White Hill Wind Farm

Environmental Impact Assessment Report

Chapter 8: Air Quality & Climate

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Contents

8.1 Introduction

8.1.1 Background

This chapter comprises an assessment of the likely effect on air quality and climate associated with the project. This report provides a baseline assessment of the setting of the proposed development in terms of air quality and climate, and discusses the likely and significant effects that the construction, operation and decommissioning of the proposed development will have on them. Where required, appropriate mitigation measures to limit any identified likely significant adverse impacts to air quality and climate are recommended.

8.1.2 Description of Project

In summary, the project comprises the following main components as described in **Chapter 3**:-

- 7 no. wind turbines with an overall tip height of 185m, and all associated ancillary infrastructure;
- All associated and ancillary site development, excavation, construction, landscaping and reinstatement works, including the provision of site drainage infrastructure;
- Upgrades to the turbine component haul route; and,
- Construction of an electricity substation and installation of c. 15km of underground grid connection cable between the White Hill Wind Farm and the existing Kilkenny 110kV electricity substation.

The wind farm site traverses the administrative boundary between counties Carlow and Kilkenny; with 4 no. turbines located in Co. Carlow and 3 no. turbines within Co. Kilkenny. The electricity substation is located within Co. Carlow while the majority, c. 14km, of the underground electricity line is located in Co. Kilkenny. Off-site and secondary developments; including the forestry replant lands and candidate quarries which may supply construction materials; also form part of the project.

The turbine component haul route, and associated upgrade works as described at **Chapter 3**, are located within counties Kilkenny, Waterford, Carlow, and Kildare. It is envisaged that the turbines will be transported from the Port of Waterford, through the counties of Kilkenny, Waterford, Carlow and Kildare to the project site.

A full description of the project is presented in **Chapter 3**.

8.1.3 Statement of Authority

This chapter was prepared by Niamh Nolan, an environmental consultant in the air quality section of AWN Consulting Ltd. She holds a BSocSci (Hons) in Social Policy and Geography from University College Dublin. She is an Associate Member of both the Institute of Air Quality Management and the Institution of Environmental Science. She has experience in mapping software primarily in QGIS and she specialises in the area of air quality, climate and sustainability.

8.2 Relevant Legislation & Guidance

8.2.1 Air Quality

The following Environmental Protection Agency (EPA) guidelines were considered in this assessment:-

- *Guidelines on the Information to be contained in Environmental Impact Statements* (EPA, 2022);

- *Advice Notes on Current Practice (in the preparation of Environmental Impact Statements* (EPA, 2003); and
- *Draft EPA Advice Notes for Preparing Environmental Impact Statements* (EPA 2015).

The statutory ambient air quality standards in Ireland are outlined in S.I. No. 180 of 2011 Air Quality Standards Regulations 2011 (hereafter referred to as the Air Quality Regulations), which incorporate the ambient air quality limits set out in Directive 2008/50/EC of the European Parliament and of the Council of 21 May 2008 on ambient air quality and cleaner air for Europe (hereafter referred to as the CAFE Directive), for a range of air pollutants. The statutory ambient air quality guidelines are discussed in greater detail in the sections below and **Annex 8.1**.

In addition to the specific statutory air quality standards, the assessment has made reference to national guidelines, where available, in addition to international standards and guidelines relating to the assessment of ambient air quality impact from road schemes. These are summarised below:-

- *Guidance on the Assessment of Dust from Demolition and Construction V1.1* (IAQM 2016);
- *Guidelines for the Treatment of Air Quality During the Planning and Construction of National Road Schemes* (TII 2011);
- *Guidelines for Assessment of Ecological Impacts of National Roads Schemes* (TII 2009);
- UK Department of Environment Food and Rural Affairs (DEFRA) *Part IV of the Environment Act 1995: Local Air Quality Management, LAQM.TG (16)* (DEFRA 2018);
- UK Highways Agency (UKHA) *Design Manual for Roads and Bridges (DMRB) – LA 105 Air Quality* (UKHA 2019); and
- World Health Organization (WHO) *Air Quality Guidelines for Particulate Matter, Ozone, Nitrogen Dioxide and Sulfur Dioxide Global Update 2005 (WHO 2005)*.

8.2.1.1 Ambient Air Quality Standards

In order to reduce the risk to health from poor air quality, national and European statutory bodies have set limit values in ambient air for a range of air pollutants. The applicable legal standards in Ireland are outlined in the Air Quality Regulations (S.I. 180 of 2011), which incorporate the CAFE Directive (EU 2008/50/EC). The Air Quality Regulations set limit values for the pollutants nitrogen dioxide (NO_2) and nitrogen oxides (NO_X), particulate matter (PM) with an aerodynamic diameter of less than 10 microns (PM_{10}), PM with an aerodynamic diameter of less than 2.5 microns ($PM_{2.5}$), lead (Pb), sulphur dioxide (SO_2), benzene and carbon monoxide (CO) (**Table 8.1**).

Pollutant	Regulation*	Limit Type	Value
NO_2	S.I. 180 of 2011	Hourly limit for protection of human health - not to be exceeded more than 18 times / year	200µg/m³ NO_2
		Annual limit for protection of human health	40µg/m³ NO_2
Nitrogen Oxides ($NO + NO_2$)		Critical limit for the protection of vegetation and natural ecosystems	30µg/m³ $NO + NO_2$
Lead	S.I. 180 of	Annual limit for protection of	0.5µg/m³

	2011	human health	
SO_2	S.I. 180 of 2011	Hourly limit for protection of human health - not to be exceeded more than 24 times / year	350µg/m³
		Daily limit for protection of human health - not to be exceeded more than 3 times / year	125µg/m³
		Critical limit for the protection of vegetation and natural ecosystems (calendar year and winter)	20µg/m³
PM (as PM_{10})	S.I. 180 of 2011	24-hour limit for protection of human health - not to be exceeded more than 35 times / year	50µg/m³
		Annual limit for protection of human health	40µg/m³
PM (as $PM_{2.5}$)	S.I. 180 of 2011	Annual limit for protection of human health	25µg/m³
Benzene	S.I. 180 of 2011	Annual limit for protection of human health	5µg/m³
CO	S.I. 180 of 2011	8-hour limit (on a rolling basis) for protection of human health	10µg/m³

**CAFE Directive replaces the previous Air Framework Directive (1996/30/EC) and daughter directives 1999/30/EC and 2000/69/EC*

Table 8.1: Air Quality Regulations (based on the CAFE Directive)

The World Health Organization (WHO) has published Air Quality Guidelines for the protection of human health (hereafter referred to as the WHO Guideline) (WHO 2006). The WHO Guideline values relating to NO_2, PM_{10} and $PM_{2.5}$ are shown in **Table 8.2**. The WHO Guideline values are more stringent than the European Union (EU) statutory limit values for PM_{10} and $PM_{2.5}$. In relation to NO_2, the compliance limit values are equivalent. However, the WHO one-hour guideline value is an absolute value while the EU standards allows this limit to be exceeded for 18-hours/annum without breaching the statutory limit value.

Pollutant	Regulation	Limit Type	Value
NO_2	WHO Guidelines	Hourly limit for protection of human health	200µg/m^3 NO_2
		Annual limit for protection of human health	40µg/m^3 NO_2
PM (as PM_{10})	WHO Guidelines	24-hour limit for protection of human health	50µg/m^3 PM_{10}
		Annual limit for protection of human health	20µg/m^3 PM_{10}
PM (as $PM_{2.5}$)	WHO Guidelines	24-hour limit for protection of human health	25µg/m^3 $PM_{2.5}$
		Annual limit for protection of human health	10µg/m^3 $PM_{2.5}$

**Air Quality Guidelines - Global Update 2005 (WHO 2006)*

Table 8.2: WHO Guidelines*

With regards to larger dust particles that can give rise to nuisance dust, there are no statutory guidelines regarding the maximum dust deposition levels that may be generated during the construction phase of a development in Ireland. Dublin City Council (DCC) has published a guidance document titled Air Quality Monitoring and Noise Control Unit's Good Practice Guide for Construction and Demolition however this guidance does not specify a guideline value (DCC 2018). Applicable guidance from other county councils within Ireland is not available.

The German TA-Luft standard for dust deposition (Verein Deutscher Ingenieure (VDI) 2002) (non-hazardous dust) sets a maximum permissible emission level for dust deposition of 350mg/(m_2*day) averaged over a one-year period at any receptors outside a proposed development's boundary. Recommendations from the Department of the Environment, Heritage and Local Government (DEHLG 2004) apply the Bergerhoff limit of 350mg/(m_2*day) to the site boundary of quarries. This guidance value can be implemented with regard to dust impacts from the construction of the proposed development.

