Air Regulations, 2016 (S.I. 659 2016).

The Clean Air for Europe (CAFE) Directive (Directive 2008/50/EC on ambient air quality), (as amended by Directive EU 2015/1480) encompasses the following elements:

- The merging of most of the existing legislation into a single Directive (except for the Fourth Daughter Directive) with no change to existing air quality objectives.
- New air quality objectives for $PM_{2.5}$ (fine particulate matter) including the limit value and exposure concentration reduction target
- The possibility to discount natural sources of pollution when assessing compliance against limit values
- The possibility for time extensions of three years (for particulate matter PM_{10}) or up to five years (nitrogen dioxide, benzene) for complying with limit values, based on conditions and the assessment by the European Commission.

The limit values of the CAFE Directive are set out in **Table 10.1**. Limit values are presented in micrograms per cubic metre (µg/m^3) and parts per billion (ppb). The notation PM_{10} is used to describe particulate matter or particles of ten micrometres or less in aerodynamic diameter. $PM_{2.5}$ represents particles measuring less than 2.5 micrometres in aerodynamic diameter.

Table 10.1: Limit values of CAFE Directive 2008/50/EC (Source: EPA)

Pollutant	Limit Value Objective	Averaging Period	Limit Value (µg/m^3)	Limit Value (ppb)	Basis of Application of Limit Value
Sulphur Dioxide (SO_2)	Protection of human health	1 hour	350	132	Not to be exceeded more than 24 times in a calendar year
Sulphur Dioxide (SO_2)	Protection of human health	24 hours	125	47	Not to be exceeded more than 3 times in a calendar year
Sulphur Dioxide (SO_2)	Protection of vegetation	Calendar Year	20	7.5	Annual mean

Pollutant	Limit Value Objective	Averaging Period	Limit Value (µg/m³)	Limit Value (ppb)	Basis of Application of Limit Value
Sulphur Dioxide (SO_2)	Protection of vegetation	1 Oct to 31 Mar	20	7.5	Winter mean
Nitrogen dioxide (NO_2)	Protection of human health	1 hour	200	105	Not to be exceeded more than 18 times in a calendar year
Nitrogen dioxide (NO_2)	Protection of human health	Calendar year	40	21	Annual mean
Nitric oxide (NO) + Nitrogen dioxide (NO_2)	Protection of ecosystems	Calendar year	30	16	Annual mean
PM_{10}	Protection of human health	24 hours	50	-	Not to be exceeded more than 35 times in a calendar year
PM_{10}	Protection of human health	Calendar year	40	-	Annual mean
$PM_{2.5}$ - Stage 1	Protection of human health	Calendar year	25	-	Annual mean
$PM_{2.5}$ - Stage 2	Protection of human health	Calendar year	20	-	Annual mean
Lead (Pb)	Protection of human health	Calendar year	0.5	-	Annual mean
Carbon Monoxide (CO)	Protection of human health	8 hours	10,000	8620	Not to be exceeded
Benzene (C_6H_6)	Protection of human health	Calendar year	5	1.5	Annual mean

Table 10.2 presents the limit and target values for ozone as per the Ambient Air Quality and Cleaner Air for Europe (CAFÉ) Directive (2008/50/EC).

Table 10.2: Target values for Ozone Defined in Directive 2008/50/EC

Objective	Parameter	Target Value from 2010	Target Value from 2020 onwards
Protection of human health	Maximum daily 8- hour mean	120 µg /m^3 not to be exceeded more than 25 days per calendar year averaged over 3 years	120 µg /m^3
Protection of vegetation	*AOT_{40} calculated from 1 hour values from May to July	18,000 µg /m^3 h^{-1} averaged over 5 years	6,000 µg /m^3 h^{-1}
Information Threshold	1-hour average	180 µg /m^3	180 µg /m^3
Alert Threshold	1-hour average	240 µg /m^3	240 µg /m^3

*AOT_{40} is a measure of the overall exposure of plants to ozone. It is the sum of the excess hourly concentrations greater than 80 µg/m^3 and is expressed as µg/m^3 hours.

10.2.3 Air Quality & Health

Environmental Protection Agency (EPA, 2020)[1], European Environmental Protection Agency (EEA, 2020)[2] and World Health Organisation (WHO, 2014) reports estimate that poor air quality accounted for premature deaths of approximately 600,000 people in Europe in 2012, with 1,300 Irish deaths predominantly due to fine particulate matter ($PM_{2.5}$) in 2020 and 30 Irish deaths attributable to Ozone (O_3) in 2016[3][4]. Fine particulate matter, ozone, along with others including carbon dioxide (CO_2), nitrogen oxides (NO_x) and sulphur oxides (SO_x) are produced during the burning of fossil fuels for energy generation, transport or home heating. There are no such emissions associated with the operation of wind turbines. Therefore, the construction of wind turbines such as in the Development will result in lower environmental levels of such parameters, and consequential beneficial effects on human health.

[1] Ireland's Environment – An Integrated Assessment 2020, EPA, 2020, accessed 04th July 2021
[2] EEA (European Environment Agency), 2020b. Air Quality in Europe 2020. EEA Report No. 09/2020. EEA, Copenhagen, accessed 04th July 2021
[3] https://www.euro.who.int/en/health-topics/environment-and-health/air-quality/news/news/2014/03/almost-600-000-deaths-due-to-air-pollution-in-europe-new-who-global-report, [Accessed 19/11/2022
[4] Irelands Environment 2016 – An Assessment', EPA, 2016, [Accessed 19/10/2022]

10.2.4 Air Quality Zones

The EPA has designated four Air Quality Zones for Ireland:

- Zone A: Dublin City and environs
- Zone B: Cork City and environs
- Zone C: 16 urban areas with population greater than 15,000
- Zone D: Remainder of the country

These zones were defined to meet the criteria for air quality monitoring, assessment and management described in the Framework Directive and Daughter Directives. The Development lies within Zone D, which represents rural areas located away from large population centres.

10.2.5 Existing Air Quality Conditions

Generally, Ireland is recognised as having some of the best air quality in Europe. However, from time to time, and under certain weather conditions, it is possible to experience some air pollution in the larger towns and cities. The most recent published report on air quality in Ireland is the 'Air Quality in Ireland 2021' report published by the EPA in 2022[5]. This report provides an overview of the ambient air quality in Ireland in 2020. It is based on monitoring data from 87 stations across Ireland. The measured concentrations are compared with both EU legislative standards and WHO air quality guidelines[6] for a range of air pollutants. The closest monitoring site to the Project within the same air quality zone is Macroom. Macroom was one of nine EU monitoring sites brought online in 2019. Results from the monitoring campaign during 2021 show:

- No levels above the EU limit value (in **Table 10.1**) were recorded at any of the ambient air quality network monitoring sites in Ireland in 2021.
- WHO guideline values were exceeded at a number of monitoring sites for PM_{10}, $PM_{2.5}$, ozone (O_3), NO_2, sulphur dioxide (SO_2) and PAHs.
- The annual mean PM_{10} and $PM_{2.5}$ levels for Macroom were 14 µg/m^3 and 9 µg/m^3 respectively. These values are below the limit values set out by Directive 2008/50/EC as per **Table 10.1**. However, the $PM_{2.5}$ is above the World Health Organization (WHO) guideline[7] of 5 µg/m^3 annual mean for $PM_{2.5}$.

[5] https://www.epa.ie/publications/monitoring--assessment/air/EPA-Air_Quality_in-Ireland-Report_2021_-interactive-pdf.pdf [Accessed 19/11/2022]
[6] https://www.who.int/news-room/fact-sheets/detail/ambient-(outdoor)-air-quality-and-health [Accessed 19/11/2022]
[7] https://www.who.int/news-room/fact-sheets/detail/ambient-(outdoor)-air-quality-and-health [Accessed 14/11/2022]

10.2.6 Do Nothing Impact

If the Project was not to proceed, the opportunity to reduce emissions of carbon dioxide (CO_2), nitrogen oxides (NO_x), and sulphur dioxide (SO_2) to the atmosphere would be lost due to the continued dependence on electricity derived from coal, oil and gas-fired power stations, rather than renewable energy sources such as the Project. This would result in an indirect, negative impact on air quality.

10.2.7 Potential Impacts of the Project

10.2.7.1 Construction Phase

Dust Emissions

The main potential source of impacts on air quality during construction is dust. There is potential for the generation of dust from excavations and from construction including construction of access roads and hardstands and the trench for the cable ducting for the grid connection.

The potential nuisance issues arising from this are dependent on the terrain, weather conditions, (i.e., dry and windy conditions), and the proximity of receptors. Dust from cement can cause ecological damage if allowed to migrate to water courses, though it is proposed that ready-mix concrete will be used with no on-site batching taking place. Therefore, this will not be a potential source of emissions. Potentially dust generating activities are as follows:

- Earth moving and excavation plant and equipment for handling and storage of soils and subsoils.
- Transport and unloading of stone materials for access track construction.
- Rock that is suitable will be extracted from borrow pit, turbine foundation areas and the sub-station and this will be used in the construction of tracks and hardstands.
- Vehicle movements over dry surfaces such as access tracks and public roads.

The potential impact from dust becoming friable and a nuisance to workers and local road users, if unmitigated, is considered, a slight, negative, short-term, direct impact during the construction phase.

Friable dust cannot remain airborne for a very long time. The distance it can travel depends on the particle sizes, disturbance activities and weather conditions. Larger dust particles tend to travel shorter distances than smaller particles. Particle sizes greater than 30 µm will generally deposit within approximately 100 m of its source, while particles between 10-30 µm travel up to approximately 250-500 m and particle sizes of less than 10 µm can travel up to approximately 1 km [8].

Generally, (depending on the conditions outlined), dust nuisance is most likely to occur at sensitive receptors within approximately 100 m of the source of the dust. It is considered that the principal sites of friable dust generation will be the turbine bases and hardstands, and also along new access roads. All turbines are situated greater than 740 m away from inhabited dwelling houses and therefore these principal sites of dust generation are greater than 100 m distant from these sensitive receptors. In addition, vegetation such as trees and hedgerows in the vicinity will help to mitigate any airborne dust migrating off the Site. Any effects of dust on vegetation will be confined to the construction and possibly the decommissioning phases and be short-term, slight, negative impact.

If unmitigated, there would also be dust deposition arising from mud on public roads, resulting from traffic leaving the construction site. Impacts from dust deposition at sensitive receptors would give rise to nuisance issues for residents of those properties. The impact would be short-term, temporary and slight negative impact on sensitive receptors.

Exhaust Emissions

Emissions from plant and machinery, including trucks, during the construction of the Project are a potential impact. The engines of these machines produce emissions such as carbon dioxide (CO_2), carbon monoxide (CO), Nitrogen Oxides (NO_x), and Particulate Matter (PM_{10} and $PM_{2.5}$).