The appropriate limits for the construction and operational phase assessment of air quality impacts from the proposed development are the Air Quality Regulations, which incorporate the CAFE Directive.

8.2.1.2 Gothenburg Protocol

In 1999, Ireland signed the Gothenburg Protocol to the 1979 UN Convention on Long Range Transboundary Air Pollution. The initial objective of the Protocol was to control and reduce emissions of Sulphur Dioxide (SO_2), Nitrogen Oxides (NO_X), Volatile Organic Compounds (VOCs) and Ammonia (NH_3). To achieve the initial targets Ireland was obliged, by 2010, to meet national emission ceilings of 42 kt for SO_2 (67% below 2001 levels), 65 kt for NO_X (52% reduction), 55 kt for VOCs (37% reduction) and 116 kt for NH_3 (6% reduction). In 2012, the Gothenburg Protocol was revised to include national emission reduction commitments for the main air pollutants to be achieved in 2020 and beyond and to include emission reduction commitments for $PM_{2.5}$.

European Commission Directive 2001/81/EC and the National Emissions Ceiling Directive (NECD), prescribes the same emission limits as the 1999 Gothenburg Protocol. A National Programme for the progressive reduction of emissions of these four transboundary pollutants has been in place since April 2005. The data available from the EPA in 2020 (EPA, 2020a) indicated that Ireland complied with the emissions ceilings for SO_2 but failed to comply with the ceiling for NH_3, NO_X and NMVOCs in recent years. Directive (EU) 2016/2284 "*On the Reduction of National Emissions of Certain Atmospheric Pollutants and Amending Directive 2003/35/EC and Repealing Directive 2001/81/EC*" was published in December 2016. The Directive applied the 2010 NECD limits until 2020 and established new national emission reduction commitments which will be applicable from 2020 and 2030 for SO_2, NO_X, NMVOC, NH_3, $PM_{2.5}$ and CH_4. In relation to Ireland, 2020 emission targets are 25.5kt for SO_2 (65% on 2005 levels), 66.9kt for NO_X (49% reduction on 2005 levels), 56.9kt for NMVOCs (25% reduction on 2005 levels), 112kt for NH_3 (1% reduction on 2005 levels) and 15.6kt for $PM_{2.5}$ (18% reduction on 2005 levels). In relation to 2030, Ireland's emission targets are 10.9kt (85% below 2005 levels) for SO_2, 40.7kt (69% reduction) for NO_X, 51.6kt (32% reduction) for NMVOCs, 107.5kt (5% reduction) for NH_3 and 11.2kt (41% reduction) for $PM_{2.5}$.

8.2.2 Climate

The assessment has made reference to national guidelines, where available, in addition to international standards and guidelines relating to the assessment of GHG emissions and associated climatic impact from road schemes. These are summarised below:-

- *Climate Action and Low Carbon Development Act* (Act. No. 46 of 2015);
- DCCAE (2017) *National Adaptation Plan*;
- DCCAE (2019) *Climate Action Plan 2019*;
- DCCAE (2021) *Climate Action Plan 2021;*
- *Climate Action and Low Carbon Development (Amendment) Act 2021 (No. 32 of 2021)* ('the 2021 Climate Act');
- Department of Transport, Tourism and Sport (DTTAS) (2019) *Transport – Climate Change Sectoral Adaptation Plan*;
- *Climate Action and Low Carbon Development (Amendment) Bill 2021 (No. 46 of 2015)* (hereafter referred to as the 2021 Climate Bill);
- Carlow County Council (2019) *Carlow County Council Climate Adaptation Strategy 2019 - 2024*;
- Kilkenny County Council and The Eastern & Midlands Climate Action Regional Office (2019) *Kilkenny County Council Climate Adaptation Strategy 2019 – 2024*;
- European Commission (EC) (2014) 2030 *Climate and Energy Policy Framework*;
- Transport Infrastructure Ireland (TII) (2011) *Guidelines for the Treatment of Air Quality During the Planning and Construction of National Road Schemes; and*
- *UKHA (2019) Design Manual for Roads and Bridges: LA 114 – Climate*.

8.2.2.1 International and National Guidelines, Policy and Legislation

Ireland is party to both the United Nations Framework Convention on Climate Change (UNFCCC) and the Kyoto Protocol. The Paris Agreement, which entered into force in 2016, is an important milestone in terms of international climate change agreements and includes an aim of limiting global temperature increases to no more than 2°C above pre-industrial levels with efforts to limit this rise to 1.5°C. The aim is to limit global GHG emissions to 40 gigatonnes as soon as possible whilst acknowledging that peaking of GHG emissions will take longer for developing countries. Contributions to GHG emissions will be based on Intended Nationally Determined Contributions (INDCs) which will form the foundation for climate action post 2020. Significant progress was also made in the Paris Agreement on elevating adaption onto the same level as action to cut and curb emissions.

In order to meet the commitments under the Paris Agreement, the EU enacted Regulation (EU) 2018/842 on binding annual greenhouse gas emission reductions by Member States from 2021 to 2030 contributing to climate action to meet commitments under the Paris Agreement and amending Regulation (EU) No. 525/2013 (the Regulation). The Regulation aims to deliver, collectively by the EU in the most cost-effective manner possible, reductions in GHG emissions from the Emission Trading Scheme (ETS) and non-ETS sectors amounting to 43% and 30%, respectively, by 2030 compared to 2005. Ireland's obligation under the Regulation is a 30% reduction in non-ETS greenhouse gas emissions by 2030 relative to its 2005 levels.

In 2015, the Climate Action and Low Carbon Development Act 2015 (No. 46 of 2015) (Government of Ireland, 2015) was enacted (the Act). The purpose of the Act was to enable Ireland '*to pursue, and achieve, the transition to a low carbon, climate resilient and environmentally sustainable economy by the end of the year 2050*' (3.(1) of No. 46 of 2015). This is referred to in the Act as the '*national transition objective*'. The Act made provision for, *inter alia*, a national adaptation framework. In addition, the Act provided for the establishment of the Climate Change Advisory Council with the function to advise and make recommendations on the preparation of the national mitigation and adaptation plans and compliance with existing climate obligations.

The first Climate Action Plan (CAP) was published by the Irish Government in June 2019 (Government of Ireland, 2019a). The Climate Action Plan 2019 outlined the current status across key sectors including Electricity, Transport, Built Environment, Industry and Agriculture and outlined the various broadscale measures required for each sector to achieve ambitious decarbonisation targets. The 2019 CAP also detailed the required governance arrangements for implementation including carbon-proofing of policies, establishment of carbon budgets, a strengthened Climate Change Advisory Council and greater accountability to the Oireachtas.

The Government published the second Climate action Plan in November 2021 (Government of Ireland, 2021a). The plan contains similar elements as the 2019 CAP and aims to set out how Ireland can reduce our greenhouse gas emissions by 51% by 2030 (compared to 2018 levels) which is in line with the EU ambitions, and a longer-term goal of to achieving net-zero emissions no later than 2050. The 2021 CAP outlines that emissions from the Built Environment sector must be reduced to 4–5Mt CO_2eq by 2030 in order to meet our climate targets. This will require further measures in addition to those committed to in the 2019 CAP. This will include phasing out the use of fossil fuels for the space and water heating of buildings, improving the fabric and energy of our buildings, and promoting the use of lower carbon alternatives in construction.

Following on from Ireland declaring a climate and biodiversity emergency in May 2019, and the European Parliament approving a resolution declaring a climate and environment emergency in Europe in November 2019, the Government approved the publication of the General Scheme for the Climate Action (Amendment) Bill 2019 in December 2019 (Government of Ireland 2019b) followed by the publication of the Climate Action and Low Carbon Development (Amendment) Act 2021 (No. 32 of 2021) (hereafter referred to as the 2021 Climate Act) in July 2021 (Government of Ireland, 2021b). The 2021 Climate Act was prepared for the purposes of giving statutory effect to the core objectives stated within the CAP.