Particulate Matter ("PM") less than ten micrometres in size (PM_{10}) can penetrate deep into the respiratory system increasing the risk of respiratory and cardiovascular disorders. PM_{10} arises from direct emissions of primary particulate such as black smoke and formation of secondary Particulate Matter in the atmosphere by reactions of gases such as sulphur dioxide (SO_2) and ammonia (NH_3). The main sources of primary PM_{10} are incomplete burning of fossil fuels such as coal, oil and peat and emissions from road traffic, in particular diesel engines. Other sources of particulates include re-suspended dust from roads. Natural Particulate Matter includes sea-salt and organic materials such as pollens.

Nitrogen oxides (NO_x), include the two pollutants, nitric oxide (NO) and nitrogen dioxide (NO_2). Anthropogenic (human) activities such as power-generation plants and motor vehicles are the principal sources of nitrogen oxides through high temperature combustion.

[8] http://www.dustscan.co.uk/Dust-Info/Definitions [Accessed 14/11/2022]

Nitrogen oxides are an important air pollutant by themselves but can also react in the atmosphere to contribute to the formation of tropospheric ozone (ozone in the air we breathe) and acid rain. Short-term exposure to nitrogen dioxide is associated with reduced lung function and airway responsiveness, and increased reactivity to natural allergens. Long-term exposure is associated with increased risk of respiratory infection in children.

The construction phase is likely to result in an increase in exhaust emission from construction vehicles and transport vehicles associated with the site works. The impact on air quality from an increase in exhaust emissions will be a short-term, slight negative impact.

10.2.7.2 Operational Phase

Dust Emissions

There will be a small number of light vehicles accessing the Site during the operational phase. This could lead to some localised dust being generated, though this will be small and sporadic as only approximately one to two site visits per week will occur at the Development. In the unlikely event that a turbine or elements of a turbine need to be replaced during the lifetime of the wind farm, there would be significantly less traffic than during the initial construction phase. There would only be one turbine delivered, compared to five turbines and the Site Access Roads and other site infrastructure will already have been established. Therefore, the operational phase will have an imperceptible negative impact.

10.2.7.3 Decommissioning Phase

Impacts during the decommissioning phase of the Project are anticipated to be less than those arising during the construction phase. The decommissioning phase will be as follows:

- Removal of five wind turbines and concrete plinths.
- Removal of permanent meteorological mast.
- Removal of all associated underground electrical and communications cabling connecting the wind turbines to the wind farm substation. Ducting is to remain *in-situ.*

All other elements of the Project will remain in-situ. The Site Access Roads and associated drainage systems will serve ongoing forestry and agriculture activity in the area. All other hard surfaced areas will be allowed to revegetate naturally.

The decommissioning phase would be expected to last approximately 2-3 months, and any air quality impacts would be predicted to be imperceptible.

10.2.8 Mitigation Measures and Residual Effects

10.2.8.1 Construction Phase Mitigation

The main potential impact during the construction phase of the Project will be from dust nuisance at sensitive receptors close to the Site. Good practice site procedures will be followed by the appointed contractor to prevent dirt and dust being transported onto the local road network. Good practice site control measures will comprise the following:

- Site Access Roads will be upgraded and built in the initial construction phases. These roads will be finished with graded aggregate which compacts, preventing dust.
- Approach roads and construction areas will be cleaned on a regular basis to prevent build-up of mud and prevent it from migrating around the Site and onto the public road network.
- Wheel wash facilities will be provided near the Site entrance to prevent mud/dirt being transferred from the site to the public road network.
- Public roads along the construction haul route will be inspected and cleaned daily. In the unlikely event that dirt/mud is identified on public roads, the roads will be cleaned. The wheel wash facility will be investigated, and the problem fixed to prevent this from happening again.
- During periods of dry and windy weather, there is potential for dust to become friable and cause nuisance to nearby residences and users of the local road network. This requires wetting material and ensuring water is supplied at the correct levels for the duration of the work activity. The weather will be monitored so that the need for damping down activities can be predicted. Water bowsers will be available to spray work areas (wind turbine area and grid connection route) and haul roads to suppress dust migration from the Site.
- Vehicles delivering materials to the site will be covered appropriately when transporting materials that could result in dust, e.g., crushed rock or sand.
- Exhaust emissions from vehicles operating within the site, including trucks, excavators, diesel generators or other plant equipment, will be controlled by the Contractor by ensuring that emissions from vehicles are minimised through regular servicing of machinery.
- All machinery when not in use will be turned off.
- Ready-mix concrete will be delivered to the Site and no batching of concrete will take place on the Site. Only washing out of chutes will take place on site and this will be undertaken at a designated concrete washout facility at the contractor's compound. The concrete wash water will be disposed of at a licensed facility as outlined in the Construction Environment Management Plan (CEMP) – Management Plan 5 Waste Management Plan (**Appendix 2.1**)

- Speed restrictions of 15 km/h on access roads will be implemented to reduce the likelihood of dust becoming airborne. Consideration will be given to how on-site speed limits are policed by the Contractor and referred to in the toolbox talks.
- Stockpiling of materials will be carried out in such a way as to minimise their exposure to wind. Stockpiles will be covered with geotextiles layering and damping down will be carried out when weather conditions require it.
- Earthworks and exposed areas/soil stockpiles will be re-vegetated to stabilise surfaces as soon as practicable.
- An independent, qualified Geotechnical Engineer will be contracted for the detailed design stage of the project and geotechnical services and will be retained throughout the construction phase, including monitoring and supervision of construction activities on a regular basis. The methodology statement will be signed off by a suitably qualified Geotechnical Engineer.
- A complaints procedure will be implemented on site where complaints will be reported, logged and appropriate action taken.