The purpose of the 2021 Climate Act is to provide for the approval of plans 'for the purpose of pursuing the transition to a climate resilient, biodiversity rich and climate neutral economy by no later than the end of the year 2050'. The 2021 Climate Act will also 'provide for carbon budgets and a decarbonisation target range for certain sectors of the economy'. The 2021 Climate Act defines the carbon budget as 'the total amount of greenhouse gas emissions that are permitted during the budget period'. The 2021 Climate Act removes any reference to a national mitigation plan and instead refers to both the Climate Action Plan, as published in 2019, and a series of National Long Term Climate Action Strategies. In addition, the Environment Minister shall request each local authority to make a 'local authority climate action plan' lasting five years and to specify the mitigation measures and the adaptation measures to be adopted by the local authority.

In June 2020, the Government published the 'Programme for Government – Our Shared Future' (Government of Ireland 2020). In relation to climate, there is a commitment to an average 7% per annum reduction in overall greenhouse gas emissions from 2021 to 2030 (51% reduction over the decade) with an ultimate aim to achieve net zero emissions by 2050. In order to achieve zero emissions by 2050 an increase in renewable energy availability to the grid will be required with a target of 70% by 2030.

In relation to carbon budgets, the Climate Action and Low Carbon Development (Amendment) Act states, "*A carbon budget, consistent with furthering the achievement of the national climate objective, shall be proposed by the Climate Change Advisory Council, finalised by the Minister and approved by the Government for the period of 5 years commencing on the 1 January 2021 and ending on 31 December 2025 and for each subsequent period of 5 years (in this Act referred to as a 'budget period').*" The carbon budget is to be produced for 3 no. sequential budget periods, as shown in **Table 8.3** The carbon budget can be revised where new obligations are imposed under the law of the European Union or international agreements or where there are significant developments in scientific knowledge in relation to climate change. In relation to the sectoral emissions ceiling, the Minister for the Environment, Climate and Communications (the Minister for the Environment) shall prepare and submit to Government the maximum amount of GHG emissions that are permitted in different sectors of the economy during a budget period and different ceilings may apply to different sectors. The sectorial emission ceilings for 2030 were published July in 2022 and are shown in **Table 8.4**. Electricity has a 75% reduction required and emissions ceiling of 3 $MtCO_2e$.

Sector	Reduction Required	2018 Emissions ($MtCO_2e$)
2021-2025	295 Mt CO_2eq	Reduction in emissions of 4.8% per annum for the first budget period.
2026-2030	200 Mt CO_2eq	Reduction in emissions of 8.3% per annum for the second budget period.
2031-2035	151 Mt CO_2eq	Reduction in emissions of 3.5% per annum for the third provisional budget.

Table 8.3: 5-Year Carbon Budgets 2021-2025, 2026-2030 and 2031-2025 (Department of the Environment, Climate and Communications 2022)

Sector	Reduction Required	2018 Emissions ($MtCO_2e$)	2030 Emission Ceiling ($MtCO_2e$)
Electricity	75%	10.5	3
Transport	50%	12	6
Buildings (Commercial and Public)	45%	2	1
Buildings (Residential)	40%	7	4

Sector	Reduction Required	2018 Emissions ($MtCO_2e$)	2030 Emission Ceiling ($MtCO_2e$)
Industry	35%	7	4
Agriculture	25%	23	17.25
Other**	50%	2	1

Table 8.4: Sectoral Emission Ceiling 2030 (Department of the Environment, Climate and Communications 2022)

8.2.2.2 Local Policy and Guidelines

The *Carlow County Council Climate Change Adaptation Strategy 2019–2024* (Carlow County Council, 2019) and the *Kilkenny County Council Climate Change Adaptation Strategy 2019 – 2024* (Kilkenny County Council and The Eastern & Midlands Climate Action Regional Office, 2019) both highlight the risks that climate change poses and the role they have as organisations to bring forward the implementation of climate resilient actions in a planned and proactive manner.

Both the Carlow and Kilkenny strategies note that each county has been vulnerable to recent climatic events such as flooding, heatwaves and large storms with these risks arising from these events only increasing without appropriate intervention. The Carlow strategy is based around 9 no. thematic goals with aims of developing a planned and coordinated approach to climate adaptation. Goal No. 3 focuses on land use and development and aims to "*promote the integrated planning, design and delivery of green infrastructure*". The Kilkenny strategy is based on 5 no. adaptation goals, objectives and actions. The first goal focuses on Energy & Buildings and states the need to "*support the increase of renewable energy produced in council operations*".

8.3 Methodology

The methodology employed as part of this assessment comprised a desktop appraisal and evaluation of existing environmental conditions; the likely impacts which may arise during the construction, operational and decommissioning phases; and identification of measures to off-set or reduce likely adverse effects. The following sections set out the methodology utilised to assess air quality and climate in respect of the construction and operational phases.

8.3.1 Construction & Decommissioning Phase

8.3.1.1 Air Quality

The assessment of air quality has been carried out using a phased approach as recommended by the UK DEFRA [UK DEFRA 2016]. The phased approach recommends that the complexity of an air quality assessment be consistent with the risk of failing to achieve the air quality standards.

The current assessment thus focused firstly on identifying the existing baseline levels of NO_2 and PM_{10} in the region of the proposed development by an assessment of EPA monitoring data. Thereafter, the impact of the development during the construction and decommissioning phases of the project on air quality at the neighbouring sensitive receptors was determined by an assessment of the dust generating construction activities associated with the proposed development. The impacts of dust from the construction and decommissioning phases will be short-term in nature and are assessed at **Section 8.5.1.1** and **Section 8.5.3.1** respectively.

8.3.1.2 Air Quality - Construction Traffic & Materials

This assessment focuses on identifying the existing baseline levels of PM_{10} and $PM_{2.5}$ in the region of the proposed development by an assessment of EPA monitoring data. Thereafter, the effect of the construction phase of the proposed development on air quality was determined by a qualitative assessment of the nature and scale of dust generating construction activities associated with the proposed development based on the guidance issued by the IAQM (2014).

The UK Highways Agency guidance document *LA 105 - Air Quality* (UK Highways Agency, 2019a) states that the following scoping criteria shall be used to determine whether the air quality impacts of a project can be scoped out or require an assessment based on the changes between the 'Do-Something' traffic scenario (with the proposed development) compared to the 'Do-Minimum' traffic scenario (without the proposed development):-

- Annual average daily traffic (AADT) changes by 1,000 or more;
- Heavy duty vehicle (HDV) AADT changes by 200 or more;
- A change in speed band; and
- A change in carriageway alignment by 5m or greater.

The above scoping criteria have been used in the current assessment to determine the road links required for inclusion in the modelling assessment. The AADT and HDV AADT are, as described in detail at **Chapter 13**, below the above criteria and therefore no further impact assessment is required. Effects are considered temporary and imperceptible and do not require further assessment.

8.3.1.3 Climate – Embodied Energy Assessment

Climate change is a result of increased levels of carbon dioxide and other GHGs in the atmosphere causing the heat trapping potential of the atmosphere to increase. GHGs can be emitted from vehicles and embodied energy associated with materials used in the construction of a development. Embodied energy refers to the sum of the energy needed to produce a good or service. It incorporates the energy needed in the mining or processing of raw materials, the manufacturing of products and the delivery of these products to site. There is the potential for a number of embodied GHGs and GHG emissions during the construction phase of the development. Construction vehicles, generators etc., may give rise to CO_2 and N_2O emissions as well as the large quantities of material such as stone, concrete and steel that will be required for a project of this magnitude. The Institute of Air Quality Management document *Guidance on the Assessment of Dust from Demolition and Construction* (IAQM, 2014) states that site traffic and plant is unlikely to make a significant impact on climate. However, due to the nature of this project, climate impacts, including the embodied energy from construction materials and site vehicles, will be assessed.

Information on the material quantities and construction traffic was obtained from the Developer and project design engineers and was used in combination with the emission factors outlined in the Inventory of Carbon & Energy (Version 3.0) (University of Bath, 2019) and UK Highways Agency carbon calculator (2019) in order to calculate the predicted embodied emissions for the materials used during the construction phase of the proposed development. The carbon calculator assessment uses known embodied carbon rates (expressed as CO_2eq) for materials and their associated transport to the site. The calculator also considers personnel travel, site energy and waste management and the associated embodied energy.

8.3.1.4 Climate – Forest Loss

Forests are an important part of the global carbon cycle and effective management at a regional scale can help to reduce GHG concentrations (UK Forestry Commission, 2012). Trees have the ability to sequester carbon with the peak CO_2 uptake rate for tree stands of the order of 5–20 tonnes of CO_2/hectare/year with CO_2 uptake rates declining before stand maturity. Additionally, after afforestation on mineral soils, there will be an increase of soil carbon soon after planting of the order of 0.2–1.7 tonnes of CO_2/hectare/year (UK Forestry Commission 2012 and Intergovernmental Panel on Climate Change (IPCC) 2006). Therefore, there is the potential for the loss of up to 21.7 tonnes of CO_2/hectare/year.

Based on this analysis, the GHG emissions associated with the loss of 15 hectares as a result of the project has been assessed. However, it should be noted that the project also provides for the planting of an equivalent area of forestry which will offset the loss of carbon sink.

8.3.1.5 Climate – Turbine Manufacture Lifecycle Assessment

A lifecycle assessment was undertaken to determine the payback period for the proposed wind turbines. The wind turbine model proposed for installation at the White Hill Wind Farm is the Vestas V162-7.2. Information on the life cycle assessment undertaken for Vestas Wind Systems A/S, who are a major supplier of wind turbines, has been reviewed in order to develop a site specific lifecycle assessment for the project and is considered appropriate for a project of this type and scale (Elsam 2004, Vestas Wind Systems A/S 2013). Where site specific information was not available indicative information from the Vestas assessment was used. The life cycle assessment quantifies the associated power consumption associated with the production, operation, transport and end-of-life of the wind turbines.

The assessment also quantifies the associated GHG emissions associated with the production, operation, transport and end-of-life of the wind turbines. The energy balance associated with the wind power production during its lifetime (assumed to be 35-years) and the energy associated with the manufacturing, operation, transport, dismantling and disposal was also calculated on a site-specific basis as the energy balance is based on the expected GWh of production during its lifetime. The energy balance is expressed in terms of the time taken for the energy consumed by the turbine through its full life cycle to be repaid in terms of wind energy exported to the electricity grid.

8.3.2 Operational Phase

8.3.2.1 Air Quality

An assessment of baseline air quality in the region has been conducted to determine whether current levels of key pollutants are significantly lower than their limit values. The savings in NOx emissions arising from the production of electricity using renewable sources have been compared against those produced using non-renewable sources. The calculations were carried out using SEAI published emission rates from non-renewable energy sources. The total NO_X savings, annually and over the lifespan of the project relative to NO_X emissions from power generation, was then established to determine the overall impact of the proposed development on air quality.

As per the construction phase scoping criteria detailed in **Section 8.3.1** and LA 105 - Air Quality (UKHA, 2019), traffic effects have been scoped out of the operational phase as they are considered insignificant.

8.3.2.2 Climate

There will be no greenhouse gas emissions from the operation of the proposed wind turbines. However, due to the displacement of electricity which otherwise would have been produced from fossil fuels, there will be a net benefit in terms of GHG emissions. The savings have been calculated and compared to Ireland's 2030 commitment target for gross electricity consumption from renewable energy sources.

Vehicular traffic is often a dominant source of GHG emissions as a result of proposed developments. However, there is no predicted significant operational phase vehicle effect due to the relatively low volume of vehicles required during operation.

8.4 Description of the Existing Environment

8.4.1 Meteorological Data

A key factor in assessing temporal and spatial variations in air quality is the prevailing meteorological conditions. Depending on wind speed and direction, individual receptors may experience very significant variations in pollutant levels under the same source strength (i.e. traffic levels) (WHO 2006). Wind is of key importance in dispersing air pollutants and for ground level sources, such as traffic emissions, pollutant concentrations are generally inversely related to wind speed. Thus, concentrations of pollutants derived from traffic sources will generally be greatest under very calm conditions and low wind speeds when the movement of air is restricted. In relation to PM_{10}, the situation is more complex due to the range of sources of this pollutant. Smaller particles (less than $PM_{2.5}$) from traffic sources will be dispersed more rapidly at higher wind speeds. However, fugitive emissions of coarse particles ($PM_{2.5}$–PM_{10}) will actually increase at higher wind speeds. Thus, measured levels of PM_{10} will be a non-linear function of wind speed.

The nearest representative weather station collating detailed weather records is Oak Park Meteorological Station, Co. Carlow, which is located approximately 17km north-east of the site. Data from the Oak Park Meteorological Station has been examined to identify the prevailing wind direction and average wind speeds over the period 2017-2021 (see **Figure 8.1**). Wind frequency is important as dust can only be dispersed by winds, and deposition of dust is a simple function of particle size, wind speed and distance. The closer the source of dust is to a receptor the higher the potential risk of impact of dust blow. The prevailing winds in the area are southerly in direction, thereby predominantly dispersing any potential dust emissions to the north of the site.

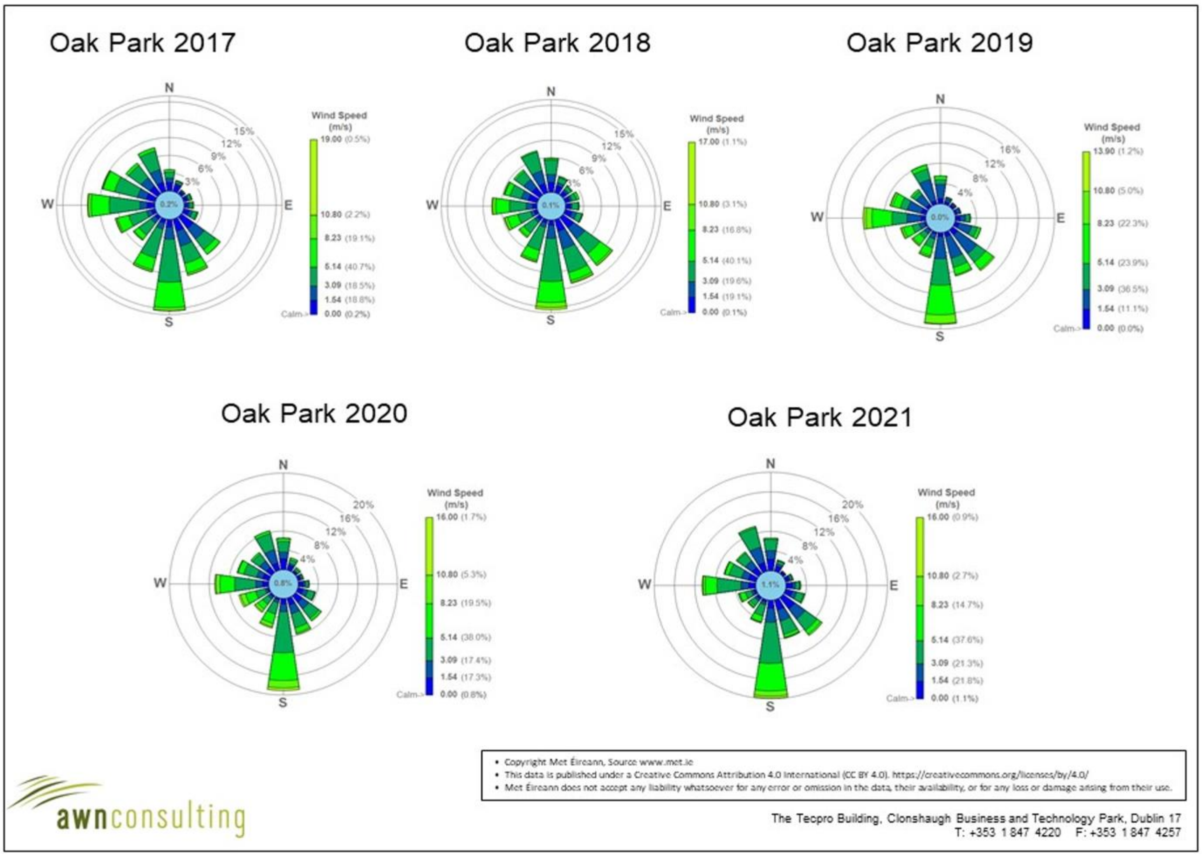

Figure 8.1: Oak Park Windroses 2017 – 2021 (Met Éireann, 2022)

Dust emissions are dramatically reduced where rainfall has occurred due to the cohesion created between dust particles and water and the removal of suspended dust from the air. It is typical to assume that no dust is generated under 'wet day' conditions where rainfall greater than 0.2mm has fallen. Long-term information collected from Kilkenny Meteorological Station (the closest representative station with long-term historical data) identified that typically 193-days per annum are 'wet' (Met Eireann 2022, 30-year averages). Thus, in excess of 50% of the time no significant dust generation will be likely due to meteorological conditions.