10.2.8.2 Operational Phase Mitigation

As the operation of the proposed wind farm will have positive impacts on air quality, mitigation measures are considered unnecessary. Where turbine components are being replaced the same mitigation measures as per the construction phase will apply.

10.2.8.3 Decommissioning Phase Mitigation

Mitigation measures during the decommissioning phase will be similar to those employed during the construction phase as outlined above.

10.2.9 Cumulative Effects

In terms of cumulative impacts, negative cumulative impacts in relation to air quality would only occur if a large development was located in the vicinity of the Site and in the process of construction at the same time as the Project. The developments considered as part of the cumulative effect assessment are described in **Appendix 2.3** and **Appendix 2.4**. There are a number of existing, consented and proposed wind energy developments within 20 kilometres of the Site as listed in **Appendix 2.3**.

In a worst-case scenario cumulative air impacts may arise if the construction, operational and maintenance period and decommissioning of any of the projects listed in **Appendix 2.3** occur simultaneously with the construction of the Project. The existing and consented wind energy developments within 20 kilometres of the Site as listed in **Appendix 2.3** have been considered for cumulative air quality effects. Only those wind energy developments that would be under construction at the same time as the Project are relevant in the context of cumulative effect.

The consented (not yet built) and the proposed wind energy developments within 20 kilometres of the Site:

- Coolea (consented);
- Coolknoohil Inchee (consented);
- Cummeennabuddoge (proposed);
- Dereenacrinnig (consented);
- Gneeves Milstreet (consented);
- Gortnakilla, Clonkeen Killarney (consented);
- Gortyrahilly (proposed); and
- Knocknamork (consented).

These wind energy developments range from 1.9 km to 14.9 km distance from the Development. Given the distances from the Site, they are not in the direct vicinity of the Development. Even if construction of these wind energy developments was to take place at the same time as construction of the Project, given the distances from the Site, there would not be any cumulative air quality effects.

During the operational phase emissions of carbon dioxide (CO_2), nitrogen oxides (NO_x), and sulphur dioxide (SO_2) or dust emissions from the Development and other projects listed in **Appendix 2.3**, will result from the operation and maintenance vehicles onsite. However, these emissions will be minimal. Therefore, there will be a long-term imperceptible negative cumulative impact on air quality and climate.

Cumulative impacts during the decommissioning phase will be similar to the construction phase although slightly less as a result of the reduced works required during the decommissioning phase as some infrastructure will be left in-situ e.g., Turbine Foundations and the Site Access Roads.

The nature of the Project and other energy developments within 20 kilometres are such that, once operational, they will have a cumulative long-term, significant, positive effect on the air quality.

10.2.10 Residual Impacts of the Project

The use of plant and machinery during the construction phase is not likely to have a significant impact on air quality in the area, both in terms of dust generation and exhaust emissions. Overall, with mitigation in place this impact is assessed as slight/imperceptible, negative, direct and temporary/short-term in nature.

During the operational phase of the Project exhaust emissions will arise from occasional machinery use and Light-Good Vehicles (LGV) that will be required for occasional onsite maintenance works. The impact will be a Long-term imperceptible negative.

However, the wind energy created by the Project will avoid the production of electricity from coal, oil or gas-fired power stations resulting in emission savings of carbon dioxide (CO_2), nitrogen oxides (NO_x), and sulphur dioxide (SO_2). This will lead to a Long-term Significant Positive Impact on air quality.

The decommissioning phase impacts and consequential effects will be similar to the construction stage, albeit of less impact as the works required will be less as described in **Chapter 2: Project Description**. For example, the turbine foundations will remain in-situ and will be covered with earth and reseeded as appropriate. The substation building will also be left in-situ. This means there will be no additional excavation works required for the decommissioning of the turbine foundations and the substation and there will be no additional truck movements that would be required for the demolition and removal of these pieces of infrastructure. The mitigation measures outlined for the construction phase of the Project will be implemented during the decommissioning phase thereby minimising any potential impacts.

10.2.11 Summary of Significant Effects

This assessment has identified no potentially significant effects, given the mitigation measures embedded in the design which will be implemented in the Project.

10.2.12 Statement of Significance

The Project has been assessed as having no significant direct or indirect effects on air quality during the construction, operation or decommissioning phases of the Project.

10.3 CLIMATE AND GREENHOUSE GASES

Greenhouse gases, if released in excessive amounts, can lead to increases in global temperatures known as 'global warming' or the 'greenhouse effect' which can influence the climate.