8.4.2 Review of EPA Monitoring Data

Dust is present naturally in the air from a number of sources including weathering of minerals, pick-up across open land, and dust generated from fires. Monitoring of dust deposition is not undertaken in the vicinity of the project and therefore background levels for the immediate vicinity of the proposed development site are not available.

However, a study by the United Kingdom Office of the Deputy Prime Minister (UK ODPM, 2002) gives estimates of likely dust deposition levels in specific types of environments. In open country, a level of 39mg/(m^2*day) is typical, rising to 59mg/(m^2*day) on the outskirts of towns, and peaking at 127mg/(m^2*day) for a purely industrial area. A level of 39mg/m^2*day can be estimated as the background dust deposition level for the project due to its rural location.

Air quality monitoring programmes have been undertaken in recent years by the EPA. The most recent annual report on air quality in Ireland is "*Air Quality In Ireland 2021*" (EPA, 2022a). The EPA website details the range and scope of monitoring undertaken throughout Ireland and provides both monitoring data and the results of previous air quality assessments (EPA, 2022b).

As part of the implementation of the Air Quality Standards Regulations 2011 (S.I. No. 180 of 2011), as amended, four air quality zones have been defined in Ireland for air quality management and assessment purposes (EPA, 2022b). Dublin is defined as Zone A and Cork as Zone B. Zone C is composed of 23 no. towns with a population of greater than 15,000. The remainder of the country, which represents rural Ireland but also includes all towns with a population of less than 15,000, is defined as Zone D.

In terms of air monitoring and assessment, the project is within Zone D (EPA, 2022b). Long-term monitoring data has been used to determine background concentrations for the key pollutants at the project site. It should be noted that background concentration accounts for all non-traffic derived emissions (e.g. natural sources, industry, home heating etc.).

In 2020, the EPA reported (EPA, 2021) that Ireland was compliant with EU legal air quality limits at all locations; however this was largely due to the reduction in traffic due to Covid - 19 restrictions. The EPA *Air Quality in Ireland 2020* report details the effect that the Covid-19 restrictions had on air monitoring stations, which included reductions of up to 50% at some monitoring stations which have traffic as a dominant source. 2020 concentrations are therefore predicted to be an exceptional year and not consistent with long-term trends. The EPA *Air Quality in Ireland 2021* report details a return to pre COVID-19 traffic levels where monitoring stations had traffic as a dominant source and as such, is once again can be used to determine baseline levels of pollutants in the vicinity of the proposed development.

NO_2 monitoring was carried out at two rural Zone D locations over the period 2016-2021, Emo and Kilkitt, and the urban site of Castlebar (EPA 2022a). Over the 2016–2021 period, annual mean concentrations ranged from 2–5µg/m^3 for the rural sites and 6–9µg/m^3 for the urban site (**Table 8.5**). Hence, long-term average concentrations measured at all locations were significantly lower than the annual average limit value of 40µg/m^3. The hourly limit value of 200µg/m^3 was not exceeded in any year, albeit 18 no. exceedances are permitted per year. The average results over the last 6-years at the rural Zone D locations suggest an upper average of no more than 3.4µg/m^3 as a background concentration. Based on the above information, a conservative estimate of the background NO_2 concentration in the region of the proposed development is 4µg/m^3.

Station	Averaging Period Notes 1, 2	Year					
		2016	2017	2018	2019	2020	2021
Castlebar	Annual Mean NO_2 (µg/m^3)	9	7	8	8	6	6
	99.8th %ile 1-hr NO_2 (µg/m^3)	66	60	60	59	76	73
Kilkitt	Annual Mean NO_2 (µg/m^3)	3	2	3	5	2	2
	99.8th %ile 1-hr NO_2 (µg/m^3)	26.1	17.0	22.3	42.3	18	-
Emo	Annual Mean NO_2 (µg/m^3)	4	3	3	4	4	4
	99.8th %ile 1-hr NO_2 (µg/m^3)	35.5	27.5	41.6	27.8	38	64

Note 1 Annual average limit value - 40 µg/m^3 (EU Council Directive 2008/50/EC & S.I. No. 180 of 2011).

Note 2 Hourly limit value - 200 µg/m³ measured as a 99.8th percentile (EU Council Directive 2008/50/EC & S.I. No. 180 of 2011).

Table 8.5: Trends in Zone D Air Quality – Nitrogen Dioxide (NO_2)

Long-term PM_{10} monitoring was carried out at the Zone D locations of Castlebar, Kilkitt, and Claremorris over the period 2016–2021 (EPA, 2022a). Annual mean concentrations range from 10–16µg/m³ for the urban sites and 7–9µg/m³ for the rural site at Kilkitt (**Table 8.6**). Hence, long-term average PM_{10} concentrations measured at these locations were significantly lower than the annual average limit value of 40µg/m³. Data for the rural site at Kilkitt suggests an upper average annual mean of no more than 8.2µg/m³ as a background value. Based on the above data, a conservative estimate of the current background PM_{10} concentration in the region of the proposed development is 10µg/m³.

Station	Averaging Period Notes 1, 2	Year					
		2016	2017	2018	2019	2020	2021
Castlebar	Annual Mean PM_{10} (µg/m³)	12	11	11	16	14	10
	24-hr Mean > 50 µg/m³	1	1	0	1	2	0
Kilkitt	Annual Mean PM_{10} (µg/m³)	8	8	9	7	8	8
	24-hr Mean > 50 µg/m³	0	0	0	1	0	0
Claremorris	Annual Mean PM_{10} (µg/m³)	10	11	12	11	10	10
	24-hr Mean > 50 µg/m³	0	1	0	0	0	1

Note 1 Annual average limit value - 40 µg/m³ (EU Council Directive 2008/50/EC & S.I. No. 180 of 2011).

Note 2 Daily limit value - 50 µg/m³ measured as a 90.4th percentile (EU Council Directive 2008/50/EC & S.I. No. 180 of 2011).

Table 8.6: Trends in Zone D Air Quality – PM_{10}

The results of $PM_{2.5}$ monitoring at Claremorris over the period 2016–2021 ranged from 4–8µg/m³ (EPA, 2022a), with an average $PM_{2.5}/PM_{10}$ ratio between 0.4–0.8. Long-term average $PM_{2.5}$ concentrations measured at this location were significantly lower than the annual average limit value of 25µg/m³. Based on this information, a ratio of 0.7 was used to generate a rural background $PM_{2.5}$ concentration of 7µg/m³.

In summary, existing baseline levels of NO_2, PM_{10} and $PM_{2.5}$ based on extensive long-term data from the EPA are well below ambient air quality limit values in the vicinity of the project.

8.4.2.1 Sensitivity of the Receiving Environment

In accordance with the UK Institute of Air Quality Management (IAQM) guidance document *Guidance on the Assessment of Dust from Demolition and Construction* (2014), prior to assessing the effect of dust from a project, the sensitivity of the area must first be assessed as outlined below. Both receptor sensitivity and proximity to construction works areas are taken into consideration. For the purposes of this assessment, high sensitivity receptors are regarded as residential properties where people are likely to spend the majority of their time. Commercial properties and places of work are regarded as medium sensitivity, while low sensitivity receptors are places where people are present for short periods or do not expect a high level of amenity.

In terms of receptor sensitivity to dust soiling, there are approximately 60 no. high sensitivity residential properties within 50m of the project (e.g. wind farm, access tracks, site entrances, grid connection route, forestry re-plant lands); the vast majority of which are located along the grid conenction route.

Due to the linear nature of the grid connection works, not all properties will be impacted at once, therefore it is considered that there will be more than 10 no. but less than 100 no. receptors affected at any given time. The worst-case sensitivity of the area to dust soiling is considered medium as per **Table 8.7**.

Receptor Sensitivity	Number Of Receptors	Distance from source (m)			
		<20	<50	<100	<350
High	>100	High	High	Medium	Low
	10-100	High	**Medium**	Low	Low
	1-10	Medium	Low	Low	Low
Medium	>1	Medium	Low	Low	Low
Low	>1	Low	Low	Low	Low

Source: Guidance on the Assessment of Dust from Demolition and Construction (IAQM, 2014)

Table 8.7: Sensitivity of the Area to Dust Soiling Effects on People and Property

In addition to sensitivity to dust soiling, the IAQM guidelines also outline the assessment criteria for determining the sensitivity of the area to human health effects. The criteria take into consideration the current annual mean PM_{10} concentration, receptor sensitivity and the number of receptors affected within various distance bands from the construction works. A conservative estimate of the current annual mean PM_{10} concentration in the vicinity of the proposed development is 10μg/m^3. The worst-case sensitivity of the area to human health impacts is considered low as per **Table 8.8**.