There are a wide range of gases known as greenhouse gases. The most critical greenhouse gases are carbon dioxide (CO_2), methane (CH_4), and nitrous oxide (N_2O). There are also other greenhouse gases known as F-Gases, man-made gases used in refrigeration and air conditioning appliances. Greenhouse gases produced by human activities are changing the composition of the earth's atmosphere. Human activities that produce greenhouse gases include:

- Carbon dioxide emissions through burning fossil fuels such as coal, oil and gas and peat
- Methane and nitrous oxide emissions from agriculture
- Emissions through land use changes such as deforestation, reforestation, urbanization, desertification

Current projections indicate that continued emissions of greenhouse gases, including the burning of fossil fuel to produce electricity, will cause further warming and changes to our climate. Climate is predicted to have indirect and direct impacts on Ireland including:

- Rising sea-levels threatening habitable land and particularly coastal infrastructure;
- Extreme weather, including more intense storms and rainfall affecting our land, coastline and seas;
- Further pressure on our water resources and food production systems with associated impacts on fluvial and coastal ecosystems;
- Increased chance and scale of river and coastal flooding;
- Greater political and security instability;
- Displacement of population and climate refugees;
- Heightened risk of the arrival of new pests and diseases;
- Poorer water quality, and
- Changes in the distribution and time of lifecycle events of plant and animal species on land and in the oceans[9]

Climate change means a significant change in the measures of climate, such as temperature, rainfall, or wind, lasting for an extended period – decades or longer. Earth's climate has changed naturally many times during the planet's existence. However, currently

[9] Climate Action Plan 2019 – To Tackle Climate Breakdown, Department of Environment, Climate and Communications, https://www.gov.ie/en/publication/ccb2e0-the-climate-action-plan-2019/, [Accessed 14/11/2022]

human activities are significantly contributing to climate change through greenhouse gas emissions. The global average temperatures have now increased by more than 1°C since pre-industrial times.

At the Paris climate conference (COP21) in 2015, 195 countries adopted the first-ever universal, legally binding global climate deal. The agreement sets out a global action plan to put the world on track to avoid dangerous climate change by limiting global warming to below 2°C above pre-industrial levels and to limit the increase to 1.5°C. Under the agreement, Governments also agreed on the need for global emissions to peak as soon as possible, recognising that this will take longer for developing countries and to undertake rapid reductions thereafter in accordance with the best available science.

The Glasgow Climate Pact (COP26) of 2021 aims to limit the rise in global temperature to 1.5°C and finalise the outstanding elements of the Paris Agreement. The Glasgow Climate Pact is manifested across three United Nations climate treaties, including the United Nations Framework Convention on Climate Change (the COP), the Kyoto Protocol (the CMP), and the Paris Agreement (the CMA).

The United Nations Climate Change Conference (COP27) held in November 2022 resulted in countries delivering a package of decisions that reaffirmed their commitment to limit global temperature rise to 1.5°C above pre-industrial levels. The package also strengthened action by countries to cut greenhouse gas emissions and adapt to the inevitable impacts of climate change, as well as boosting the support of finance, technology and capacity building needed by developing countries. Governments took the ground-breaking decision to establish new funding arrangements, as well as a dedicated fund, to assist developing countries in responding to loss and damage.

The Climate Action Plan 2021 as set out by the Department of the Environment, Climate and Communications provides a detailed plan for Ireland. It plans for taking decisive action to achieve a 51% reduction in overall greenhouse gas emissions by 2030 and setting us on a path to reach net-zero emissions by no later than 2050, as committed to in the Programme for Government and set out in the Climate Act 2021. This Plan makes Ireland one of the most ambitious countries in the world on climate.

The provision of the Project will have a long-term positive impact by providing a sustainable energy source. Should the Project not proceed, fossil fuel power stations will be the primary alternative to provide the required quantities of electricity. This will further contribute to greenhouse gas and other emissions. It will also hinder Ireland in its commitment to meet its target to increase electricity production from renewable sources and to reduce greenhouse gas emissions as agreed at the Paris climate conference (COP21) in 2015 and Glasgow Climate Pact (COP26) in November 2021.

10.3.1 Relevant Legislation and Guidance

Greenhouse gases are the subject of international agreements, such as the United Nations Framework Convention on Climate Change, Kyoto Protocol and the Paris Agreement. The Glasgow Climate Pact is manifested across these three United Nations climate treaties. These agreements along with International and National Policy and Legislation are discussed in the **Planning Statement**. This section will examine the Carbon losses and savings from this Project and its impact on the Climate.

10.3.2 Assessment Methodology

This assessment of climate involved the following:

- A desk study of the climate baseline in the area of the Project and nationally;
- Evaluation of potential effects;
- Evaluation of the significance of effects, and
- Identification of measures to avoid and mitigate potential effects.

10.3.3 Existing Climate

The Köppen climate classification divides regions of the globe based on seasonal precipitation and temperature patterns. The five main groups are tropical, dry, temperate, continental, and polar. The Irish climate is defined as a temperate oceanic climate on the Köppen climate classification system[10]. Ireland's climate is mild, moist and changeable with abundant rainfall and a lack of temperature extremes. The country generally receives cool summers and mild winters and it is considerably warmer than other areas on the same latitude. Ireland's land mass is warmed by the North Atlantic Current all year and as a result does not experience a great annual range of air temperatures.

Nationally, the mean air temperature is generally between 9 and 11 °C. Annual rainfall totals on the west coast generally average between 1,000 mm and 1,400 mm with the wettest months being December and January and April being the driest month. The prevailing wind direction is between south and west. Average wind speed ranges from 3 m/s in south Leinster to 8 m/s in the extreme north of the country.

[10] https://www.britannica.com/science/Koppen-climate-classification/World-distribution-of-major-climatic-types, [Accessed 14/11/2022]

For the purpose of the assessment of changes to the climate, meteorological data from the nearest meteorological station to the Project, Cork Airport monitoring station, over a period of 1991-2021 is shown in **Table 10.3**. Cork Airport is located 51 km south-east of the Project and is the closest Met Éireann climate station.