Receptor Sensitivity	Annual Mean PM_{10} Concentration	Number Of Receptors	Distance from source (m)			
			<20	<50	<100	<200
High	< 24 μg/m^3	>100	Medium	Low	Low	Low
		10-100	Low	**Low**	Low	Low
		1-10	Low	Low	Low	Low
Medium	< 24 μg/m^3	>10	Low	Low	Low	Low
		1-10	Low	Low	Low	Low
Low	< 24 μg/m^3	>1	Low	Low	Low	Low

Source: Guidance on the Assessment of Dust from Demolition and Construction (IAQM, 2014)

Table 8.8: Sensitivity of the Area to Human Health Impacts

The IAQM guidelines also outline the assessment criteria for determining the sensitivity of the area to ecological effects from dust. The criteria takes into consideration whether the receiving environment is classified as a Special Area of Conservation (SAC), a Special Protected Area (SPA), a Natural Heritage Area (NHA) or a proposed Natural Heritage Area (pNHA) or whether the site is a local nature reserve or home to a sensitive plant or animal species. The project site is not located in the immediate vicinity of any such designated site therefore there is no likelihood of effects.

8.4.3 Climate

8.4.3.1 Climate Pollutants

Climate is defined as the average weather over a period of time, whilst climate change is a significant change to the average weather. Climate change is a natural phenomenon but in recent years human activities, through the release of GHGs, have impacted on the climate (Intergovernmental Panel on Climate Change (IPCC) 2015). The release of anthropogenic GHGs is altering the Earth's atmosphere resulting in a 'Greenhouse Effect'. This effect is causing an increase in the atmosphere's heat trapping abilities resulting in increased average global temperatures over the past number of decades. The release of carbon dioxide (CO_2) as a result of burning fossil fuels, has been one of the leading factors in the creation of this 'Greenhouse Effect'. The most significant GHGs are CO_2, methane (CH_4) and nitrous oxide (N_2O).

For the purposes of this assessment, the definition outlined in Council Directive 2009/28/EC on the promotion of the use of energy from renewable sources and amending and subsequently repealing Directives 2001/77/EC and 2003/30/EC (European Parliament and Council of Europe 2009) for GHGs has been used. In 'Annex V, C. Methodology Point 5' the relevant GHGs are defined as CO_2, CH_4 and N_2O. CO_2 accounted for 60.9% of total GHG emissions in Ireland in 2020 while CH_4 and N_2O combined accounted for 37.7%. The main source of CH_4 and N_2O are from the agriculture (37.1%) sector.

GHGs have different efficiencies in retaining solar energy in the atmosphere and different lifetimes in the atmosphere. In order to compare different GHGs, emissions are calculated on the basis of their Global Warming Potential (GWPs) over a 100-year period, giving a measure of their relative heating effect in the atmosphere. The Intergovernmental Panel on Climate Change (IPCC) 5th assessment report (AR5) (IPCC 2015) sets out the global warming potential for 100-year time period (GWP100) for CO_2 as the basic unit (GWP = 1) whereas methane gas (CH_4) has a global warming potential equivalent to 28 units of CO_2 and N_2O has a GWP100 of 265.

8.4.3.2 Baseline Climate

Anthropogenic emissions of greenhouse gases in Ireland included in the EU 2020 strategy are outlined in the most recent review by the EPA which details provisional emissions up to 2020 (EPA, 2021b). The data published in 2021 states that Ireland will exceed its 2020 annual limit set under the EU's Effort Sharing Decision (ESD), 406/2009/EC1 by an estimated 6.73Mt. For 2021, total national greenhouse gas emissions are estimated to be 57.70 million tonnes carbon dioxide equivalent (Mt CO_2eq) with 44.38Mt CO_2eq of emissions associated with the ESD sectors for which compliance with the EU targets must be met. Agriculture is the largest contributor in 2021 at 37.1% of the total, with the transport sector accounting for 17.9% of emissions of CO_2.

GHG emissions for 2020 are estimated to be 3.6% lower than those recorded in 2019. Emission reductions have been recorded in 6 of the last 10 years. However, compliance with the annual EU targets has not been met for five years in a row. Emissions from 2016 – 2020 exceeded the annual EU targets by 0.29 MtCO_2eq, 2.94Mt CO_2eq, 5.57Mt CO_2eq, 6.85Mt CO_2eq and 6.73Mt CO_2eq respectively. Agriculture is consistently the largest contributor to emissions with emissions from the transport and energy sectors being the second and third largest contributors respectively in recent years.

The EPA 2022 GHG Emissions Projections Report for 2021–2040 (EPA, 2022) provides an assessment of Ireland's total projected greenhouse gas (GHG) emissions from 2021 to 2040, using the latest Inventory data for 2020 and provides an assessment of Ireland's progress towards achieving its National ambitions under the Climate Action and Low Carbon Development (Amendment) Act 2021 (Government of Ireland, 2021) and EU emission reduction targets for 2030 as set out under the EU Effort Sharing Regulation (ESR) 2018/842. Two scenarios are assessed – a "*With Existing Measures*" (WEM) scenario, which is a projection of future emissions based on the measures currently implemented and actions committed to by Government, and a "*With Additional Measures*" (WAM) scenario, which is the projection of future emissions based on the measures outlined in the latest Government plans at the time Projections are compiled. This includes all policies and measures included in the WEM scenario, plus those included in government plans but not yet implemented.

The EPA report states under the "*With Existing Measures*" scenario, the projections indicate that Ireland will cumulatively exceed its ESR emissions allocation by 52.3Mt CO2eq over the 2021-2030 period even with full use of the flexibilities available. Under the "*With Additional Measures scenario*", the projections indicate that Ireland can achieve compliance under the ESR over the 2021-2030 period using both flexibilities but only with full implementation of the 2021 Climate Action Plan. Both projected scenarios indicate that implementation of all climate plans and policies, plus further new measures, are needed for Ireland to meet the 51% emissions reduction target and put the country on track for climate neutrality by 2050 (EPA, 2022).

8.5 Description of Likely Effects

8.5.1 Construction Phase

8.5.1.1 Air Quality

In terms of air quality, the greatest likelihood of effects during the construction stage will be from dust emissions associated with the construction works. The key works likely to be associated with dust emissions include earthworks and excavation activities, construction of hardstanding areas and movement of vehicles on and off site.

During construction, the primary source of dust emissions likely to affect sensitive receptors will be movement of vehicles on and off site. Materials with the highest likelihood of dust emissions will be concrete and aggregates for the construction of the hardstanding areas and access tracks.

Earthworks will result in some dust emissions, particularly during excavations. However, the majority of properties are located a significant distance from the most extensive excavations (e.g. turbine foundations); while works to be undertaken at closer proximity to properties are of a reduced scale (e.g. site entrances) and/or of a transitory nature (e.g. grid connection). The magnitude of dust emissions according to IAQM guidance (IAQM 2014) is Large; and when combined with the previously established sensitivity of the area (Medium sensitivity to dust soiling, Low sensitivity in terms of human health impacts), there is a likelihood of adverse dust effects. The likelihood of a significant nuisance arising from dust effects as a result of earthworks, prior to mitigation is, Medium. With respect to human health effects, the likely effect is assessed to be Low (see **Table 8.9**).

Sensitivity of Area	Dust Emission Magnitude		
	Large	Medium	Small

High	High Risk	Medium Risk	Low Risk
Medium	Medium Risk	Medium Risk	Low Risk
Low	Low Risk	Low Risk	Negligible

Table 8.9: Likelihood of Dust Effects - Earthworks

Construction works taking place within the wind farm site will result in some dust emissions. However, the majority of properties which border the site are a significant distance from the actual works areas. Work areas that are in closer proximity to sensitive receptors along the grid connection route will have more limited activities and short construction periods. The magnitude of dust emissions according to IAQM guidance (IAQM 2014) is Small; and when combined with the previously established sensitivity of the area (Medium sensitivity to dust soiling, Low sensitivity in terms of human health), there is a likelihood of adverse dust effects. The likelihood of significant nuisance dust effects as a result of construction, prior to mitigation, is Low. With respect to human health effects, the likely effect is assessed as Negligible (**Table 8.10**).

Sensitivity of Area	Dust Emission Magnitude		
	Large	Medium	Small
High	High Risk	Medium Risk	Low Risk
Medium	Medium Risk	Medium Risk	Low Risk
Low	Low Risk	Low Risk	Negligible

Table 8.10: Likelihood of Dust Effects – Construction

The likelihood of trackout for vehicles leaving the site has also been assessed. According to the IAQM guidance (2014), the number of one-way vehicle movements per day is classified as Large in terms of potential dust emission magnitude. While there will, on average, be c. 21 no. HGVs per day; this will increase to c. 100 no. per day during the concrete pours for turbine foundation construction. As a result, a worst case Large classification has been selected for this assessment.

When combined with the previously established sensitivity of the area (Medium sensitivity to dust soiling, Low sensitivity in terms of human health impacts) the likelihood significant nuisance dust effects, prior to mitigation, is Medium with the overall likelihood of human health impacts predicted to be Low (see **Table 8.11**).

Sensitivity of Area	Dust Emission Magnitude		
	Large	Medium	Small
High	High Risk	Medium Risk	Low Risk
Medium	Medium Risk	Medium Risk	Low Risk
Low	Low Risk	Low Risk	Negligible

Table 8.11: Likelihood of Dust Effects - Trackout

8.5.1.2 Climate

Construction Materials & Forestry

The construction phase of the project will result in a number of GHG emissions from various sources. Embodied carbon is carbon dioxide emitted during the manufacture, transport and construction of building materials, together with end-of-life emissions. In terms of this project, construction stage embodied GHG emissions are categorised under the following headings:-

- Manufacture of materials
- Materials transport to site; and
- Construction works (including personnel travel and project size).

Detailed project information including volumes of materials was obtained from the Developer and project design engineers for the purposes of this assessment. For the purposes of this assessment, it is has been assumed that concrete will be sourced from Roadstone Bennettsbridge (30km) and aggregates will be sourced from Kilcarrig Quarries Limited (15km); however, other quarries (see **Chapter 2**) may also need to be utilised to source materials during the construction stage.

The selected quarries have been chosen to provide an estimate of the distance likely to be travelled to the wind farm site for materials. Approximately 73,700m^3 of rock and fill material will be required for the construction phase (e.g. hardstanding areas, access tracks, substation compound, temporary construction compound, grid connection, and haul route upgrades); with c. 56,000m^3 of this material being sourced from on-site excavations and the balance, c. 17,700m^3, being imported from local quarries. It is estimated that 10,657m^3 of concrete will be required in the construction of the project (e.g. turbine foundations, electricity substation, grid connection, and haul route upgrades).

Table 8.12 details the embodied carbon emissions associated with each category. The project is expected to have a construction phase of approximately 15-18 months and an operational lifespan of 35-years. The predicted embodied emissions can be averaged over the full construction phase and the lifespan of the project to give the predicted annual emissions to allow for direct comparison with national annual emissions and targets. Emissions have been compared against the total national GHG emissions in Ireland for 2020 (57,716,000 tonnes CO_2eq) and against Ireland's EU 2030 target of a 30% reduction in non-ETS sector emissions based on 2005 levels (33.3Mt CO_2eq) (set out in Regulation EU 2018/842 of the European Parliament and of the Council).

The GHG emissions associated with the loss of 15ha of forestry has been calculated and amounts to an upper limit of 326 tonnes of CO_2. The forestry comprises primarily conifer plantation and small pockets of woodland. This is an indirect effect and is classified as a temporary, negative, imperceptible effect. Any emissions due to forestry loss will be offset by the replanting the equivalent area of forestry.

The total construction phase embodied emissions totals 4,485 tonnes CO_2eq; which equates to 0.008% of Ireland national GHG emissions in 2020 or 0.013% of Ireland's 2030 GHG emission target. The likely effect on climate during the construction phase is, therefore, short-term and negative, but not significant. However, the proposed development involves the erection of 7 no. wind turbines with a generation capacity of c. 150GWh. Therefore, the embodied carbon due to the construction phase will be offset in the operational stage as a result of the generation of renewable electricity.

	Construction Phase Embodied Emissions (tonnes CO_2eq)
Manufacture of materials, transport and construction works	4,159
Emissions from forestry loss	326[Note 1]
Total Construction Phase Emissions	4,485
Total Annual Emissions as % of Irelands Total GHG emissions (2020 actual)	0.008%
Total Annual Emissions as % of Irelands 2030 GHG emission target	0.013%

[Note 1] *Emissions from forestry loss will be offset by replanting the equivalent area of forestry*

Table 8.12: Predicted Construction Stage GHG Emissions

Wind Turbine Manufacture

The project will involve the erection of 7 no. wind turbines with an export capacity of 50.4MW. For the purposes of this assessment, a capacity factor for wind generation of 34% was used, based on future capacity factors for wind farms in this region provided in the EirGrid report "*Enduring Connection Policy 1 Constraints Report for Area A Solar and Wind*" (EirGrid, 2020). On this basis, the expected electricity production is c. 150,111MWh per annum.

Information on the life cycle assessment undertaken for Vestas Wind Systems A/S, who are a major supplier of wind turbines, has been reviewed (Elsam 2004, Vestas Wind Systems A/S 2013). Using the data contained in the life cycle assessments, a site-specific assessment of the energy balance for the subject project has been undertaken:-

- Annual expected MWh production = 150,111MWh/Year;
- Expected GWh production during lifetime (35-years) = 5,254GWh;
- Expected Energy Consumed / Turbine Life Cycle = 3,636MWh;
- Total Energy Consumed / 7 no. Turbines Life Cycle = 25,452MWh;
- Energy balance assessment period = 35-years ; and
- Energy balance = (25,452MWh/5,253,898MWh)*420 months = 2.03-months.

Thus, the site-specific energy balance gives a payback period for the wind turbines of approximately 2.03 months.

8.5.2 Operational Phase

8.5.2.1 Air Quality

The assessment of baseline air quality in the region of the project has shown that current levels of key pollutants are significantly lower than their limit values. Due to the size, nature and remote location of the project, the minor associated increase in road traffic emissions is assessed as having an imperceptible effect on air quality during the operational phase. The grid connection element of the project will have a neutral impact on air quality during the operational phase as it will be buried underground and there will be no significant operational emissions associated with it.

As described above, the power generation from the project is assessed to be approximately 150GWh per annum. The supply of c. 150GWh of renewable electricity to the national grid will lead to a net saving in terms of NO_X emissions which may have been emitted from fossil fuels to produce electricity. Results, outlined in **Table 8.13**, indicate that the effect of the project on Ireland's obligations under the Gothenburg

Protocol and the Directive (EU) 2016/2284 targets are positive. The annual impact of the project is to decrease annual NO_X emission levels by 0.4% of the ceiling levels (relative to the NO_X emissions associated with power generation in Ireland 2019 (EPA, 2021)). The total NO_X emissions savings over its 35-year life-span will amount to 1052.4 tonnes of NO_X which is equivalent to 12.78% of the total NO_X emissions from power generation in 2019. This is assessed as a slight positive, long-term effect on air quality.

Scenario	NOX (tonnes/annum)
Emissions Saved Due To Wind Farm Note 1	30.1
National Emission Ceiling Note 2	66,913
Positive Impact of Wind farm (%) (as a percentage of National Emission Ceiling on an annual basis)	0.4%
Total NOX Saving (%) Over 35-Years Relative To NOX Emissions From Power Generation in 2019	12.78%

Note 1 For NO_X emissions associated with power generation in Ireland (taken from EPA (2021) Ireland's Air Pollutant Emissions 1990-2030

Note 2 National Emission Ceiling (EU Directive 2016/2284) applicable from 2020

Table 8.13: Predicted Impact of White Hill Wind Farm on Ireland's National Emissions Ceiling Obligations

8.5.2.2 Climate

During the operational phase, there will be no GHG emissions from the operation of the project. However, due to the displacement of c. 150GWh of electricity per annum which would otherwise have been produced from fossil fuels, there will be a net benefit in terms of GHG emissions.

The reduction in GHG emissions, as a result of this project, will be imperceptible in terms of Ireland's obligations under the European Union's Effort Sharing Regulation (Regulation 2018/842); however, as stated above, the generation of c. 150GWh of renewable electricity to the national grid will result in a net saving in terms of GHG emissions. The Climate Action Plan (Government of Ireland, 2021) states a RES-E target of 70% by 2030 with wind energy being the primary source in achieving this target.