The mean annual air temperature as shown in **Table 10.3** between 1991 and 2021 was 9.975°C. Mean monthly temperatures ranged from 5.8°C in January to 15.2°C in July. Mean annual rainfall over this period was 1240.7 mm, with a maximum monthly mean rainfall of 136.3 mm in December and a minimum monthly mean rainfall of 82 mm in June[11].

[11] https://www.met.ie/climate/30-year-averages, [Accessed 14/11/2022]

Table 10.3: Cork Airport Meteorological Station Data Averages (1991- 2021)

Month	Mean Air Temperature (°C)	Maximum Air Temperature (°C)	Minimum Air Temperature (°C)	Mean Maximum Temperature (°C)	Mean Minimum Temperature (°C)	Precipitation Amount (mm)	Grass Minimum Temperature (°C)	Mean Wind Speed (knot)	Highest Gust (knot)	Sunshine Duration (hours)
January	5.8	12.2	-1.8	8.3	3.2	130.4	-6.1	10.9	53.9	62.0
February	5.9	12.3	-1.5	8.6	3.1	103.1	-5.7	11.0	51.0	73.9
March	6.9	14.2	-1.1	9.9	3.8	91.1	-5.3	10.5	49.3	109.3
April	8.5	16.6	0.3	12.0	5.1	84.4	-4.3	9.8	45.3	162.0
May	10.9	20.1	2.8	14.5	7.3	83.3	-1.3	9.4	41.1	191.2
June	13.5	22.0	6.0	17.1	9.9	82.0	1.7	8.9	37.6	184.0
July	15.2	22.9	8.0	18.7	11.6	85.5	3.9	8.5	35.7	165.0
August	15.0	22.5	7.9	18.5	11.5	95.2	3.6	8.5	37.8	158.6
September	13.3	20.6	5.9	16.6	10.1	90.7	1.3	8.8	40.0	127.5
October	10.6	16.9	2.9	13.5	7.7	134.3	-1.4	9.7	48.8	99.1
November	7.8	14.1	0.3	10.4	5.2	124.4	-3.8	10.1	48.9	75.1
December	6.3	12.4	-0.9	8.7	3.9	136.3	-4.7	10.9	52.6	54.4

10.3.4 Calculating Carbon Losses and Savings

10.3.4.1 Carbon Calculator

To assess the impact of the Project on the climate, the carbon emitted or saved as a result of the Project was determined using a carbon calculator. The Scottish Government have produced an online carbon calculator which aims to assess, in a comprehensive and consistent way, the carbon impact of wind farm developments. This is done by comparing the carbon costs of wind farm developments with the carbon savings attributable to the wind farm. The carbon calculation takes into account the carbon released from a number of sources during the construction, operational and decommissioning stages. These include the effects of drainage works on peat soils, forestry felling, losses associated with harvesting and transport of felled trees, changes in land use and wind turbine manufacture, transportation and construction. Also included in the assessment tool is the assessment of peat disturbance. The Scottish calculator is used as no carbon calculator specific to Ireland has been developed and the peat habitat of Scotland is similar to Ireland.

Assessments are also carried out to estimate the carbon saving over the lifetime of the wind farm, compared to electricity produced using fossil fuel. The assessment of carbon savings relates to the capacity of the wind farm over the number of years for which it is operational, site improvement works, (i.e., peatland improvement, habitat creation, etc.), forestry felling, and site restoration works, (i.e., removal of infrastructure and restoration of previous site conditions), when the wind farm will be decommissioned.

The completed worksheet, including the assumptions used in the model, is provided in **Appendix 10.1** of this EIAR. The model calculates the total carbon emissions associated with the Project including manufacturing of the turbine technology, transport, construction of the Project and tree felling. The model, which is assessed for both the lower range (5.6 MW) and the higher range (6.6 MW) of turbine, accounts for improvement works (see **Appendix 5.5 Habitat Enhancement Plan**) and the years taken for the site to return to its original characteristics but does not factor in the potential re-use of turbine components. All metal components can be recycled, while there is limited potential for the recycling/reuse of the fibreglass blades.

The model also calculates the carbon savings associated with the Project against three comparators:

i. Coal fired Electricity Generation;
ii. Grid mix of Electricity Generation, and

iii. Fossil fuel mix of Electricity Generation (oil, gas and coal)[12].

This is to compare this renewable source of electricity generation to traditional methods of electricity generation to assess the carbon savings and losses.

10.3.4.2 Carbon Losses

The potential carbon losses were assessed for the Project.

The main CO_2 losses due to the Project are summarised in **Table 10.4**. A copy of the input and output data is provided in the completed worksheet in **Appendix 10.1**.

Table 10.4: Carbon Losses

Origin of Losses	Total CO_2 Losses (tonnes CO_2 equivalent)	
	Lower Range Output	Higher Range Output
Turbine manufacture, construction and decommissioning	25,341	30,013
Losses due to Backup	18,543	21,854
Losses due to reduced carbon fixing potential	731	731
Losses from soil organic matter	14,691	14,691
Losses due to Dissolved Organic Carbon (DOC) and Particulate Organic Carbon (POC) leaching	2,216	2,216
Felling of Forestry	11,074	11,074
Total Expected Losses	72,597	80,580

The worksheet model calculated that the Project is expected to give rise to 72,597 tonnes of CO_2 equivalent losses at the lower range (5.6 MW) and 80,580 tonnes of CO_2 equivalent losses at the higher range (6.6 MW) over its 35-year life. Of this total figure, the proposed wind turbines directly account for tonnes, or 35% at the lower range and tonnes, or 37% at the higher range. Losses due to backup account for 18,543 tonnes, or 25% at the lower range and 21,854 tonnes or 27% at the higher range.

[12] Ireland's energy imports comprise oil (56%), gas (31%) and coal (10%). http://ireland2050.ie/present/oil-and-gas/?q=where-does-ireland-get-its-electricity#:~:text=Ireland%20has%20only%20small%20proven,%25)%20and%20coal%20(10%25, [Accessed 14/11/22]

Losses from soil organic matter, reduced carbon fixing potential, DOC and POC leaching and the felling of forestry accounting for the remaining 39% or 28,712 tonnes at the lower range and 36% or 28,712 tonnes at the higher range. The figure tonnes of CO_2 arising from ground activities associated with the Project is calculated based on the entire Project footprint being "Acid Bog", as this is one of only two choices, the other being Fen. The habitat that will be impacted by the Project footprint comprises predominantly agricultural land and commercial forestry rather than the acid bog assumed by the model that gives rise to the tonnes (lower and higher range) and therefore the actual CO_2 losses are expected to be lower than this value.

The figures discussed above are based on the assumption that the hydrology of the Site and habitats within the site are not restored on decommissioning after its expected 35-year useful life. However, at the end of the 35-year lifespan of the Project, the turbines may be replaced with newer models subject to a consent for the same being obtained. This would mean the carbon losses associated with not restoring the habitats hydrology at the Site would be offset by the carbon-neutral energy that the new turbines would generate.

10.3.4.3 Carbon Savings

The carbon calculator assessed the carbon savings of the Project for habitat improvement works as 5,709 tonnes of CO_2 per year at the higher and lower range. However, the carbon calculator is pre-loaded with information specific to the CO_2 emissions from the United Kingdom's electricity generation plant, which is used to calculate emissions savings from proposed wind farm projects in the UK and similar data was not available for the Irish electricity generation plant. Therefore, these CO_2 emissions savings from the Project were calculated separately from the worksheet.

According to the model described above, the Project will give rise to total losses of 72,597 tonnes (lower range) or 80,580 tonnes (higher range) of carbon dioxide.

A simple formula is used to calculate carbon dioxide emissions reductions resulting from the generation of electricity from wind power rather than from carbon-based fuels such as peat, coal, gas and oil.

The formula is:

$$CO_2 \text{ (in tonnes)} = \frac{(A \times B \times C \times D)}{1000}$$

where:

A = The maximum capacity of the wind energy development in MW

B = The capacity or load factor, which takes into account the availability of wind turbines and array losses etc.

C = The number of hours in a year

D = Carbon load in grams per kWh (kilowatt hour) of electricity generated and distributed via the national grid.

For the purposes of this calculation, the rated capacity of the Project is assumed to be approximately 28 MW at the lower range and 33 MW at the higher range. A load factor of 0.35 (or 35%) has been used for the Project.

There has been a strong reduction in the CO_2 emissions intensity of electricity generation, especially after 2016, with intensity falling below 300 g CO_2/kWh for the first time in 2020. It is now less than a third of its 1990 value[13]. These falls are due to increased use of higher-efficiency gas turbines, increased electricity generated from zero-carbon renewable sources, especially wind. The most recent data for the carbon load of electricity generated in Ireland is for 2021 and was published in Sustainable Energy Authority Ireland's (SEAI) December 2022 report, Energy in Ireland. The emission factor for electricity in Ireland in 2021 was 348 g CO_2/kWh. The number of hours in a year is 8,760.

[13] Energy-Related CO_2 Emissions in Ireland 2020 Companion Note to 2020 National Energy Balance October 2021, Sustainable Energy Authority of Ireland
Online: https://www.seai.ie/publications/Energy-CO2-emissions-2020-Short-Note-FINAL.pdf [Accessed 14/11/2022]

The calculation for carbon savings at the lower range and higher range are therefore as follows:

$$CO_2 \text{ (in tonnes)} = \frac{(28 \times 0.35 \times 8{,}760 \times 348)}{1000}$$

= 29,875 tonnes per annum at the lower range

$$CO_2 \text{ (in tonnes)} = \frac{(33 \times 0.35 \times 8{,}760 \times 348)}{1000}$$

= 35,210 tonnes per annum at the higher range

Based on this calculation, approximately 29,875 (lower range) or 35,210 (higher range) tonnes of carbon dioxide will be displaced per annum from the largely carbon-based traditional energy mix by the Development.

Therefore, including the carbon savings for the habitat improvements works 5,709 tonnes (lower range) and 5,709 tonnes (higher range) it is estimated that 1,051,334 tonnes (lower range) or 1,238,059 tonnes (higher range) of carbon dioxide will be displaced over the proposed 35 year lifetime of the wind farm.

The Scottish Government carbon calculator as presented above calculated 72,597 (lower range) and 80,580 (higher range) tonnes of CO_2 will be lost to the atmosphere due to changes in the peat environment and due to the construction and operation of the Project. This represents 7% (lower range) and 7% (higher range) of the total amount of carbon dioxide emissions that will be offset by the Project. The 72,597 (lower range) and 80,580 (higher range) tonnes of CO_2 that will be lost to the atmosphere due to changes in the peat environment and due to the construction and operation of the Project will be offset by the Project in approximately 29 months of operation at the lower range and 27 months of operation at the higher range.