In order to calculate the net benefit in terms of GHG emissions, the GHG emissions from the average fossil fuel electricity mix in 2020 has been calculated (**Table 8.14**). The production of wind energy for export to the national grid transforms the project from negative in terms of GHGs (associated with embodied energy from construction) to having a net positive annual impact on GHG emissions of the order of 0.095% of the annual Total GHG Emissions in Ireland in 2019. The total annual GHG emission savings will amount to approximately 55,039 tonnes of CO_2eq which over 35-years is equivalent to 16.11% of the total predicted annual GHG emissions from the energy sector in 2020 (EPA, 2019). This is a slight, positive, long-term effect on climate.

	CO_2	N_2O	CH_4	% Of Irelands Total Emissions[(1)]
CCGT Producing 150 GWh (tonnes)	54,941	2.16 [(4)]	16.21 [(4)]	-
CCGT Producing 150 GWh (tonnes CO_2 Equivalent)	54,941	572.8	372.9	-
Total Energy Consumed During Manufacture (inc forestry removal) / Disposal of 7 Wind Turbines (averaged over 35 years)[(3)] (tonnes CO_2 Equivalent)	266			-
Total / Annum (tonnes CO_2 Equivalent) Savings Due To Wind farm	55,039			0.095%
Total GHG Saving (%) Over 35-Years Relative To GHG Emissions From Power Generation in 2020[(2)]	16.11%			-

(1) Based on an electricity generation of 0.325 tonnes CO_2/MWh (EPA, 2020b) and Irelands total 2019 GHG emissions

(2) Estimated GHG Emissions From Energy Sector (With Measures) of 13.3 Mtonnes in 2020.

(3) Based on ((148,920 x 0.325)/30)

(4) N_2O & CH_4 based on Volume 2 Table 2.2 of IPCC Guidelines (2006)

Table 8.14 GHG Benefit from Proposed Development as A Result of Exporting 150GWh per annum

8.5.3 Decommissioning Phase

8.5.3.1 Air Quality

The decommissioning phase will involve the removal of the project infrastructure. Vehicles and generators associated with the removal of infrastructure are likely to result in a temporary negative impact on local air quality. However, due to the short-term nature of any associated works and low background pollutant concentrations in the vicinity of the project site, decommissioning is assessed as likely to have an imperceptible, temporary, negative impact on local air quality.

8.5.3.2 Climate

Similar to the air quality effect, vehicles related to the decommissioning phase will give rise to CO_2 and N_2O emissions. It is not assessed as likely that the decommissioning phase will involve the use of a significant number of vehicles, with a significantly lesser number of vehicles required than during the construction phase. Therefore, emissions from vehicular traffic are likely to be negligible. Decommissioning will be undertaken in accordance with the methods set out at **Chapter 3** and, given the significant potential for recycling of materials, the climatic impact will likely be temporary and imperceptible.

8.5.4 Cumulative Effects

During the construction and decommissioning phases, there is potential for cumulative effects to arise in relation to dust. This effect is only likely to arise these phases of the project run concurrently with the construction of another project.

However, while significant cumulative effects are not assessed as likely to occur; following the implementation of the measures set out at **Section 8.6**, dust emissions from the project will be wholly contained within the project site and are unlikely, in combination with other construction activities, to adversely affect sensitive receptors.

During the operational phase, it is assessed that there is no likelihood of significant adverse cumulative effects. The project will, in combination with other wind energy developments, result in long-term beneficial effects on both air quality and climate.

8.6 Mitigation & Monitoring Measures

The preceding sections have determined that the project is not assessed as likely to result in any significant adverse impacts on air quality and climate. Notwithstanding this, and in order to sufficiently ameliorate the effects which are likely to arise, a schedule of air quality control measures has been formulated for both the construction and operational phases of the proposed development. It should be noted that measures implemented during the construction phase are also relevant for the decommissioning phase.

Specific mitigation measures, additional to best practice methods, are not proposed in relation to climate as the project will result in a net benefit in the abatement of GHGs.

8.6.1 Construction Phase

8.6.1.1 Air Quality

The greatest likelihood of effects on air quality during the construction and decommissioning phases is from dust emissions and nuisance dust. In order to minimise dust emissions during construction, a series of mitigation measures have been prepared in the form of an outline Dust Management Plan (see **Annex 8.2**).

A detailed Dust Management Plan will be formulated prior to the construction phase of the project, and will include the following:-

- Access tracks and public roads in the vicinity of the site shall be regularly cleaned to remove mud, aggregates and debris and maintained as appropriate. All road sweepers shall be water assisted;
- Any road that has the potential to give rise to fugitive dust shall be regularly watered, as appropriate, during dry and/or windy conditions;
- Public roads in the vicinity of the site shall be regularly inspected for cleanliness and cleaned as necessary;
- In the event of dust nuisance occurring outside the site boundary, movement of materials will be immediately terminated and satisfactory procedures implemented to rectify the problem before the resumption of operations;
- If issues persist and the above measures are not satisfactorily controlling dust emissions, a wheel washing system with rumble grids to dislodge accumulated dust and mud prior to leaving the site should be installed;
- During movement of materials both on and off-site, trucks will be stringently covered with tarpaulin at all times. Before entrance onto public roads, trucks will be adequately inspected to ensure no potential for dust emissions;
- Material handling systems and site stockpiling of materials will be designed and laid out to minimise exposure to wind. Water misting or sprays will be used as required if particularly dusty activities are necessary during dry or windy periods; and

- The Dust Management Plan shall be reviewed at regular intervals during the construction phase to ensure the effectiveness of the procedures in place and to maintain the goal of minimisation of dust through the use of best practice and procedures.

At all times, these procedures will be strictly monitored and assessed. In the event of dust nuisance occurring outside the site boundary, movements of materials likely to raise dust will be curtailed and satisfactory procedures implemented to rectify the problem before the resumption of construction operations.

8.6.1.2 Climate

Construction related plant, machinery and vehicles, generators etc., may give rise to some CO_2 and N_2O emissions. However, due to the short-term and temporary nature of these works, the impact on climate will not be significant. Best practice construction methods including just in time delivery methods to prevent material waste, reuse of on-site materials, where possible; and the minimisation of fuel use, including generators, will reduce construction related climate emissions.

8.6.2 Operational Phase

8.6.2.1 Air Quality

The project will not result in any significant adverse air quality effects during the operational phase and no mitigation measures are proposed. Effects on local air quality as a result of emissions associated with site maintenance vehicles are predicted to be neutral and imperceptible in the long-term as the number of vehicles is predicted to be low and infrequent in nature.

8.6.2.2 Climate

The project will have a positive and beneficial effect on climate through the reduction of GHG emissions associated with energy generation and will make a substantial contribution to Ireland's GHG abatement commitments. Thus, no mitigation measures are necessary in terms of the operational phase.

8.6.3 Decommissioning Phase

Measures similar to those implemented during the construction phase will also be implemented during the decommissioning phase.

8.7 Residual Effects

8.7.1 Construction & Decommissioning Phase

8.7.1.1 Air Quality

With effective implementation of the Dust Management Plan, outlined in **Section 8.6.1** and **Annex 8.2**, the project is assessed as likely to have an imperceptible effect on air quality during the construction and decommissioning phases.

8.7.1.2 Climate

No significant residual impacts from the proposed development are assessed as likely for the construction or decommissioning phases as any effects will be off-set during the operational phase.

8.7.2 Operational Phase

8.7.2.1 Air Quality

No significant residual effects from the project are assessed as likely for the operational phase.

8.7.2.2 Climate

No significant adverse residual effects from the project are assessed as likely for the operational phase. Residual effects are assessed to be positive and long term due to the production of 150GWh of renewable electricity per annum which will lead to a net saving in terms of CO_2 emissions which may have been emitted from fossil fuels to produce electricity.

8.8 Summary

An assessment of the likely air quality and climate effects associated with the project has been undertaken. The project will comprise 7 no. wind turbines with an export capacity of 50.4MW. The wind farm design life is 35-years after which the turbines will be decommissioned. The assessment of baseline air quality in the region has shown that current levels of key pollutants are significantly lower than their limit values.

During the construction phase of the project, appropriate mitigation measures will be implemented to minimise any likely adverse effects on air quality and climate. During the operational phase, the project will result in a long term positive effect on both air quality and climate. The annual generation of c. 150GWh of electricity from the project will lead to a net saving in terms of greenhouse gas emissions. The production of this renewable electricity results in the project having a net positive annual effect on GHG emissions of the annual Total GHG Emissions in Ireland in 2020

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