10.3.5 Do Nothing Impact

If the Project was not to proceed, greenhouse gas emissions, e.g., carbon dioxide, carbon monoxide and nitrogen oxides associated with construction and decommissioning works would not arise. However, the greenhouse gas savings that would arise from the operation of the Project would also be lost leading to a long-term, moderate, negative impact.

10.3.6 Potential Impacts of the Project

10.3.6.1 Construction Phase

Greenhouse gas emissions, e.g., carbon dioxide (CO_2), carbon monoxide (CO) and nitrogen oxides (NO_x) are associated with vehicles and plant utilised for construction activities. This potential impact will be slight, given the insignificant quantity of greenhouse gases that will be emitted, and will be restricted to the duration of the construction phase. Therefore, this is a short-term, slight, negative impact. Mitigation measures to reduce this impact are outlined in **Section 10.2.9**.

10.3.6.2 Operation Phase

The Project is a renewable energy project in that it will generate electricity from a renewable source. This energy generated will be in direct contrast to traditional energy and the associated emission of greenhouse gases from electricity-generating stations dependent on fossil fuels, thereby having a positive impact on the climate. The Project will displace carbon dioxide from fossil fuel-based electricity generation, over the proposed 35-year lifespan of the Project. The Project will assist in reducing carbon dioxide (CO_2) emissions (30,038 tonnes per annum at the lower range or 35,373 tonnes per annum at the higher range) that would otherwise arise if the same energy that the Project will generate were otherwise to be generated by conventional fossil fuel plants. This is a long-term, moderate, positive effect on the climate.

10.3.6.3 Decommissioning Phase

Any impacts that occur during the decommissioning phase are similar to that which occur during the construction phase. The mitigation measures prescribed for the construction phase of the Project will be implemented during the decommissioning phase thereby minimising any potential impacts.

10.3.7 Mitigation Measures

It is considered that the Project will have an overall positive impact in terms of carbon reduction and climate.

The Project will assist Ireland in meeting a 51% reduction in overall greenhouse gas emissions by 2030. Also, it will aid in increasing the onshore wind capacity, as per the Climate Action Plan 2023 (CAP2023). The CAP 2023 commits Ireland to installing up to 9 GW of onshore wind capacity by 2030, in order to support the reduction in Ireland's greenhouse gas emissions.

10.3.7.1 Construction Phase

All construction vehicles and plant will be maintained in good operational order while onsite, thereby minimising any emissions that arise.

10.3.7.2 Operation Phase

The operation phase of the Project will have a positive impact on the climate due to the displacement of fossil fuels and therefore no mitigation is necessary for this phase.

10.3.7.3 Decommissioning Phase

Mitigation measures during the decommissioning phase will be similar to those employed during the construction phase as outlined above.

10.3.8 Cumulative Effects

Potential cumulative effects on the climate between the Project and other developments in the vicinity were also considered as part of this assessment. The other developments considered as part of the cumulative effects assessment are described in **Appendix 2.4**.

During the construction phase of the Project and other developments within 20 kilometres of the proposed turbines that are yet to be constructed, there will be minor exhaust emissions from construction plant and machinery and dust emissions from construction activities. In a worst-case scenario if any of these developments were constructed at the same time as this Project there will be short-term slight negative cumulative impact on climate due to exhaust and dust emissions.

The nature of the Project is such that, once operational, it will have a long-term, moderate, positive impact on the air climate. It is considered that the cumulative impact will be positive in terms of carbon reduction and the climate also.

During the operational phase emissions of carbon dioxide (CO_2), nitrogen oxides (NO_x), and sulphur dioxide (SO_2) or dust emissions from the Project and other projects listed in **Appendix 2.2** and **Appendix 2.4**, will result from the operation and maintenance vehicles onsite. However, these emissions will be minimal. Therefore, there will be a long-term imperceptible negative cumulative impact on the climate.

Cumulative impacts during the decommissioning phase will be similar to the construction phase although slightly less as a result of the reduced works required during the decommissioning phase as some infrastructure will be left in-situ e.g., turbine foundations and the site roads.

The nature of the Project and other energy developments within 20 kilometres are such that, once operational, they will have a cumulative long-term, significant, positive effect on climate.

10.3.9 Residual Impacts of the Project

10.3.9.1 Construction Phase

There will be a short-term imperceptible negative impact on Climate as a result of greenhouse gas emissions.

10.3.9.2 Operational Phase

There will be a long-term, moderate, positive impact on Climate as a result of reduced greenhouse gas emissions.

10.3.9.3 Decommissioning Phase

Any impacts and consequential effects that occur during the decommissioning phase are similar to that which occur during the construction phase, albeit of less impact. For example, turbine foundations and site roads will be left in-situ. No forest felling will take place during the decommissioning phase.

10.3.10 Summary of Significant Effects

This assessment has identified no potential significant effects, given the mitigation measures embedded in the design and recommended for the implementation of the Project.

10.3.11 Statement of Significance

It is estimated that 1,051,334 tonnes (lower range) or 1,238,059 tonnes (higher range) of carbon dioxide will be displaced over the proposed 35-year lifetime of the wind farm. The Project has been assessed as having the potential to result in a short-term imperceptible, negative impact on Climate during construction. There will be long-term moderate, positive impact on Climate as a result of reduced greenhouse gas emission during the operational phase.

Potential cumulative impact of the Project with other energy developments including wind and solar within 20 kilometres on climate was assessed as having a long-term, significant, positive impact on the Climate.